

Institution: 10007140 Birmingham City University		
Unit of Assessment: UoA 13 Architecture, Built Environment and Planning		
Title of case study: Financial and efficiency improvements from socio-technical digitalisation of costing and procurement in the built environment		
Period when the underpinning research was undertaken: 2005-2017		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
David Boyd Hong Xiao	Professor of Construction Senior Lecturer in Property, Construction & Planning	1987 - Present 2003 - Present
Niraj Thurairajah	Senior Lecturer	2011 - 2018
Period when the claimed impact occurred: 2015- 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact (indicative maximum 100 words)		
<p>Industry funded research led by Boyd has highlighted the need for secure long-term supply chain partnership in the fragmented construction industry to help overcome the workflow challenges experienced by digitalizing the supply chain. National contractor Willmott Dixon and its subcontractor NG Bailey have improved costing and procurement strategies, saving them hundreds of thousands of pounds since 2018. More widely across the international construction industry, the research encouraged and normalised the switch to digital integration through socio-technical transformation of the supply chain and properly representing costs such that Small and Medium Enterprises (SMEs) are more secure and effectively procured and managed. This work has been recognized by the construction industry, including in the Procuring for Value report from the UK Construction Leadership Council which has been adopted for value-based procurement by the Construction Innovation Hub and within UK government departments.</p>		
2. Underpinning research (indicative maximum 500 words)		
Introduction		
<p>Through the period of 2006-2017, Boyd (supported by colleagues Xiao and Thurairajah, and PhD students) explored the need for designers, contractors and suppliers to engage with each other at the early stages of procurement of a construction project [R01]. The research is in response to identified conflicts in the supply chain [R02] with the digitalization of construction processes, through Building Information Modelling (BIM) adoption. According to [R02], in the absence of secure long-term engagement within the supply chain layers, the aim of digitalizing construction processes will be defeated as these just reproduce current practice and not substantively change cost and project management.</p> <p>Techniques and engagement from an earlier UK Department of Trade and Industry (DTI) funded project [R03] were used in research on digital transformation with the industry working with clients [R04], contractors [R02] and with industry bodies [R05]. Key findings revealed:</p>		
<ul style="list-style-type: none"> • The complexity of negotiations during projects created a separation between digital and project activities due to the fragmentation/multi-tiered system of subcontracts [R04]; • There is loss of cost information as costing does not adequately reflect the work carried out, and this is made worse in digital practices [R05] and • The main benefits arise from transparent integration which requires a cultural change in procurement and costing practices. This enables comprehensive planning of delivery 		

schedules, identification of inefficient processes early on in the design cycle and better building performance [R06].

Understanding challenges of BIM adoption among sub-contractors

Boyd's research investigated the key challenges of BIM adoption of 170 subcontractors in the UK construction supply chain [R02]. The research revealed difficulties of communication and planning within the supply chain layers through digital platforms. To overcome this, subcontractors desire a strategic change in the main contractor's supply chain management from the current project-based short-term supply chain arrangements, to longer-term arrangements. This secure relationship creates an atmosphere conducive to improving trust levels, encourage value-based procurement and investing in hardware, software and training for digitalization. Cultivating such collaborative work habits in the construction supply chain will also prevent repetition of mistakes, easier adoption of best practices and delivery of optimal end products.

Understanding cost as information to improve construction

Research reported in *Construction Management and Economics* (a highly respected journal) [R05], which analysed cost information using information theory, showed that the current practices of costing leads to information loss, as the cost information is either not created by the subcontractor who will do the physical work, or is obscured as it is passed on simply as quotations for work in a tendering situation. These current costing practices build-up distorted cost information to the client through layers of commercial decisions and reporting from the bottom of the supply chain upwards [RG01]. Although the practices are acceptable for buying, payment and budgeting, they are however not useful for construction improvement, making them unable to evaluate the advantage of BIM adoption. Therefore, without adequate engagement with the supply chain which would result in increased trust levels in the supply chain, merely collecting/automating costing in BIM would not improve the industry's ability to inform decisions that improve processes across the supply chain but would rather make the meaning of costs even more opaque.

Improving Industry Financial Return on Customer Satisfaction

The Building Alliance and BCU's Digital Construction Research Centre organized a workshop with 50 cross-industry stakeholders, to identify the opportunities that digital construction can offer to improve the process of building and living in new homes. The workshop's report: 'Housing- the digital revolution' [R06] concluded that digital construction offers the housing industry enormous opportunities to improve their financial return and customer satisfaction. This needs to be undertaken through integrated approaches: involving more efficient planning, design and construction processes, enhanced customer experience through feeding back information on needs, and pro-active management of whole-house performance and maintenance through collection and display of operational information.

3. References to the research (indicative maximum of six references)

- R01.** Boyd, D. (2013) 'Using events to connect thinking and doing in construction management', *Construction Management and Economics* vol. 31 no. 11 pp. 1144-1159, DOI: 10.1080/01446193.2013.866260
- R02.** Robson A., Boyd D., and Thurairajah N.(2014), UK Construction Supply Chain Attitudes to BIM, 50th Annual Conference, Associated Schools of Construction Conference, Washington 26th – 28th March, Ed. Tulio Sulbaran, <http://ascpro0.ascweb.org/archives/cd/2014/paper/CPRT224002014.pdf>
- R03.** Boyd D., Xiao H., and Chinyio, E (2005) Can Knowledge-Event Approach Work in Construction SMEs? *In 21st Annual Conference of the Association of Researchers in Construction Management (ARCOM)*, London, Sept, (Ed) F. Khosrowshahi https://www.arcom.ac.uk/-docs/proceedings/ar2005-1279-1288_Boyd_Xiao_and_Chinyio.pdf

R04. Çıdık, M. S., Boyd, D. and Thurairajah, N. (2017) Ordering in disguise: digital integration in built environment practices, *Building Research & Information*, 45(6), DOI: 10.1080/09613218.2017.1309767

R05. Robson, A, Boyd, D and Thurairajah, N (2016), Studying 'cost as information' to account for construction improvements, *Construction Management and Economics*, 34:6, 418-431, DOI: 10.1080/01446193.2016.1200734

R06. Boyd, David & Thurairajah, Niraj & Leonard, Mike. (2015). Housing - the digital revolution. ISBN: 978-1-904839-82-8 Building Alliance and BCU 10.13140/RG.2.1.1674.1846.

Grants

RG01. PhD sponsorship fees and bursary by Willmott Dixon Construction including access to commercial information and company operations. Jan 2013 to 2017, £54,000.

4. Details of the impact (indicative maximum 750 words)

The overarching impact of Boyd's research in socio-technical digitalization is a change in culture, engaged management and secure long-term relationships given financial and efficiency improvements.

Improved costing and management practices in the supply chain

Two large national construction companies; Willmott Dixon (WD), and NGB; have applied Boyd's recommendations to costing and procurement in the supply chain, thus saving money and delivering better projects. A £1.3bn turnover main contractor, Willmott Dixon (WD), improved the gap between tender pricing and operational costs within a digital environment. As a consequence of the research, WD has appointed a dedicated supply chain manager to enable the socio-technical digitalization transformation. According to WD's commercial director **[S01]**, '*research work helped us... to make savings of about 2% in procured packages.*' These savings correspond to several hundreds of thousands of pounds.

NG Bailey (NGB), a sub-contractor with £550M turnover, was open to cultural change and was able to better integrate their digital transformation processes by improving the engagement with supply chain partners. NGB has been able to reduce uncertainties around project delivery and there has been an increase of confidence in expected contract performance, resulting from a reduction in the likelihood of complaints and rework. According to the former Project Manager of NG Bailey, '*the research saved us [NGB] hundreds of thousands of pounds in the portfolio of projects through greater certainty and more engaged sub-contractors*' **[S02]**.

BIM costing development informed report on construction procurement changing policy and government procurement

Boyd's research informed the Procuring for Value report **[S03]** delivered by the Construction Leadership Council (CLC) workstream chair, who is also the Global Chair of Rider Levett Bucknall (RLB). Paper **[R05]** was referenced and the Global Chair of RLB states in **[S04]** that this research '*was a significant launch pad for the development of the CLC's Procuring for Value thought processes and my subsequent work*' which has led to the value-based procurement adoption within government departments. In September 2019, the recommendations of the Procuring for Value report were accepted by the Construction Innovation Hub (formed from the government's industry strategy to deliver the required change) and have been adopted for value-based procurement within government departments producing a value toolkit in July 2020 (a suite of tools for clients and policy makers to drive change). Whilst we do not have precise breakdowns of the secondary impacts which arose from this, between the high influence of this report, [it being adopted by Infrastructure and Project Authority (government delivery agency); major industry bodies such as Build UK (client, contractor and supplier network), the Civil Engineering Contractors Association and the Chartered Institute of Housing], the size of the industry (117bn GBP, 2018 UK Government statistics) and its influence on pre-qualification standards, contracts and retentions; and taking into account the caveat of limited time to produce impact (6 months),

we feel an estimate of several millions of GBP is justifiable primarily from transaction efficiency, reduction in waste, positive investment in change processes and in job creation.

Digital Housing Integration developing company policy and economics

As demonstrated by Boyd's research, the housing industry is ideally poised to adopt digital approaches particularly when wider socio-technical integration was enabled [S05], [S06]. Boyd led the Housing Forum: a unique workshop with many sections of the housing community including planners: Barton and Wilmore; Indemnity providers: NHBC; industry accountants: KPMG; logistics: Wincanton; architects: AHR; materials manufacturers: H&H Celcon and Plasmor; social housing developers: Keepmoat; specification providers: Robust Details; as well as housing developers: Barratt, Redrow and Taylor Wimpey. Together with knowledge acquired during the event, the report 'Housing: the digital revolution' [R06] was circulated to the industry. H&H Celcon has been enlightened on the clear and influential way in which digital transformation can benefit the construction industry, especially the subcontractors in the supply chain. As the technical director of material manufacturer H&H Celcon with a £750M turnover, states [S06] *'We are using these ideas, stimulated by the report, to position ourselves in future markets and develop the capabilities to help the industry with its material choices ...the principles are being transmitted to our sister companies abroad'*.

The 'Housing: the digital revolution' report [R06] informed Redrow Homes to improve its product offer without compromising on immediate delivery. The group CAD Manager of Redrow Homes Limited with a £1.339M turnover states [S05] *'... this report offers insights as we seek to constantly improve our product offer... We understand that overall cost and time savings from a fully integrated approach, as suggested by the report, could help us to deliver a significant value uplift in product as well as enhancing our reputation with the home occupiers'*.

5. Sources to corroborate the impact (indicative maximum of 10 references)

- S01.** Letter from Commercial Director, Willmott Dixon corroborating overall impact of the BCU research on Willmott Dixon's work in their construction supply chain [Named Corroborator 001]
- S02.** Letter from former Project Manager, NG Bailey corroborating research impact on the company's approach to work organisation [Named Corroborator 002]
- S03.** Procure for Value report July 2018, Construction Leadership Council, London, reference to Boyd and to paper [R03], [RLB-Procuring-for-Value-18-July-.pdf \(constructionleadershipcouncil.co.uk\)](https://www.constructionleadershipcouncil.co.uk/RLB-Procuring-for-Value-18-July-.pdf)
- S04.** Letter from Global Chair RLB and chair of Procurement and Supply chain work stream of Construction leadership council corroborating influence of the BCU research [Named Corroborator 003]
- S05.** Letter from Group CAD Manager, Redrow Homes Limited, corroborating influence of the BCU research on understanding digital housing development [Named Corroborator 004]
- S06.** Letter from Technical Director, H&H Celcon material manufacturer corroborating influence of the BCU research on understanding digital housing development [Named Corroborator 005]