Knowledge acquisition to address skills challenges in UK construction industry

Sivagayinee Ganeshamoorthy
PhD Student, Department of Build and the Environment, Birmingham City University, UK
(Sivagayinee.Ganeshamoorthy@bcu.ac.uk)
Niraj Thurairajah
Senior Lecturer, Department of Build and the Environment, Birmingham City University, UK
(Niraj.Thurairajah@bcu.ac.uk)
Melvyn Lees
Faculty Dean, Department of Build and the Environment, Birmingham City University, UK
(Melvyn Lees@bcu.ac.uk)

Abstract

The successful implementation of new technologies plays a major role in the economic growth of the country. Building Information Modelling (BIM) is considered to be one of the most recent technologies introduced within the Architecture, Engineering and Construction (AEC) industry. However people who are involved in BIM based construction projects are struggling to achieve their project outcomes due to not having enough knowledge and skills to work with this new technology. The main aim of the paper is to explore how knowledge can be distributed among the project participants to acquire the appropriate knowledge and skills during the implementation of new technologies. Connectivism theory has been adopted in this study to understand the distribution of knowledge and the learning process in the BIM construction projects. Following that, data was obtained through conducting the interviews with the professionals who have used BIM in their construction projects. The collected data focused on the knowledge acquisition in the implementation of BIM technology. In addition the learning process within BIM construction projects was also looked in terms of achieving the knowledge and appropriate skills which is essential to support the various stakeholders to efficiently use BIM technology.

Keywords: Building information Modelling (BIM), Connectivism, Construction, Learning, Skills, Knowledge.

1. Introduction

Productivity in a country influences in determining the competitiveness for the businesses and wages for people at work (UKCES, 2015). According to HM Treasury (1988) productivity is ‘a fundamental yardstick of economic performance’ however the UK significantly lags the best performing OECD countries due to poor productivity records (Allen, 2015). The construction industry has been one of the main engines of UK economic growth nevertheless still UK’s productivity gap is driven back due to skills challenges faced in the construction industry. One

of the reasons for the construction industry to face these skills challenges is due to its resistance to adopt new technologies. However, the purpose of introducing these new technologies is to improve productivity (UKCES, 2015) which also leads to alter and create quicker ways to deliver goods and services (Corney, 1997), high performance work practices (Bresnahan *et al*, 2002) and economic well-being (Hansushek and Woessmann, 2008). The studies in construction industry highlight the skills challenges as a major barrier in improving productivity (UKCES, 2015). Supporting this construction skills report (CITB, 2004) suggests that employer's skills requirements need to be taken into consideration to enhance efficiency of the construction projects to cope up with continuous changes in construction industry. Even though skills challenges have been highlighted in many construction studies lack of knowledge is the key factor that leads to these skills issues in the construction. Therefore distribution of knowledge is important within the project participants to acquire the appropriate skills to achieve the project outcomes. Therefore the aim of the study is to explore how knowledge can be distributed to acquire the appropriate skills during the implementation of new technologies within the construction industry.

2. Literature Review

2.1 Importance of skills and knowledge in construction industry

Acquiring appropriate skills encourages economic performance (O'mahoney and de Boer, 2002), innovation and flexibility (Leiponen, 2005). Moreover it helps to determine individual's employability to productivity (HM Treasury, 2006) and business profitability (Bosworth, 2013). This has been highlighted in Sami's (2008) study where he claimed more attention is needed to reskill, multi-skill or upskill professionals in construction industry to successfully achieve project targets. However, skills must be grounded and the meaning might differ according to its reference to context (Spencer, 1990) as shown below.

Table 1: A summary of the skills definition

Author/s	*Year*	*Definition*
Becker	*1964*	*Capabilities of workers that they acquire outside the work place and the job on and the capabilities have meaning only when they translate into productivity and job rewards, such as earning.*
Mangham and Silver	*1986*	*Dexterity and knowledge of the workforce.*
Wood	*1988*	*Expertise that describes the quality of overt behaviour in a particular job.*
Odusami	*2002*	*Ability to perform the task well or better than average. Skills can also be described as the ability to translate knowledge into action.*
Boyatzis et al	*2002*	*Emotional intelligence which includes both self-awareness of one's emotional reaction to specific events, situations and unexpected circumstances and the coping strategies that may be developed to handle those feelings and concomitant reactions effectively.*
HM Treasury	*2006*	*Capabilities and expertise in a particular occupation or activity.*

These definitions state that skills are centred on various different factors such as capabilities, people, physical and practical activities. However, Odusami's (2002) definition is adopted in this study which states that skills are not only about completing the task better than average but also translating the knowledge into action. The UK Commission's Employer Skills Survey 2013 (UKCESS 2013) and CITB (2015) have discussed about the skill deficiencies and highlighted the need for people with appropriate skills and knowledge. Moreover these studies show that knowledge should be developed along the process to acquire the appropriate skills to complete the task. Therefore to resolve this current situation there is a need for people who are capable, agile and able to respond to the challenges presented by new technologies.

2.1.1 Skills gaps, Skills shortages and Latent Skills shortages

Current skills challenges within the construction industry are mainly due to skill gaps, skills shortage and latent skills shortages. Skills gap happens due to employees in workplace not having appropriate skills to achieve the organisation's objectives (Campbell *et al.*, 2001). On the other hand skills shortages also occur when there is shortage of skilled people in labour market to fill in the vacancies (Barnes and Hogarth, 2001).Campbell *et al* (2001) argued that there are more skills gaps in construction industry and Bloom *et al* (2004) believed skills shortage plays a significant role towards the economic growth. Apart from this, latent skills shortage is also an issue, which is a situation where establishment fall short of what might be considered good or best practice. This might be the reflection of low skills or poor business performance, even though there is no report of recruited problem or skills gap (Hogarth, 2001). Generally this occurs when the organisation starts to manage a project with existing skills without being aware of necessary skills. Chan and Cooper (2006) claimed that this situation is more frequent in construction industry because construction practitioners often do not know what skills they need to produce to achieve their project outcomes. Therefore skills challenges are problematic to move towards the digital world. Building Information Modelling (BIM) is a recent technological development introduced within the AEC industry to integrate processes throughout the entire project lifecycle (Aouad and Arayici, 2010). Moreover BIM also helps to drive a step-change to increase the productivity of the construction process, tangible quality improvement in the end product and associated reduction in true cost (O'Rourke, 2015). Recently the UK government has mandated to use BIM in public sector projects since 2016 (Cabinet Office, 2011) therefore construction companies have slowly started to adopt BIM in their construction projects.

2.2 Building Information Modelling (BIM)

There are many ways of looking at BIM as shown in below in Table-2; this study has adopted the National BIM Standard (2014) definition that looks from a knowledge point of view. Here BIM is about unlocking knowledge and insight, creating the platform for more efficient and sustainable solutions through sharing the information. While the information is shared through BIM, knowledge needs to be distributed among the project participants for the decision making

to achieve the project targets. Therefore this paper is looking at how knowledge is shared and distributed among the project participants using BIM in construction projects. Furthermore Connectivism theory has been adopted in this paper to study the knowledge distribution and learning process to achieve the project outcomes.

Table 2: A summary of the BIM definition

Author/s	*Year*	*Definition*
Autodesk	*2007*	*A building design and documentation methodology characterized by the creation and use of coordinated, internally consistent computable information about a building project in design and construction.*
Eastman et al	*2008*	*A computer aided modelling technology for managing and generating building information, with the related processes of producing, communicating, and analysing building information models.*
Vanlande et al	*2008*	*The process of generating, storing, managing, exchanging, and sharing building information in interoperable and usable way.*
McGraw Hill	*2009*	*The process of creating and using digital models for design, construction and or operations of projects.*
Nisbet and Dinesen	*2010*	*A digital model of a building in which information about a project is stored. It can be 3D, 4D (integrating time) or even 5D (including cost) – right up to 'nD' (a term that covers any other information).*
National BIM Standard (NBIMS)	*2014*	*A digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.*

The impact of technology on humanity continues to grow in greater prominence which allows entering into a new form of 'knowledge society'. Moreover Bloom *et al* (2004) claimed that even though new technologies are out there, significant amount of knowledge and skills are not there to work with those new technologies. Therefore, there is a need for a suitable learning theory to increase human cognitive functioning to cope with this changing society. Connectivism is a theory introduced by Siemens and Downes (2009) for the digital world.

2.3 Connectivisim

Connectivism is an application of network premises that define both knowledge and process of learning. In this, knowledge is defined as a particular pattern of relationship whereas learning is defined as the creation of new connections and patterns along with the ability to maneuver around existing networks/ patterns. Moreover Connectivism focuses on the presence of technology as a part of cognition and knowledge. Previously philosophers and theorist had different views of learning where they failed to address the learning that occurs outside the individual and to discuss the learning process that happens among the group of people or organisation. According to Sieman (2004) Connectivism is an intriguing development where learning happens with the knowledge and perception gained through the additional personal network. Even though it is impossible to experience everything, there is an opportunity to

develop the knowledge through sharing and collaboration. In this digitalised world there is a necessity for further knowledge to understand the amount of the data available to complete specific tasks. Therefore Connectivism which is an actionable knowledge can be considered as a learning theory, where understanding of where to find the knowledge is more important instead of answering how and what the knowledge incorporates. According to Siemens (2005) and Downes (2005) Connectivisim theory is appropriate to handle this digital world where its main principle is linking ideas and connecting people and information sources. However opposing this Duke *et al* (2013) state that in comparison to existing learning theories there is an overlap of ideas and therefore this cannot be accepted as new learning theory.

Learning process in Connectivism is not entirely focused on the control of the individual and more focused on connecting the specialised information sets and enable people to learn more than their current status of knowing. In this process information flow is a key factor where new information will be continuously acquired. In Connectivism, the starting point for learning occurs when knowledge is actuated through the process of learners and then connecting and feeding information into learning community. This begins with an individual and the personal knowledge is included of a network which feed into organisations and institutions, which in turn feed back into the network, and then continue to provide learning to individual. This cycle of knowledge development allows the leaners to be up to date in their field through the connections they have formed. Therefore the fundamental idea of this is about 'Distribution of knowledge'. This means a property of one entity must lead to or become a property of another entity in order for them to be connected; the knowledge that results from such connections is referred as connective knowledge.

The Diagram-1 generated by García (2008) shows the Connectivist view of learning as a network creation process that impacts the way learning is designed and developed. Diagram-1 emphasis the central principle of Connectivism which is the creations with usual nodes (element connected to any vertices, elements, or entities) supports and strengthens existing large effort activities. The integration of learning, knowledge and understanding through the personal extension of a personal network is the key of Connectivism.

Diagram 1: Connectivism: Process of creating network (García, 2008)

Supporting the Connectivism theory several studies have highlighted the importance of the knowledge to successfully complete the tasks. Hutchins (1993) in his study emphasised that knowledge is necessary and it should be distributed among the team to carry out a certain task. Moreover Lave (1988) suggested that relationships between human thoughts, human action and the environment is so tightly interwoven that the mind cannot be studied independently of the culturally organised settings within which people function. On the other hand Nonaka and Takeuchi (1995) believe that the knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge. Therefore these previous studies have highlighted the important to view the knowledge as composed of connections and network entities to encourage the interaction within these complex systems. This will then lead to the acquisition of appropriate skills to complete a task in an efficient way. From this discussion it is clear that initially knowledge needs to be acquired to gain the appropriate skills to work with the new technologies to achieve the project outcomes. However in this study the knowledge acquisition and learning process is viewed through Connectivism which is appropriate to tackle the rapid technological changes.

3. Methodology

The purpose of this research is to explore how knowledge can be distributed to acquire the appropriate skills when new technologies are introduced to achieve the project outcomes. The situations were analysed through interacting with BIM professionals by asking about their experience and their beliefs. Therefore, qualitative research is adopted as a method best suited to explore the new area. Qualitative research is ‘‘Multi-method in focus, involving an interpretive, naturalistic approach to its subject matter’’ (Denzin and Lincoln, 1994). Moreover this method explores and understands the meaning where individuals or groups ascribe to a social or human problem (Creswell, 2008). The purpose of this qualitative method study is to understand how construction project participants gain their knowledge and acquire skills during technology change within the construction industry.

Data for qualitative study analysis is collected through conducting 10 semi structured interviews with BIM professionals working in the UK construction industry. Firstly BIM professional’s personal opinion about BIM and their BIM experiences were collected. Secondly gaps within BIM learning and their causes were discussed. Finally their learning experience to work with BIM and recommendations for future BIM professionals were discussed. These interviews were conducted to understand the significant of skills challenges and to explore the skills issues in BIM construction projects. Moreover this is also to understand how project participants within the construction projects learn and acquire the appropriate skills to work with the new technologies. During these interviews professionals engaged with BIM construction projects shared their experience and individual perception about the skills related issues faced in BIM construction projects. Two pilot studies were conducted with the construction professionals working with BIM before conducting the interviews. This has assisted to refine some of the questions with appropriate wordings and made the questions clear to the interviewees. This semi

structured interviews were conducted across the UK, open-ended questions were employed to get a wider view of the situation and interpretation was done along the way. The data collected through the semi structured interviews explained how knowledge is distributed among the project participants which have then led to the skills acquisition to work with the new technologies introduced in the construction industry.

4. Discussion

The data collected from the interviews clearly show that the way of gaining knowledge has been changed from old days. In the beginning knowledge acquisition is more focused on individual and their influences on the organisation or community. This is supported through one of the interviewee saying ‘‘learning the new software in BIM with the multidisciplinary team helped us to know the difficulties the other employees face’’. Moreover another interview stated that ‘‘Learning process with other project team members provide us a wider knowledge of the new software’’. Therefore it is evident that currently knowledge is not about focusing on the individual but also gaining the knowledge outside the primary knowledge.

As discussed in the literature, skills challenges can be viewed from the point of skills gap, skills shortage and latent skills shortages. BIM professionals indicated that they had to face several skills gaps such as detailing elements in BIM applications and using software , lack of understanding about family creation and detailed understanding, lack of knowledge about in putting the data into the objects and extracting it, process and standard gaps and lack of engineering. This is due to lack of knowledge within the internal workforce. On the other hand latent shortage is also a problem where skills gaps are unrecognised because project organisations have simply coped operationally without the necessary knowledge and skills. In BIM projects latent skills shortages are derived from lack of defined project process, lack of understanding of role and responsibilities and frequent change of software to work with BIM. In addition this happens more often in BIM construction projects due to lack of communications between the project team members. In other words the problems faced by the project team members are rarely discussed among them and in most situations doesn’t not get reported to the top management. This clearly shows that skills gap, skills shortages and latent skills shortages are significant constraints to achieve the project outcomes. Interviewees believe that adopting a new way of gaining knowledge which will then invest in skills acquisition could produce a radical shift in employees’ perception of working which can lead to achieve the project outcomes quickly.

From the interview results a similar situation is observed in BIM construction projects. In BIM construction projects individuals gained their fundamental knowledge through different learning methods such as degree programs/ education, self-learning, basic software training, attending meeting, conference and workshops. However most of them expressed that they were reluctant to use BIM due to lack of understanding of fundamental aspects of BIM enabled technologies. This involved in understanding what BIM is and some of the benefits associated with it. Therefore interviewees suggested that old learning theories that focused only on the individuals needs to be replaced to tackle the new digital world.

After the individuals have gained the fundamental knowledge BIM models were used to share the information among the project participants. In this situation knowledge needs to be distributed among the project participants to complete the necessary tasks through decision making. Therefore after connecting the information resources and people within the BIM construction projects the property of one entity leads to become a property of another entity in order for them to connect and finally connected knowledge will be generated. This will allow all the project participants involved in the project to gain the knowledge and also to understand the current situation of the project. The connections and knowledge gained allow individuals to work effectively and help to avoid mistakes during the projects. While an individual keeps repeating this process again in different BIM projects he/she is expected to become a skilled person with ability to deal with BIM issues in any project setting. However it is important to notice that every project is unique and has its own BIM related skills challenges. Therefore as interviewees suggested more training, engaging with other BIM projects, following BIM courses, getting constant feedbacks about software from the newsletters, understanding the standards and setting out the project goals in the beginning of the project needs to done to achieve better project outcomes.

Therefore this current situation in the construction industry has confirmed that new technology such as BIM has created a new culture and it has reshaped the way of learning. In early days learning theories were only concerned of individual learning whereas currently learning as a function is not under control of learner therefore learning needs to be redesign as two-way process (García, 2008). Actuate known knowledge at the point of application is vital in a learning theory. When the knowledge is needed and not known; it is important to have the ability to plug in the sources to meet the requirements. Connectivism theory is suitable to adapt these circumstances and these interview results highlight the importance of distribution of knowledge within the construction team during the implementation of new technology. Diagram-2 explains the learning ecology in BIM construction projects. Understanding this learning process helps to improve the knowledge as well as makes the individual as a skilled person.

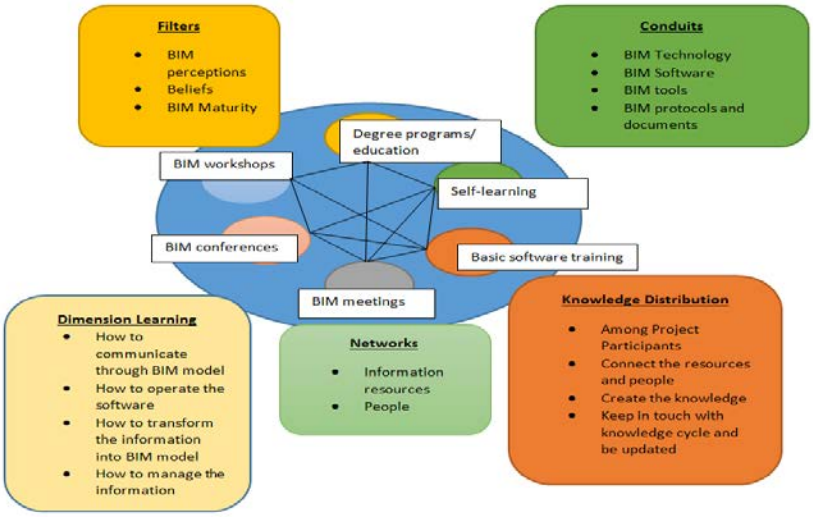

Diagram 2: Knowledge acquisition and learning process in BIM Construction projects

5. Conclusions

The construction industry has been one of the main engines of UK economic growth. Therefore several new technologies are introduced to improve productivity. BIM is one of the recently introduced technologies in the UK construction industry however it is not fully utilised due to the skills challenges. Therefore it is ever more important to focus on knowledge and skills acquisition during the technological change. The study conducted with BIM professionals working in the UK construction industry articulate that a new way of learning and knowledge acquisition needs to be introduced among the project participants to gain the appropriate skills to work with new technologies. Connectivism theory has been identified as a suitable approach to develop knowledge among project participants during the implementation of new technologies. The main principle of this theory is to distribute the knowledge through forming the connections between nodes. Therefore in this situation the knowledge acquired will be both individual learning and the learning outside the primary knowledge. This would help the project participants to achieve the project outcomes efficiently. Since a project participant keeps on accessing back to the knowledge cycle he/ she not only becomes a skilled person but also knows about the up-to date situation of their field. Therefore Connectivism theory is beneficial to understand the use of new technology and to improve the distribution of knowledge among project participants.

References

Allen.K (2015). *OECD warns UK must fix productivity problem to raise living standards*. Available: http://www.theguardian.com/business/2015/feb/24/oecd-warns-uk-must-fix-productivity-problem-to-raise-living-standards [Accessed on 25/11/2015]

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

Autodesk (2007).Maintaining BIM Integrity in Structural Engineering Office, Available: http://images.autodesk.com/apac_japan_main/files/maintaining_bim_integrity_in_structural_engineering_office.pdf. [Accessed 03/11/2015]

Barnes.S.A and Hogarth.T (2001) *Sector Skills Insights: Education.* Available: http://dera.ioe.ac.uk/15956/1/evidence-report-57-education-v2.pdf [Accessed on 19/11/2015]

Becker G (1964) *Human Capital*, 2nd edn. Columbia University Press, New York.

Bosworth D L (2013) *UK Skill Levels and International Competitiveness, 2013*. UK Skills level and international competitiveness.UK.

Bloom N, Conway N, Mole K, Möslein K and Neely A (2004) *Solving the skills gap* Available:http://wi1.uni-erlangen.de/sites/wi1.uni erlangen.de/files/Solving_the_Skills_Gap1.pdf [Accessed on 30/10/2015]

Boyatzis R E Stubbs L and Taylor S (2002), "Learning cognitive and emotional intelligence competencies through graduate management education", *Academy of Management Journal on Learning and Education*, 1(2), 150-162.

Bresnahan T, Brynjolfsson E and Hitt, L M (2002) "Information Technology, Work Organization and the Demand for Skilled Labor: Firm-Level Evidence," *Quarterly Journal of Economics*, 117 (1), 339-376.

Cabinet Office (2011) *Policy Paper Government Construction Strategy, Documents, Government Construction Strategy: One year on and Action Plan Update*, Available: https://www.gov.uk/government/publications/government-construction-strategy [Accessed 12/07/2015]

Campbell M (2001) *Skills in England 2001: The Research Report*, Department for Education and Skills, UK.

CITB-Construction skills (2004) *Skills Needs Analysis for construction*, London.

CITB (2015) *Industry insights: Construction skills network blueprint for construction 2015-2019*.Available:https://www.citb.co.uk/documents/research/csn%20reports%202015-2019/construction-skills-network-uk-2015-2019.pdf [Accessed on 30/10/2015]

Chan P and Cooper R (2006) ''Talent management in construction project organisations: do you know where your experts are?'' *Construction information quarterly*. 8(1), 12 – 18.

Corney M (1997) ''Individual Lifelong Learning Accounts: Research Consortium III'', Chichester: M.C. Consultancy (mimeo).

Creswell J W (2008) *Education research: Planning, conducting and evaluating quantitative and qualitative research*. Upper Saddle River, New Jersey: Pearson.

Denzin and Lincoln. Y S (Eds.) *Handbook of qualitative research*. London: Sage.

Downes S (2005) *An Introduction to Connective Knowledge*. Available: http://www.downes.ca/cgi-bin/page.cgi?post=33034 [Accessed02/12/2015]

Duke.B, Harper.G, and Kaplan.M.J (2013), ''Connectivism as a Digital Age Learning Theory'', *The International HETL Review*, University, USA.

Eastman C, Teicholz P, Sacks R., and Liston K (2008) ''*BIM Handbook: A Guide to Building Information Modelling for Owner, Managers, Designers, Engineers, and Contractors*'', John Wiley and Sons, New York.

García I (2008) ‘‘Connectivity theory as an emerging solution strategies-innovative learning (e-learning)’’ *International Conference on Education for Higher Education Innovation: Convergence to this process*, Madrid.

Hanushek E.A and Woessmann.L (2008) ‘‘The role of cognitive skills in economic development’’, *Journal of Economic Literature*. 46(3).607-668.

Hogarth T and Wilson R (2001) ‘‘Skills Matter: a synthesis of research on the extent, causes and implications of skill deficiencies’’, DfES Publications.

Hutchins E (1993) Learning to navigate. In S. Chaiklin & J. Lave (Eds.), *Understanding Practice, Perspectives on Activity and Context*. Cambridge University Press, 35-63.

Lave J (1988) *Cognition in practice: Mind, mathematics, and culture in everyday life*. Cambridge, England: Cambridge University Press.

Leiponen A (2005) ‘‘Managing knowledge for Innovation: The case of business and business services’’, *Journal of Product Innovation Mnagement*, 23(3), 238-258.

Love P E D., Haynes N S.and Irani, Z (2001) ‘‘Construction managers’ expectations and observations of graduates’’. *Journal of Managerial Psychology*, *16* (8), 579-593.

Mangham I and Silvers M S (1986) *Management Training: Context and Practice*, London: ESRC.

McGraw Hill. (2009). *Building Information Modelling (BIM): Transforming Design and Construction to Achieve Greater Industry Productivity*. Available: http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aias077483.pdf [Accessed 05/11/2015]

NBIM-US (2014), *The National BIM Standard - United States*. Available: http://www.nationalbimstandard.org/ [Accessed 12/11/2015]

Nisbet N and Dinesen (2010) *Construction the Business Case: Building Information Modelling*, BuildingSmart: International Alliance for Interoperability: London.

Nonaka I and Takeuchi H (1995) *The knowledge-creating company*, New York: Oxford University Press.

Odusami, K.T (2002) ‘‘Perception of Professionals Concerning Important Skills of Effective Project Leader’’, *Journal of Management in Engineering*, 18 (2), 61-67.

O'Mahoney M., and de Boer W (2002), ‘‘Britain's relative productivity performance: Has anything changed?’’, *National Institute Economic Review*, 179, 38-43.

O'Rourke (2015) *Digital Built Britain Level 3 Building Information Modelling - Strategic Plan.*Available:https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/410096/bis-15-155-digital-built-britain-level-3-strategy.pdf [Accessed 11/11/2015]

Sami (2008) *2020 Vision – The Future of UK Construction*, Available: http://www.cskills.org/uploads/2020visionscenariosforconstructionskills_tcm17-11077.pdf. [Accessed 30/10/2015]

Siemens G and Downs S (2009) *Open learning Analaystics*, Available:http://www.elearnspace.org/blog/[Accessed at 27/11/ 2015]

Siemens G (2004) *A learning theory for the digital age* Available: http://www.elearnspace.org/articles/connectivism.htm [Accessed on 23/11/2015]

Siemens G (2005), ''Connectivism: A learning theory for the digital age''. *International Journal of Instructional Technology & Distance Learning*. Available: http://www.itdl.org/Journal/Jan_05/article01.htm [Accessed 2/11/2015]

Spenner K I (1990) "Skill: meanings, methods, and measures", *Work & Occupations*, 17(4), 399-421.

UK Commission for employment and Skills (UKCES) (2015). *Annual reports and accounts 2014/2015*.Available:https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/441289/UKCES_2014-15_Annual_Report.pdf [Accessed 29/10/2015]

UK Commission for employment and skills. (2013). UK Commission's Employer Skills Survey 2013:UKResults.Available:https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/327492/evidence-report-81-ukces-employer-skills-survey-13-full-report-final.pdf. [Accessed 02/12/2015]

UKCES (2014) *UK Commission's Employer Skills Survey 2013: UK Results*. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/327492/evidence-report-81-ukces-employer-skills-survey-13-full-report-final.pdf [Accessed 02/11/2015]

Vanlande R., Nicolle C and Cruz C (2008) ''IFC and building lifecycle management'' *Automation in Construction*, 18(1), 70-78.

Whetten D A and Cameron K S (1991), *Developing Management Skills*, 2nd edition, New York: Harper-Collins.

Wood D (1988) *How children think and learn*, Oxford: Blackwell.