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INSTITUTIONAL FOUNDATIONS OF CONSTRUCTION ICT: A VIEW FROM THE WEST MIDLANDS OF ENGLAND

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Construction industry is of strategic importance to economic development and growth within any region and nation. However, the industry is confronted by many challenges including poor labour productivity. Part of the explanation frequently provided in literature is that the industry has been slow to adopt and institutionalize useful information and communication technologies (ICT). The research questions asked in this article are: What are the institutional foundations for West-Midlands construction firms to deliver their projects based on ICT and how can these be strengthened? These questions are asked for two reasons. The first is to understand the reasons behind slow ICT adoption and second, to inquire into what can be done about it. The article provides an overview of projects using advanced ICT in the region and presents the results of a focus group discussion undertaken with six industry experts. Scott's pillars of institutions were used for understanding how the foundations for ICT adaption in the region can be strengthened. Findings are that present regulations, incentives and perceptions of ICT can be further strengthened. While ICT adoption appears to accelerate in large projects, many practitioners remain sceptical as to whether the excessive costs associated with ICT adoptions are justified. The regulative pressures exerted by government in support of ICT adoption do not seem to have fully materialised in industrial practice. However, it is apparent that the normative and cultural cognitive pressures are rendered weak in the region with using advanced ICT being viewed as extraordinary rather than standard industrial practice.

Keywords: institutional theory, ICT, West-Midlands

INTRODUCTION

The construction industry suffers from poor labour productivity when compared to other sectors of the economy. Farmer (2016) states that the construction industry and its labour model is at a critical crossroads in terms of its long-term health. Whilst the diagnosis points to a deep-seated market failure, there are certain industry trends and wider societal changes happening now that represent both unprecedented risk and opportunity for the industry and its clients. If the opportunities are not harnessed, the risks may become overwhelming. The report suggested the industry to 'modernise or

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die' in order to safeguard its future. The productivity in the UK construction industry has been fundamentally flat since 1994 (DDCM&S 2017). One way to modernize the construction industry is to embrace the adoption of emerging information and communication technology (ICT) solutions that promote efficiency in communication, firm performance and driving innovation (Baxter and Berente 2010; Eastman *et al.*, 2011; Francom and El Asmar 2015, Froese 2010, Azhar 2011).

Recognizing the potential of ICT, the UK government has initiated major programs such as Digital Built Britain to contribute to further digitalising the industry. Consequently, there is a growing body of research focussing on ICT diffusion and adoption in construction. Cao *et al.*, (2014) argue that project adoption is a complexly socialized activity that is not only motivated by participants' rational needs to proactively address internal process problems, but also driven by external isomorphic pressures related to the acquisition of institutional legitimacy. Review of literature show that there is little research that examines institutional foundation for ICT-based work in West Midland. Doing this will assist in understanding reasons behind slow ICT adoption in the region and subsequently, it allows for an understanding of what can be done about it. The research question asked in this paper is: What are the institutional foundations for West-Midlands construction firms to deliver their projects based on ICT and how can these be strengthened?

Scott's pillars of institutions theoretical framework allows for understanding the authoritative guidelines for social behaviour (Scott 2001). The social behaviour at the core of this research study is ICT adoption in the construction industry. Institutional theory has proven its value for studying how innovations become adopted and how they can be made to stick in industrial practice. Data was collected through one focus group interview with six subject experts from the Midlands region and from assessing documents related to ICT-based work in construction projects. The paper is structured as follows, first an overview of recent ICT solutions for the construction industry is presented, second Scott's pillars of institutions as theoretical view are explicated, third the methodology is presented and fourth the findings of both the document study and the focus group interviews are presented. Last, the findings are discussed and conclusions is drawn.

Emerging ICT in the UK Construction industry

Construction organisations increasingly view ICT as a strategic asset driving business performance and generating competitive advantage (Underwood and Khosrowshahi 2012). ICT comprises of computer software, hardware and communication devices that allow easy communication at local and international level (Forbes and Ahmed 2011). Construction projects planning and site work require extensive information and personnel at all stages, starting from the front-end planning through to completion. In 2011, UK Government mandated the use of level 2 Building Information Modelling (BIM) on all public-sector projects by 2016. BIM is considered the most promising development to construction industry for its ability to produce accurate virtual models (Eastman *et al.*, 2011). The realistic visual produced ignite construction clients to understand the design and construction process better when compared to 2D drawings. These emerging technologies are recognized as main source of improvement and competitive advantage to construction firms and as critical solution to shortage of skilled labour, safety for construction workers and boost to productivity (Ho and Liu 2003). Digital technologies are electronic resources, tools, systems and devices with the capacity to store, generate and process data. An

overview of the emerging ICT and their applications in construction industry is provided in Table 1. The technologies listed below represent the artefacts placed at the core of both document analysis and the focus group discussion.

Table 1: Details of emerging ICT in Construction.

Emerging Technology in ICT	Application in construction
Software, online platform, mobile devices and the cloud	For communication, reporting, collaboration and enhancement of decision-making.
Big data, Artificial Intelligence (AI) and Advance Analytics	Analyse big data for decision making. Provide users real-time information for maintenance and decision making.
Project management and digital collaboration	Enhance collaboration, assign tasks and assists contractor with administration and compliance with regulations and safety on site. Allows for transparency and enable data-mining in large scale.
Building Information Modelling (BIM)	3D modelling of design allows virtual twinning of the structures, speed decision making process, manage changes and enable workers to run various scenarios. 3D, 4D, 5D, 6D and 7D BIM is for visualization, construction sequencing, estimation, facility management and materials/objects tracking respectively.
Sensors and Internet of Things (IoT)	IoT is connectivity of many intelligent devices with the ability to communicate with one another and humans. Sensors measure operational variables such as identification of individuals, tools, materials, speed, telecommunication devices, infra-red, body temperature, fatigue and environmental conditions.
Spatial measurement, tracking and geolocation	Helps information to be transmitted wirelessly from workers, tools, materials, vehicles and equipment to a designated server for display, process and analyses. Geolocation technologies are used for personnel safety, site security, fraud detection, and project management.
Augmented Reality (AR) and Virtual Reality (VR)	Enable construction clients to interact and understand the unbuilt structure. Allow a live direct and indirect view of real-world, physical environment

Theoretical Lens

Institutional theory suggests that organisations are primarily stimulated by the motivations of seeking social legitimacy (Scott 2001). Oliver (1991) reckons that institutional theory is capable of explaining nonchoice behaviour in the context of taken-for granted norms and beliefs and suggested that attention should be given to ways in which organisations strategically respond to institutional pressures. In Three Pillars of Institutions (Scott 2014) points out that organisations could be persuaded not only by the regulatory coercive pressures but also compelling influences from other competitors and external isomorphic pressures. Institutional theory is organisational change theory, with relatively established theoretical perspectives capable enough to explain the connection between organisational activities and institutional environments.

Explaining innovation diffusion process, Westphal *et al.*, (1997) argued that social and economic motivations in innovation implementation by an organisation substitute for each other instead of working in a parallel sense. Also, Tolbert and Zucker (1983) strongly support the idea that adoption of new innovations by organisations is importantly determined by the law or gradual legitimacy. Institutional theory however has been criticised by researchers. For instance, Martinez and Dacin (1999) observed

the theory ignored the place of organisation economic considerations and overemphasising the social legitimacy Lounsbury (2007). Also, leveraging on institutional theory contended that economic and social legitimacy motivation for innovation diffusion should not be decoupled from broader institutional beliefs. Cao *et al.*, (2016) affirmed that construction project participants such as clients may strongly advocate the use of BIM. Cao *et al.*, (2016), using questionnaire survey and construction professionals' interviews, established that impacts of isomorphic pressures will probably be not completely isolated from the motivations to seek economic performance improvement.

Institutionalisation is the action of establishing something as a convention or norm in an organisation or culture. Institutional theory stresses that institutional environments are crucial in shaping organisational structure and actions (Scott 2001). The theory claims that organisations are likely to be wooed to adopt ICT because of external isomorphic pressures from the government, competitors and customers rather than deliberate internally driven decision. Organisation's actions and decision are not only driven by sensible goals of efficiency and increase productivity but also by social and cultural factors and concerns for legitimacy (Oliveira and Martins 2011). Cao *et al.*, (2016) summarised from literatures three categories of factors catalysing firms to implement ICT. One, decisions that are informed by external entities like trade partners and industry professionals. Two, innovation implementations that are not primarily influenced by external requirements but by imitative motivations and three, organisation implementation of innovations based on proactive decision by internal economic motivations hinged on desire to improve communication and reduce cost and not necessarily based on significant environmental factors or practice of other competitors.

Scott (1995) defined institutions as regulative, normative and cognitive structures and activities that provide stability and meaning for social behaviour. Institutionalisation theory is a powerful tool to explain individual and organisational behaviours in technology adoption (Lounsbury 2008). The regulative institutional pillar is established system of rules that is backed by surveillance and sanction such as formal institution of laws.

Table 2: Three pillars of institutions (Scott 2014).

	Regulative	Normative	Cultural - cognitive
Basis of compliance	Expedience	Social obligation	Taken for granted
Mechanism	Coercive	Normative	Mimetic
Logic	Instrumentality	Appropriateness	Orthodoxy
Indicators	Rules, laws, sanctions	Certification, accreditation	Prevalence, isomorphism
Basis of legitimacy	Legally sanctioned	Morally governed	Culturally supported, conceptually correct

The behaviour of institutional regulative actors are based on consequential logic but also seek to maximize their investment strategically. The normative pillar is centred on norms and values in explaining actions and behaviour. Institutionalisation in normative context is viewed as internalized moral beliefs of logic of appropriateness and forces of social patterns that influence behaviour. The cognitive pillar is built on

share conceptions of social reality and ways by which meaning is made. Institutional actors react to external stimulus by imitating others through various templates such as mere conceptions, pattern of action and routines. Cognitive paradigm stress that socially structured meaning determines how people are treated and on how rules are set in the society. In nutshell, the three pillars are interrelated, vital and mutually reinforced institutions.

METHODOLOGY

The overall strategy used for the collection of the data were in twofold. First, an overview of the industrial context and the projects using emerging technology in the West Midlands was generated based on web searches. Examples for keywords used in the searches include the names of the emerging technologies in Table 1, construction, project and West Midlands. While we claim that these searches did return data helpful for understanding the present state of construction ICT adoption in the region we cannot claim that the overview is complete. This is so because not all projects announce their ICT usage on the web. However, we double-checked our findings with the focus group experts and thus argue that this data serves well for providing an initial understanding of ICT adoption. Secondly, to understand how current regulations, incentives and perceptions in the region motivate how firms institutionalise new innovations in construction management and process, a focus group interview with six industry experts from the region discussing the institutionalisation of ICT innovations was conducted. The combined intention of document analysis and focus group interview focused on gaining an in-depth understanding of the foundations for institutionalisation of ICT in construction projects in West-Midlands region of England and how can this process be improved.

The purpose of the focus group interview to gain in depth understanding on issue of ICT institutionalisation complementing our findings from the web searches. Ten industry professionals from construction company and academics in the region were contacted through personal visits and email to explain why a focus group interview is been conducted. Only six out of ten construction experts contacted confirmed their availability and willingness to take part in the interview. The professionals that participated in this interview were one mechanical engineer, two quantity surveyors, a digital designer, a building surveyor and a site manager. All expert interviewed had over 20 years of industrial experience in the construction industry expect for one quantity surveyor. The meeting was held on Monday the 19th of March 2018 at John Laing Building, faculty of engineering, Coventry University between 15.00 and 16.30. Four simple and short questions around the research enquiry were drawn up but not made known to the participants prior the meeting. These questions formed the bases of discussion alongside with findings from the document analysis in Table 3. Proceedings of the meeting were recorded, transcribed and processed using Nvivo 12 qualitative data analysis. Signed informed consent was obtained from all participants.

FINDINGS AND DISCUSSIONS

The West-Midlands Industrial context

At regional level there are several notable initiatives focusing on ICT implementation. BIM in Birmingham initiative started in 2017 in West-Midland, it is a collaboration event between the Association of Academic Educators (AAE) and the Royal Institute of British Architects (RIBA). The event is aimed at educating, informing and to showcase the work of talented BIM managers across the region so as to promote

adoption, diffusion and career opportunities locally. The event this year welcomed over 500 students from the UK and South America alongside professionals from construction industry. BIM west midland (BIMwm) is another initiative in the region. BIMwm is a collaboration effort of three construction stakeholders in the region namely: Sandwell Council, Sandwell College and the University of Wolverhampton. The group established a technology and skills development suite with computer workstations, BIM viewing software, e-learning platforms, to assist West-Midlands construction firms and to encourage small and medium sized enterprises (SMEs) in West-Midlands to acquire necessary skills to adopt and implement necessary software and remain competitive in business. Over 2,000 users ranging from clients, architects, buyers, suppliers and other support service providers have registered to use the facility.

Analysis from archive documents from recently completed and ongoing project across the region is presented in Table 3. Project selection is based on table 1, projects that adopt BIM and other ICT at different phases of delivery were selected randomly. Analysis reveals BIM is gaining awareness in the region and that adoption of emerging ICT is gradually increasing on mainly public-funded projects. Archive document search for privately funded construction projects implementing emerging ICT did not yield any result. However, other emerging technologies in ICT such as Augmented Reality and Virtual Reality, the cloud, big data are not widely use in Mid-Westland region. Some of the twenty-one projects reviewed are award winning projects and first of its kind in the region and some on national level. Educational buildings dominate project samples in Table 3. ICT adoption in construction projects in the region is not limited to new construction projects entirely, some of the projects considered are refurbishment and redevelopment works on existing structures.

Table 3: Sample projects adopting emerging ICT in the West-Midlands (2015-2018).

Project Cost range	Educational	Industrial	Office	Leisure	Mixed Residential/commercial	Health
£5-10m	-	-	1	-	-	1
£10-20m	7	-	-	1	-	-
£20-30m	2	1	-	-	-	-
£30-40m	1	-	-	-	1	-
Over 40m	3	1	-	1	-	1

The Three Pillars of Institutions

Findings from the focus group discussion with the industry experts are presented along the three pillars of institutions as proposed by Scott (2014). The progressive collaboration between businesses and academic institutions in the region is a promising indication that the UK construction industry can realise its potentials and tackle poor labour productivity and other illustrious challenges confronting the industry.

Regulative pillar: The regulative pillar may be viewed as coercive because of its formal power affirmation by constituted authority. The focus group experts acknowledged that the UK government mandate, which enforced BIM level 2 on all public sector procured projects has played an important role through legislative strategy to inspire institutionalisation and uptake of emerging ICT in the region. For

example, interviewees were asked to express their view concerning the impact of government mandate enforcing BIM level 2 on implementation of BIM in the region. Some textual excerpts from the interview transcribed are as follows:

I think with most things in construction, it all comes down to the law and the penalty. We change or comply when we are told to do so (Site manager).

I definitely think the law has made impact in implementation of new technologies (Quantity Surveyor).

I believe the uptake is mainly because of government policy and competitive advantage but it is a gradual process, we still have a long way to go (Senior Quantity Surveyor).

The enforcement of the mandate was criticised by some participants, from their viewpoint, the mandate favours the large construction companies in neglect of the SMEs because of high capital investment required for adoption. In practice, subcontractors are mandated to acquire mobile gadget like tablets for use on construction site to enable them paired with main contractor on collaboration platform where useful information needed for their work could be retrieved. The focus group discussion indicates that regulative forces play a significant role when it comes to the institutionalisation of new technologies in the industrial context of the West Midlands. However, it became apparent that coercive impact of regulative force may limit institutionalisation, noting that some construction firms may limit their ICT adoption to the minimum level/requirement as specified in the law without aspiring to go beyond.

Normative pillar: The normative pillar is centred on norms and values in explaining actions and behaviour. BIM was considered as a ‘fashionable’ technology by one participant of the focus groups meeting alluding that main contractors on construction projects are only willing to partner with subcontractors who can implement new technologies, therefore it would appear that using emerging ICT is becoming a social obligation in construction project team selection. To understand the institutionalisation of emerging technologies in the region participants were probed further on reasons for adoption of new ICT on construction projects based on the outcome of document analysis in table 3, their answers are presented below:

When people say they use BIM, it does not necessary mean that they are digitally literate; perhaps they use 3D, probably they used 3D AutoCAD for design, but people think it is fashionable to associate with BIM and therefore equate everything to BIM (Digital Designer).

Years down the line, it is becoming less viable to use old equipment, you wait till ten years’ time. I won’t say it is the government law but people think it is not good enough to give client 2D drawings. Adoption is more than the government law or for competitive advantage, it is what more and more people are expecting. No one is expecting the shoddy 2D drawings anymore (Site Manager).

Probably the software is becoming cheaper, more people are getting interested but implementation is combination of many factors (Building Surveyor).

Acceptance will take time, it is a slow process ..., it will gradually circulate, [and] West Midland region is behind London (Mechanical Engineer).

Although the imposition of the level 2 mandate influenced institutionalisation of BIM in the region, there are other factors contributing to adoption according to the quotes above. These factors may include the intent of the project, how acceptable a technology is being perceived, the affordability of the software and clients demand. While some participants opine that the initial cost of adoption especially for SMEs, is

enormous, other experts reckon that software subscriptions are becoming cheaper and affordable. However, there is gradual adoption in the region.

Cultural-cognitive pillar: The cultural-cognitive pillar recognises the importance of making meaning of an innovation in a cognitive and cultural way. The cultural-cognitive element in implementation of new technology in the region is attributed to the number of ongoing activities and events aimed at showcasing the impact of BIM in the region. These activities and initiatives reflects a community seeking to create value and provide a culture of learning to influence adoption and institutionalisation. The cultural-cognitive pillar may not be popularly reported in construction management research, but it is a valuable deeper process of institutionalisation. One of the interviewee gave cogent insight into gradual adoption and institutionalisation of useful information and communication technologies in the region by this quote:

I train people locally on how to use Revit software, the initiative is funded by Coventry University and European Development Fund. The problem is that many senior people in construction business are old and can't be bordered with new technologies (Digital designer).

Decision of top executives in construction organisation is vital to adoption and institutionalisation of new ICT. Laggard decision makers will need to be enlightened to speed up rate of adoption and stimulate institutionalisation in the region. While ICT adoption appears to accelerate in large projects, top practitioners and construction firm's executives in the region remain sceptical as to whether the excessive costs associated with ICT adoptions are justified.

Institutionalisation Challenges and Barriers

Based on the outcome of strategy used for the data collection, some challenges and barriers hindering adoption and institutionalisation of ICT in the region were identified. Initial cost of procuring ICT by most SMEs is a challenge despite the availability of the laudable initiatives for training in the region. A thinkable solution to stimulate institutionalisation could be to form industry clusters where firms could share their experiences. There is more to learn from construction cluster organisation in many part of Europe with the main aim of improving domestic and international competitiveness of its member firms through commercial cooperation and networking, training, education, research and development activities. Educational buildings dominate project samples in Table 3, it is apparent is that the normative and cultural cognitive pressures are rendered weak in the region with using advanced ICT being viewed as extraordinary rather than standard industrial practice. Implementation of ICT is key to institutionalisation, role of ICT in project delivery in the region should be further strengthened especially among the top executives of construction firm. UK construction industry is faced with challenge of recruiting experts to meet the demands for emerging ICT application. While ICT technologies such as BIM, diverse software and project management platform are being adopted increasingly by large construction firms emerging ICT such as Sensors and Internet of Things (IoT) and Augmented Reality (AR) and Virtual Reality (VR) within the region are being utilise as training facilities. An example is UK's first construction training simulation centre in Coventry University, Solihull College and University Centre Virtual Reality (VR) and Robotics Development Centre among others.

CONCLUSIONS

A clear deduction from the study is that institutional foundation required for the West Midlands construction firms to deliver their projects based on ICT is to tackle

resistance to new technologies through quality training of companies' chief executives. The regulative pressures exerted by government in support of ICT adoption has started to materialise in industrial practice. However, most of the identified use cases of emerging ICT (Table 3) were found in public sector projects and the interviewees stressed that firms limited the use of advanced ICT unless otherwise demanded by their clients. One thinkable avenue for extending the outreach of regulative pressures to other types of projects could be for planning permission authorities to demand model-based designs or simulations as part of the approval criteria. In this way, other non-public sector projects would be compelled and hence increase ICT adoption. Moreover, there is an increasing ICT uptake in large projects, but general adoption among SMEs in the area remains a concern. It appears that many construction executives remain hesitant and sceptical as to whether high capital investments in ICT are justified. To tackle the risk averseness and resistance to new technologies and lack of 'innovativeness' among top executive in the region, new initiatives that target top executives should be considered. This would then strengthen the normative and cultural cognitive pressures. Dossick and Neff (2010) argued that even as technological advances such as BIM that enable collaboration and better information exchange, decision-making power in building projects is often divided organisationally. People make or break change, hence successful institutionalisation of emerging ICT is dependent on decisions of enthusiastic top executives of construction firms and stakeholders to embrace new technologies.

Application of the findings is peculiar to the region, this may limit the transferability of the results and recommendations given. Further research using qualitative and quantitative approaches could complement this work. From the perspective of institutional theory, assessment of institutionalisation of information and communication technologies in West Midlands was carried out. The existing initiatives towards construction practitioners and the SMEs are important for industry development. The normative and cultural cognitive pressures are rendered weak in the region as emerging ICT is viewed as extraordinary rather than standard industrial practice. The impact of non-regulative pressures in the region needs to be strengthened for progressive adoption that will lead to eventual institutionalisation.

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