POTENTIALITY OF EMERGING TECHNOLOGIES TO MINIMISE LATE-PAYMENTS QUANDARY IN CONSTRUCTION

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Globally, late payments to contractors remain a persistent issue in the construction industry. Recent studies in UK reveal substantial rise of 27% cases of late-payments; with over £30 billion of unpaid invoices to construction contractors. Yet, there is little empirical study concerning the role of emerging digital technologies such as Agresso Unit 4, 5D-BIM and Automated Payment Systems (APS) in alleviating chronic late-payment quandary in the construction industry. What are the potentiality (likely quality that can be developed) via use of emerging technologies to minimise late-payment in the construction industry? The study adopts a sequential explanatory type of mixed methods design strategies; in addition to use of five case studies to investigate potentiality of emerging technologies in minimising late-payments. Representative population sample that includes digital technology experts and construction professionals in the UK participated in the study; for better understanding of the research problem. The findings show that implementation of emerging technologies at the right level has potential to significantly minimise late payments menace in the construction industry. In specific terms, emerging technologies have potentials to leverage deep rooted administrative payment glitches, cultural and technical problems associated late-payment problems in construction. Other findings are presented in the conclusion section of the study. The study is part of on-going PhD study that seek to develop of a smart valuation and cash flow systems that will help minimise late-payment predicaments to construction contractors.

Keywords**:** emerging technologies, late-payments, construction industry

INTRODUCTION

Globally, the issue of late-payment to construction contractors remain a reoccurring problem. In the UK, dilemma of late-payment seems to have defied various contractual, government and private initiatives designed to curb the menace. Stallons (2017) claim that "late-payment is a huge and debilitating problem for most businesses in the UK". The Euler (2015) report assert that there has been substantial increase from 18% to 27% in number of late-payment cases in the UK construction industry; with over £30 billion of unpaid invoices to Small and Medium Enterprises (SMEs) contractors. Certainly, late-payment predicament is not peculiar to SMEs alone; major contractors in the industry also experience similar problems. Construction Excellence (2016) confirm that on average large construction companies

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spends 130 hours per year; with approximated cost of £1,500 per business chasing late-payment. Indeed, the issue of late-payment in construction is truly a deep-rooted problem; that requires holistic approach including government interventions; clients/contractors' charters, legislative initiatives, awareness of stakeholders, et cetera. Desjardins-Proulx *et al.*, (2017) assert that there is no gainsaying that emerging digital technologies such as Agresso Unit 4, 5D-Building Information Modelling (BIM), Automated Payment Systems (APS), Smart contracts and Artificial Intelligence (AI) systems are moulding business landscape, dramatically reduces delinquencies, enhances reliability and changes pattern of work.

Yet, there is little empirical study concerning how these modern technologies can be used to alleviate chronic late-payment problem in the construction industry. Therefore, the study seeks to investigate potentiality (i.e. likely quality that can be developed) via the use of emerging technologies in minimising late-payment quandary in construction.

LITERATURE SURVEY

Emerging Technologies and Their Leverage on Construction

A report from the Department for Digital, Culture, Media and Sport entitled "A Digital Strategy for a Digital Economy" (DDCM&S (2017) claims that use of emerging technologies especially smart systems has potentials to boost business transparency, create platforms for better connectivity to businesses; save time, money, dramatically reduces delinquencies, enhances reliability and changing work practices that are unproductive. However, there is little literature concerning the role of emerging technologies in minimising late-payment to construction contractors. Thus, there is need for thorough understanding of literature, theories, and dynamics about likely quality that can be developed via use of emerging technologies (such as 5D-BIM, Automated Payment Systems (APS), Smart contracts, Agresso Unit 4, and Artificial Intelligence) in minimising late-payment quandary in construction.

For example, BIM level 1to 3 have grew to become useful tool in solving problems in the construction industry. The Associated General Contractors of America (AGCA, 2006) define BIM as "a data-rich, object-oriented, intelligent and parametric digital representation of a facility" that enables users to extract comprehensive and accurate information that can be used to improve processes and making decision on a facility throughout its lifecycle. Yet, development of 5D-BIM is even a "data-rich" objects that support the function of cost modelling; assemblies of cost components; added either by incorporating cost data in the model itself or "live-linking" to estimating software tools (Boon and Prigg 2012).

Kamardeen (2010) and Forgues *et al.*, (2012) affirm that the benefits of 5D BIM includes value engineering, cost certainty, effective design, time savings in take-off of quantities, estimation; transparency and increased control and predictability to project stakeholders. Moreover, efficacy of 5D is predicated on dynamic link to information model that forms a foundation of living cost plan (Mitchell, 2012). Foundation living cost referred to by Mitchell (2012) is an updated estimation model that changes simultaneously with finance, funding, budget variances, cost forecasting, investment decisions as well as negotiations with contractors. Besides that, 5D BIM information model allows extraction and modification of cost information on BIM framework by creating relationship between elements, specifications and properties of individual

elements and objects that generate cost related data for a project (Eastman *et al*., 2011).

Moreover, other contemporary digital technologies have been proven to have great leverage over construction process. Barber (2012) posit that digital devices such Automated Payment Systems (APS), Smart contracts and Agresso Unit 4 provide opportunity for instant and timely payments practices that are accurate, efficiency and easily interrogated within project base organisation. These devices have dynamic link on modelled information that allows for easy recompilation of quantities that enhance progress payment calculations visible to supply chain.

 Mitchell (2012) is of the view that these technologies are likely to minimise dependence on cost consultant or quantity surveyors concerning valuation of works at project level together with associated administration costs. However, numerous factors such as lack of investment, cultural resistance, setup costs, lack of government interventions and professional capabilities are likely to hinder smooth implementation of these technologies. Regardless, of acclaimed benefits of emerging technologies on construction; their influence on minimising late-payment remain unsubstantiated.

Overview of Late-Payment in the Construction Industry

The phrase "late payment" or "delay payment" are often used interchangeably to mean payment not received at as when due. Ramachandra and Rotimi (2015) expound that the phrases are often used to denote the same thing. However, UK government report titled "Late Payment and Grossly Unfair Terms and Practices" consistently used the word "late-payment" to illustrate a contract situation where a party fails to reciprocate payment to another party upon satisfactory completion of assignment based on pre-agree contract payment terms. Harris and McCaffer (2003) define late payment as failure of paymaster to pay within the period of honouring of certificates as provided in the contract. Late payments normally occur when there is delay between the duration and the agreed stipulated time frame for receiving payments.

Failure to pay complete invoice on time has many negative effects on construction; particularly contractors' financial ability to execute projects, negative cash flow and profitability problems (Jiang, 2014). Salder (2015) asserts that more than one-third of main contractors are paid more than 60 days after issuing invoices. Recent survey conducted by Federation of Small Business (FSB, 2016) claim that on average 15% of SMEs contractors' turnover are tied up due to late payments bottleneck.

Judi and Rashid (2010) acknowledged that late-payment to construction contractor is a universal problem caused by host of factors. Ye and Rahman (2010) argued that clients' inability to rise sufficient funds, poor administrative acumen on the part of contractors, contractual misunderstanding and system failures are major causes of late-payment in the construction industry. Besides, Rotimi *et al*., (2010); Pettigrew (2005); Abdul-Rahman (2009) and Abdul Rahman *et al*., (2010) all argued that typical construction payment syndrome that encourages "execution of work by contractors and get paid later" is the main reason for deep-rooted deferred payment problem in the industry. Other authors such as Ansah (2011); Ramachandra (2013) and Danuri *et al*., (2006) argued that poor financial management, inadequate funds and the use of "pay-when-paid" tactics by major contractors all contributes to chronic late payments dilemma in the industry. Hindsight of corrupt activities often associated with the industry is also a likely factor (Arewa and Farrell, 2016). The Australian Procurement and Construction Council (1996); Pettigrew (2005) and Ramachandra and Rotimi (2011) are of the view that existence of multi-tiered hierarchical structure, together

with cascade payment obligations makes the industry susceptible to unavoidable late-payment dilemma.

In essence, prevailing payment mechanisms in construction, long supply chain, delays in approval of works, errors in submitting claims/valuations for work done, client failure to implement good governance in business, administrative errors, contractors delaying submission of claims/invoices, inadequate supporting documents, cascade payment obligations, multi-tiered hierarchical structure of contractual framework; paymaster withholding of payments, client poor financial management, insufficient financial resources and disputes over payment claims all contribute to lingering late-payment problems (Judi, 2010; Pettigrew, 2005; Ramachandra and Rotimi, 2011).

Government and Private Initiatives to Curb Late-Payment in Construction

The UK government acknowledged the problem of late payment in construction; and reactively put forward various legislations and contractual measures to curb the menace. For example, the Housing Grants Construction and Regeneration Act (HGCRA 1996) made clear payment provisions for any construction contracts. The Act stipulate 28 days payment timeline to contractors; with total delay period of 45 days afterwards interest on delayed payment will apply. In addition, the Local Democracy, Economic Development and Construction Act (2009) is believed to have stringent penalties concerning delay payment to contractors. The Scheme of Construction Contract Act 1998, the Late Payment of Commercial Debts Regulation (2013) and the Construction Supply Chain Payment Charter are all initiatives employed by government to checkmate chronic late-payment matter in construction.

Arguably, the issue of late-payment in construction appears to defy various contractual and private initiatives. For example, various Standard Forms of Contract such as the Joint Contract Tribunal (JCT 2016), New Engineering Contract NEC 4, the International Federation of Consulting (FIDIC), etc. all have standard payment guidelines. The Construction Leadership Council (CLC) payment charter backed by the UK government in 2014; is an initiative of major contractors, SMEs and other private clients. The Council agreed to pay all contractors under its umbrella within 30 days. However, these Acts, charters and initiatives though designed to provide security of payment to contractors seem to be ineffective for various reasons. Perhaps, due to factors such as client care consideration, administrative lapses, lack of political will and varying economic situation of clients.

Recent study reveals that over 62% of late-payment issues in construction relates to technical, managerial and contractual issues (FSB, 2017). The Department for Digital, Culture, Media and Sport's 'Digital Strategy for a Digital Economy' stresses that emerging technologies have potential to minimise profound industry problems, cultural practices, human and legislative factors that are difficult to resolve by mere human tendencies (DDCM&S 2017). But, it is myopic to assume that emerging technologies alone, will solve persistent late-payment delinquent considering the scale and other cultural issues that exist in construction.

RESEARCH APPROACH

The study methodology is hinged on pragmatic paradigm; because the research focuses on practicality i.e. potentiality of emerging technologies to minimise late-payment quandary in the UK construction industry. The choice of pragmatic research paradigm is predicated upon the fact that it provides an underlying philosophical framework for mixed-methods research (Teddlie, and Tashakkori, 2003).

The multi-methods research design used QUAL-QUAN concept (Creswell, 2003); meaning that qualitative method is the lead data collection instrument, while quantitative data are used to support and validate the qualitative findings. The study used sequential explanatory type of mixed methods design strategies; for better description of the research theme; as illustrated in interview and discussion sections. Research ethics approval was sought from Coventry University Research Ethics Committee and it was granted, see attached ethics certificate attached as appendix A. The study research method design considered data collection techniques, location of the study and data analysis as illustrated in the succeeding sections.

Study Location, Population Sample and Data Collection Technique

Data collected relates to potentiality of emerging technologies to minimise late-payment to contractors in the construction industry. The study quantitative and qualitative data targeted a population sample that comprises seasoned digital technology experts and construction professionals such as Architects, Construction Managers, Clients, and Quantity Surveyors. The study data were collected in various locations in England.

The study data collection and analysis are divided into three stages. Phase 1: questionnaires data to ascertain contemporary factors that influences late-payment to contractors. Phase 2: interviews data designed to tease out potentiality of emerging technologies to minimise late-payment and Phase3: used of archive data to ascertain likely quality of emerging technologies in alleviating problem of late-payment.

Phase 1: entailed design of questionnaire, data collection, and analysis using SPSS. Factors that influences late-payment to contractors identified in the study literature were used to design the questionnaire to ascertain contemporary factors that influences late-payment to contractors. These factors were then ranked using Relative Importance Index (RII) as illustrated in Table 1 below. See discussion section for findings concerning table 1.

Table 1: Relative Importance Index (RII) of Factors that Influences Late-payment to Contractors

Ranking of factors that influences late-payment to contractors	RII	RANK
Delay to approving work done	0.705	1
Insufficient financial resources	0.698	2
Inadequate supporting documents	0.677	3
Contractors delaying submission of claims /invoices	0.621	4
Client failure to implement good governance in business	0.547	5
Disputes over payment claims and responses	0.464	6
Administrative errors	0.422	7
Cascade payment obligations	0.402	8
Errors in submitting claims and valuation for work done	0.391	9
Paymaster withholding of payments	0.365	10
Multi-tiered hierarchical structure of contractual framework	0.344	11
Other factors	0.321	12

Phase II: Interview Data

History of Qualitative Research Reveals Endless Theoretical Arguments about Validity and Credibility; Often Referred to As "Truth and Integrity of Qualitative Research" (Kvale 1996; Gaskell and Bauer, 2000). to Avoid Philosophical Arguments about Validity of Qualitative Research; the Authors Accepted Standpoint of Kuzmanić (2009) Who Asserted That "There is a Pure 'Form of Truth' Somewhere Out There, Which Can Be Discovered Through (Construct, External and Internal Validity) Use of Appropriate and Valid Research Methods. Credibility and Validity of the Study Were Upheld in Three Fundamental Areas Namely: Production (Design of Interview Questions, Interview Process and Recording of the Data), Presentation (Replicability, Valid Inference and Arrangement of the Data) and Interpretation (Meaningful Discussion of Data). the Interview Data Were Analysed Using Content Analysis for Easy Inferences to Antecedents of Interviewees' Discussions; Concerning the Study Subject Matter. for Example, Interviewees Were Asked to Evaluate and Express Their Views Concerning Potentiality of Emerging Technologies in Minimising Late-Payment to Contractors in the UK Construction Industry. Textual Contents of the Interview Data Were Transcribed into Manuscript, Inputted into Nvivo 10 Software; and Coded Using Key Study Themes. Subsequently, the Key Themes Were Trimmed for Better Understanding and Spontaneity of the Interaction Between Study Participants and the Researchers. Some Textual Excerpts Are Expressed Verbatim; As Illustrated Below for Better Understanding of Interviewees' Thoughts.

> …Late Payment to Contractors Remains Emotive Issue, Uncertainties Exist Within Payment Terms Stipulated in Contracts … It is Doubtful Whether Technologies Can Be Used to Leverage Deep Rooted Human Attitudes about Late-Payments (Contractor - Birmingham UK)

> … At this Point in the History of Construction … Digital Technologies Have Potentials to Interpolate Contract, Cost, and Payment Data … Their Latent Qualities Will Certainly Reduce Administrative, Human and Technical Errors That Influences Late Payments (Software Design Engineers - London).

However, When Participants Were Probed Further on Potentiality of Specific Emerging Technologies Such As BIM and Digitalisation of Payment Processes to Alleviate Chronic Late-Payment to Contractors; Their Answers Were Wide-Ranging. Some Participants' Responses Are Presented Thus:

> ...Currently Design Features in BIM Do Not Tackle Late-Payment Peril; …But Its Digital Potential Can Be Reconfigured to Ease Out Technical and Contractual Errors Associated with Payment Processed Such As Delay and Valuation Errors (BIM Coordinator, London UK).

> …Certainly, Digital Technologies Such As Agresso Unit 4 Version 5.6 and Automated Payment Systems (APS) … Have Potentials to Enhances Payment Practices and Minimise Scepticism Surrounding Administrative Errors, Delay in Approving Work Done and Other Human/Cultural Risks Linked to Late-Payment … Unfortunately Only Few Businesses Have Invested in Such Technologies (Project Manager, Norway)

Phase III: Archive Data

Table 2 Illustrates Summary of Average Time-Line Between Manual and Use of Digital Payments Systems in Various Construction Companies. the Captured Data Consist of Five Case Studies in the UK Construction Industry; Scrutinised to Ascertain Payment Time-Frame Between Manual and Automated Payment Systems.

FINDINGS

The study quantitative inquiry summarised in table 1 above show that "Delay to approving work done"; "insufficient financial resources", "inadequate supporting documents" and "contractors delaying submission of invoices" ranked 0.705, 0.698, 0.677 and 0.621 respectively in RII test. The ranking in table 1 illustrates important index factors that influences late payment in the construction industry. The study qualitative inquiry suggest clearly that digital technologies have potentials to interpolate contract, cost, and payment data; with latent qualities to reduce bureaucratic and technical errors that are hallmark of late payments. Table 2 findings demonstrate that automated payment systems provide adherence to stipulated contract payment time-frame.

Table 2: Summary of average time-frame between manual and automated payment systems

Nature contractors; clients; Value of project and country	Payment process technique	Contract Stipulated time-line for payment (in days) from the day of receiving invoice	Average number of days professed by contractors to receive payment from clients
1. Nature of project: roof work; Contractor: SMEs. Project value £32,345; Client: Large construction company. Turnover: over £121M. Country: UK	Traditional value and manual invoice system	28 days	32 days
2. Nature of project: Refurbishment and construction of new classroom; Project value: £3.7M. Contractor: Large construction company; Client: Local Government Council. Country: UK	Traditional value and manual invoice system	28 days	41 - 45 days
3. Nature of project: painting and road marking; Contractor: SME Project value: £11,504; Client: Large Local Government Council Country: UK	Traditional value and manual invoice system	28 days	28 - 45 days
4. Nature of project: construction of water channel. Contractor: Local SME; Project value: £92,870; Client: Local Airport Authority. Country: UK	Automated systems	28 days	26 - 28 days
5. Nature of project: Framework agreement for plumbing work. Contractor: M&E SME contractor. Project value: varies depending on number of call-out. Client: Utility company with average annual turnover above £607M. Country: UK	Automated systems	14 days	14 days

DISCUSSIONS

A common deduction from the three set of data analysed reveal that late-payment to contractor's remains a deep-rooted problem within the UK construction industry. The study quantitative findings summarised in table 1 identified host of factors that influences late-payment to contractors; with "delay to approving work done" ranked most common factors. Thorough examination of these factors suggests combination of both administrative and technical failure. Indeed, emerging technologies places significant role in dynamic interoperability and modelling of information that allows for easy recompilation of quantities that enhance calculation of progress payment and

transparency. Moreover, analysis of archive data in table 2; show that organisations that uses emerging technologies or automated payment systems are more likely to adhere to contract payment stipulated time-frame compared to traditional valuation payment system. Most interviewees consent that emerging technologies have potentials to minimise late payment. An interviewee particularly mentioned that "… certainly, digital technologies such as Agresso Unit 4, BIM level 4 and Automated Payment Systems (APS) if adopted properly have potentials to enhances payment practices and minimise scepticism surrounding administrative errors, delay in approving work done and other human/cultural risks linked to late-payment. However, some study participants appear to exhibit element of doubt on whether emerging technologies can be used to leverage deep rooted human attitudes and contractual culture that exist in the construction industry.

CONCLUSION

The aim of the study is to identify potentiality of emerging technologies in minimising late-payment dilemma in the UK construction industry. The study literature suggest that late-payment remains a serious problem to both large and SMEs contractors. Key deduction from the study show that emerging technologies such as Automated Payment Systems (APS), Smart contracts and Agresso Unit 4 have potentials via interoperability of contract, cost, processing of work done and invoice data for timely payments practices that are accurate and efficiency. Moreover, emerging technologies have potentials for in-depth scrutiny and interrogation of checkered history of late payment that is commonplace in the construction industry. However, there are number of drawback that may hinder businesses from using these emerging technologies; such as lack of willingness to invest, scepticism about return on investment and huge initial costs involved in the procurement and installation of these technologies.

Besides, there are insinuations that practitioners in the construction industry are not yearning or doing enough to promote the use of emerging technologies. The construction industry is generally deemed to be slow in adopting new technologies compared to other industries. But there is need to harness interoperability potentials of emerging technologies to reduce administrative, human and technical errors that influences late payments. From professional standpoint, emerging technologies have latent qualities to minimise dependence on cost consultant or quantity surveyors concerning valuation of works at project level together with associated administrative costs. Many, experts are of the view that advancement in smart contracts and Artificial Intelligence (AI) systems if syntactically interpolated into BIM framework have potentials to expedite payment process and offer greater transparency to all supply chain.

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