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EDUCATING BUILDING PROFESSIONALS FOR THE FUTURE IN THE GLOBALISED WORLD

TECHNOLOGY
VOLUME 2

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CURTIN UNIVERSITY
This study investigates how disputes are increasing in both the short and long range. In Australia, there is evidence to suggest that 50% of all legal costs are associated with the construction industry. This is widely believed that a prerequisite for disruptive change is the incorporation of Building Information Modelling in order to bridge the gap between the phases of the development cycle. The Intelligent Contract is the logical next step towards this goal to fill the gap; however, the relevant literature is scarce and there is lack of in-depth investigation to identify drivers and barriers of using this technology. This study investigate how Intelligent Contracts could be best implemented within the construction industry and how the current information modeling systems could offer the initial catalyst for their adoption. The paper aims to identify whether BIM offers a definitive platform for the implementation of Intelligent Contracts in the Construction Industry. The benefits of this new approach is greater administrative efficiency with reduced costs and less disputes. Surety of payment would lead to additions small companies being able to operate with confidence in the sector. Creating an environment where the sophistication of data exists from all stakeholders, that will be the fuel for a central Intelligent Contract system, will require a huge step towards the digitisation of the industry. It is predicted that increasing levels of digitisation occurring in pockets around the Construction Industry will eventually lead to the Internet of Contracts.

Keywords: BIM, Collaboration, Construction, Intelligent Contract.

1 Introduction

At the centre of all construction projects is the contract between the client and contractor and, as any construction project is a relatively complex process, the industry has demanded contracts of greater sophistication as the sector has evolved. The recommended use of one single standard form of contract for the construction sector has existed since the 1960’s (Banwell, 1964). Organisations compete to promote their own suite of contracts but the perceived need to amend construction contracts to suit individual construction projects still exists as does the careful consideration of project specific parameters to be inserted in order to achieve a successfully executed contract (Foreward, 2002).

The construction industry has a reputation for being adversarial and motivating dispute. In Australia, there is evidence to suggest that 50% of all legal costs associated with construction projects are a direct result of dispute (Chern, 2010). According to the ARCADIS Global Construction Disputes Report 2016, the global dispute value is down from US$31 MILLION in 2014 to US$46 MILLION in 2015 but the average length of these disputes has increased from 13.2 months to 15.5 months in the same period. The continuing trend observed over the past 6 years is that disputes are increasing in both value and in the length of time taken to resolve them (Arcadis, 2016).

Barriers and drivers of Intelligent Contract implementation in construction

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Abstract:
The new wave of multi-party, alliancing and collaborative tools contracts have paved the way for the disruptive change required to finally force collaboration into the construction industry. It is widely believed that a pre-requisite is the incorporation of Building Information Modelling and Target Cost Pre-control Management, in: Proceedings of the 20th International Symposium on Advancement of Construction Management and Real Estate. Springer, Singapore, pp. 875–882. https://doi.org/10.1007/978-981-10-0855-9_77


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1 Introduction

At the centre of all construction projects is the contract between the client and contractor and, as any construction project is a relatively complex process, the industry has demanded contracts of greater sophistication as the sector has evolved. The recommended use of one single standard form of contract for the construction sector has existed since the 1960’s (Banwell, 1964). Organisations compete to promote their own suite of contracts but the perceived need to amend construction contracts to suit individual construction projects still exists as does the careful consideration of project specific parameters to be inserted in order to achieve a successfully executed contract (Foreward, 2002).

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The deep-rooted cultural aversion to the trusting approach has seen partnering and framework agreements falter within the industry (J Mason, 2017). The problem of gaining trust has baffled social science since the day of Thomas Hobbes (Ceric, 2015). In the United Kingdom, standard form contract providers stand at a cross-roads on whether multi-party contracts, encouraged by the partnering ethos, is the way forward (Saxon, 2016). It is postulated that the solution to the trust issue is to make contracts trust-less. Truly autonomous, intelligent contract minimise the need for conventional human management. Furthermore, using blockchain-type technology, trust can be built into the model through immutable records in a distributed ledger. The full or semi-automation of contract administration alone which could be achieved through implementing Intelligent Contracts would stand to save the industry an attractive percentage of any projects costs (Cardeira, 2015). The fanfare of BIM technology brought with it all the pomp and promise of a technology saviour that would transform the industry. The level of BIM usage and the capabilities of the major platforms are not at a stage yet where the platform could be harnessed to facilitate the implementation of Intelligent Contracts. Potential user numbers would not be viable and technology capabilities are not sophisticated enough. Put simply, intelligent (or “smart”) contracts are computer protocols that facilitate, verify, or enforce the negotiation or performance of a contract, or that obviate the need for a contractual clause (Szabo, 1994). The proposal of embedding the terms and conditions of an agreement into a physical item contracts immensely from a traditional paper contract which, upon being agreed, is used only when the parties are in dispute. Intelligent Contract is the term used when a contracts purports to manage itself (J Mason, 2017). The Intelligent Contract will set out the requirements and decision inputs (hold points) that will start a series of if / then’s that will execute the terms of the contract between client and different members of the project team, main contractor, sub-contractor to design, monitor, approve, tender, install, certify and take handover of the built asset (Hughes, 2017). The ‘black and white’ or ‘1 or 0’ execution of an Intelligent Contract is a huge obstacle to overcome in adopting the potential technology in the construction industry. This is due to the complexities of the construction process requiring judgement and discretion which would normally be handled through subtlety and refinement in the language of traditional contracts (J Mason, 2017). The language of code does not allow for grey areas, but could this be the catalyst for changing the combative attitude of the industry by forcing parties to agree most, if not all, terms prior to engagement? By creating an all-encompassing contract process - that: ensures all parties adhere to the terms agreed; offers protection of payment, insurance and data; as well as the potential to increase efficiency and reduce risk – it should make the successful implementation of Intelligent Contracts the top priority for the Construction Industry. The first step to making this possible could be to build on the momentum that the BIM agenda has created and to compliment the BIM platform before evolving into further technologies. By replacing the ‘hammer’ that is the current construction contract with a more streamlined, efficient and collaborative tool that Intelligent Contracts could be, perhaps the industry will stop treating each other as nails.

The aim of this paper is to show how Intelligent Contracts could be best implemented within the construction industry and how BIM could offer the initial catalyst for their adoption. The industry’s adversarial history has led to a point where a truly innovative and disruptive change is required at the very heart of the binding contract in order to advance the sector into the digital age. Is the need to force parties to trust, rather than appeal to them to do so, which is required after the slow acceptance of the collaborative culture championed in the previous decades?

2 Literature Review

The ARCADIS report shows the ranking of the main causes for dispute in 2015 globally: i) Failure to properly administer contracts; ii) Poorly drafted or incomplete and unsubstantiated claims; iii) Errors and/or omissions in the contract document. Main Contractors can be especially susceptible to disputes due to the complexity of overseeing a construction project and the risks involved (Klee, 2015). Add into this the difficulty of an international construction project, where stakeholders and vendors may span the globe with different jurisdictions and laws, and you have a machine with a lot of moving parts that may not fit perfectly together. Understanding how to adequately deal with any dispute that arises in a project is often the difference between success and failure (Lamont, 2016). The evaluation of what party will be more negatively or positively affected if the risk does or does not take place must also be a consideration when balancing any contract based on the intention of the contracted parties. There is long list of biased amendments that can be imposed upon unwary contractors. The formation of a concise strategy to assess the risks from any contract and respond appropriately so as to mitigate exposure is a must to the successful operation by any contractor or sub-contractor. (Jim Mason, 2016).

In the United Kingdom, standard form contract providers stand at a cross-roads on whether multi-party contracts, encouraged by the partnering ethos, is the way forward (Saxon, 2016). The industry outlook in the last decade has centred on partnering arrangements which are still very reliant on the duty of good faith between the contracting parties (J Mason, 2007). The deep cultural adoption of a distrustful approach to contracts and the adversarial nature of the industry has seen partnering and framework agreements falter within the industry (J Mason, 2017). Could the very crux of the industry’s problems in executing contracts be human nature? It is said that the term “business ethics” has been deemed an oxymoron in the industry (Jim Mason, 2009).

The multi-contracutal links over the main stages of a construction project, due to the multitude stakeholders involved, the contract administration required and the time needed for each stage of the process is extremely onerous. The full or semi-automation of contract administration alone which could be achieved through implementing Intelligent Contracts would stand to save the industry an attractive percentage of any projects costs (Cardeira, 2015). Improvement in the Industry has been sought through collaborative practices since the (Latham, 1994) and (Egan, 1998) reports stipulated the deficiencies of the industry and the need to shift from the historically adversarial attitudes that has plagued the sector. Many innovations have been implemented, and while there have been some breakthroughs, progress has been slow. While Construction 2025 (HMG, 2013) does not set collaboration as a specific goal, a SWOT (strengths, weaknesses, opportunities, and threats) analysis within the report classes collaboration as: a weakness - due to limited knowledge sharing from projects which are often team-based with knowledge lost when the team breaks up at project completion; an opportunity - through BIM which it states could improve sector productivity and lower costs due to improved information flow and greater collaboration; and a threat - due to fragmentation in the sector which impacts on levels of collaboration, innovation and ability to access foreign markets. The Government Construction Strategy (GCS) 2016-20 set out the Government’s plan to develop its capability as a construction client and act as an exemplary client across the industry. It built on the success of GCS 2011-15 and including the development of collaborative procurement practices, developing a collaborative culture within the supply chain and mandating BIM on all centrally procured projects moving towards BIM level 3 maturity.
Seeking to address the issues raised in the numerous reports on construction sector practices, the industry has responded with many tools and process that have provided guidance on the best practice of implementing collaboration. However, the successful implementation of collaborative technologies is reliant on the environment being collaborative. This has at times created a ‘cart before the horse’ scenario as many of these technologies have been produced in order to create such an environment (Briggs, 2006). Kwan (2000) claims collaborative environments cannot be created using software tools and that collaborative technologies are more successful when collaborative working environment already exists prior to implementation.

2.1 BIM and collaboration – an evaluation on the current status and future

The United Kingdom Government Construction Strategy (GCS) 2011-15 mandated the UK industry to use BIM level 2 on Government projects and must demonstrate collaborative practices in order to win Government contracts as BIM is a tool that encourages open, collaborative working (HMG, 2015). BIM increases the scope and speed of data exchange which highlights the input required, the timing of the input and the reliance of the data from any member of a project team. The proposition is that this process enables and depends upon increasing collaboration as a means for success (Mosey, Howard, & Bahram, 2016). For BIM to be truly used to its full potential, a collaborative environment must be present to offer ‘real-time’ collaboration. The 2015 NBS National Survey noted that 57% of those surveyed agreed with this and most described their contract form as collaborative, especially users of the NEC3 or PCC2000 form of contract (Mosey et al., 2016). Some standard form contracts have adopted a light touch in relation to the inclusion of BIM provisions with many using clauses that simply refer to the Construction Industry Council (CIC) BIM Protocol. The CIC Protocol is designed to encourage BIM adoption through a series of supplemental contract documents which are signed by the client and then bi-laterally with the main contractor, subcontractors and consultant that make up the project team. This network of bi-lateral contracts is the alternative to a multi-party contract and serves the purpose of creating the necessary ‘consensus ad idem’ well in its absence (J Mason, 2017).

The flawed nature of the industry’s attitude is evident in the CIC Protocol (Jim Mason, 2016). The lack of warranty in relation to the integrity of electronic data transfer, before and after transmission, and the lack of liability for the modification, amendment, transmission, copying or use of BIM models other than for the agreed purpose. The most obvious limitation of the CIC Protocol however is in clause 4.1.2 where the production of models in accordance with the Agreed Levels of Detail specified in the Model Production and Delivery Table to ‘reasonable endeavours’. As (Mosey et al., 2016) states, “this is a lower, less clear duty of care than the widely accepted standard of reasonable skill and care.” This is of course unclear and has been interpreted by the courts in many ways according to the context in which it is used.

A growing interest in the role that multi-party contracts play in successfully supporting BIM enabled projects has been evident in the use of PCC2000 and other comparable multi-party contracts that have been developed in Australia and the USA (Mosey et al., 2016). The cooperative nature of these contracts creates the necessary environment for BIM to be optimised. When we contemplate the implementation of BIM level 3 the level of collaboration is starting to rely more on stovepipe collaboration where each piece of work is indistinguishable from the next and the author is not notified of any changes to their contribution by other project members (Elliott, 2006). Collaboration at this level is most certainly reliant on a multi-party contract, if only to deal with the liability of the project insurance (Jim Mason, 2016).

2.2 Barriers of utilisation of information modelling and intelligent systems

Technology adoption refers to steps taken through which a decision maker passes to evaluate a new technology and make a decision to accept or reject it. In the next step, the decision maker organisation enters into a new process of using the technology which is called implementation (Sepasgozar, Davis, Li, & Luo, 2018). This suggests that utilised technology could add value to the organisation, and if this process of utilising the intelligent contract is successful, it will be a source of competitive advantage and is critical for the organisation to collaborate effectively with the stakeholders. The success of implementing any new technology depends on many factors. For example, personnel’s attitudes toward new technologies are shaped by the risks involved in using unknown means and methods, the difficulty of implementation, financial risks, and the perception of other workers’ attitudes toward new technologies (Tatum, 1989). While BIM is expected to deliver many benefits to the industry, a range of barriers have hampered its widespread implementation. (Liu, Xie, Tivendale, & Liu, 2015) categorised these into five major groups: lack of a national standard; the high cost of application; the lack of skilled personnel; organisational issues; and legal issues. Standards are common throughout the every facet of the AEC industry but successful BIM implementation requires the development of new standards pertinent to the technology (Liu et al., 2015). The lack of appropriate governing standards for sharing data between all stakeholders in the development process is seen as a barrier to the technology being accepted. In the 2014 Pinsent-Mason Survey it stated, “The overriding message…points to clear collaboration if BIM is to be a success.” However, they provide evidence showing that collaboration is not a new objective or concept for the construction industry, and policy makers and industry stakeholders have strived to create a more collaborative environment, albeit limited success (Roberts, 2014).

Data inconsistency is the most prominent data-related barrier as well as data compatibility between stakeholders. Willingness to share information among project stakeholders is critical to BIM, therefore any issue with transmitting and reusing the BIM data constitutes a very real barrier to BIM implementation (Ahmim & Venkatesh, 2014). A survey taken by the National Building Specification (NBS) organisation showed that a single BIM data platform is yet to be established and 26% of BIM users relied on multiple pieces of software (J Mason, 2017). The interoperability of BIM software is seen as a key issue, but it is one that is being addressed, by new tech company flux.io, in the next wave of AEC technology. Flux.io are investigated further in this paper regarding their solution for this issue.

Addressing the legal aspects of BIM development is also necessary and intellectual property rights is a topic that has caused some nervousness around BIM (Jim Mason, 2016). If owners pay for the architectural design of construction projects, they may claim ownership of the design documentation but licensing problems may arise when other stakeholders contribute data that is integrated into BIM (Azhar, 2011). Determining who controls access to the BIM data and is thus responsible for inaccuracies is an aspect that could bring about a great deal of risk (Liu et al., 2015). Stakeholders require security of confidential data in the BIM model, but a range of legal and security issues have been identified in connection with the administration of construction projects within an electronic environment (Chynoweth, Christensen, McNamara, & O’Shea, 2007). New legal solutions will be required in order for BIM to be the vehicle by which project delivery is achieved (Jim Mason, 2016).
3 Research Methodology

The research focuses on the qualitative data to understand people’s perceptions of the existing contract and BIM environment in the industry in order to discuss the possibility for Intelligent Contract implementation. The views and perceptions of interviewees forms the backbone of this study. Empirical research has been collected to support the findings in the Literature Review and develop a practical understanding of the technologies. Due to the embryonic nature of the subject, case studies were not found to exist. Primary research will be collected through selected interviews from a cross section of the construction industry. The decision to focus the data collection on a chosen selection of sources is due to the incipient nature of the subject. The alternative strategy of collecting data from a larger uncontrolled group would have resulted in more generalised and unreliable response due to the limited knowledge of the subject matter that currently exists. A base questionnaire was developed in order to provide consistencies with the interviews, but this acted as a guide as each subject offered specific focus for discussion due to the differing backgrounds of the chosen subjects. The research is limited due to the cutting edge nature of the subject and lack of real world application of the Intelligent Contract technology in construction. This paper investigated theoretical and conjectural literature based on progressive ideologies and commented on the possible applications within construction. As the subject of the interviews were extremely theoretical, the most effective responses were from a senior management level, who can be more difficult to access. A selected number of 5 interviewees were chosen from the respected fields of: project management (with BIM expertise), legal, facilities management, construction dispute and construction technology software. Due to the extended nature of the interview process with each subject, the limitation of the focused nature of the data collection does bring a limitation to the research. For this reason, each subject was chosen carefully from their respected fields in order to give a more rounded viewpoint from the cross-section of professions chosen. The selected professional fields offer the complete cross section of expertise for this subject across the construction industry required to give a well-rounded commentary on the Intelligent Contract concept. Access to a large network in a range of professions across the Sydney construction industry, along with the willingness of interviewees from further afield has been largely accommodated from my work as a client-based Project Director.

4 Findings and Discussion

The construction industry is a very fragmented sector with poor efficiency across all aspects of the development cycle. While production rates have remained the same wages and resources have increased (McNamara, 2002). Unless we embrace new technologies to increase productivity the industry will struggle. By embracing new technologies greater value can be harnessed through the procurement process by opening up a global supply chain network.

"If we don’t improve efficiency and productivity. Streamline global supply chain and embrace technology we will continue to fail. I’m waiting for the tech sector, someone like Google or an Elon Musk to come in and take over" CC

The perceived lack of collaboration and penchant for litigation was also exhibited by the following responses.

"The industry by nature has to collaborate, which doesn't necessarily happen." HC

The general consensus between all interviewees was that current construction contracts are merely used as a weapon which predominantly favoured the bigger player in any given dispute. Contracts are seen as a reactive tool to be used when situations demanded.

"The only time a contract comes out is if the relationship has broken down and you have to refer to the ‘rulebook’,“ CC

Table 1 shows a list of factors relevant to the Intelligent Contract implementation and barriers in the construction industry. Inconsistency and ambiguity of construction contracts was also identified as a major factor for the adversarial environment within the sector. This is seen as a major flaw in the drafting of contracts in not only the primary contract but subsequent sub-contracts. Clarity of terms and a less legalese approach to drafting would mitigate this factor, but the human element involved in administrating the contract would still offer exposure to miss-interpretation.

<table>
<thead>
<tr>
<th>Table 1. Selected factors and quotations.</th>
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<tr>
<td>Factor ID</td>
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<td>5</td>
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</tbody>
</table>
The onerous nature of administering contract in current practice was also a shared opinion. For instance, in a dispute situation where there has been a delay on site, the workflows and waterfall aspect of notifications and responses was something that was identified as being receptive to automation in order to mitigate human error in what can be an onerous activity. Automating data collection and processing for other contract administration tasks was another benefit discussed that Intelligent Contracts could potentially perform.

“The link of the BIM data flowing back and forth between the Intelligent Contract would certainly reduce the manpower required to run the same processes manually.” AA

Defining risk is tantamount to success in many industries, none more so than in construction. By shifting an organisation to a model-based cost plan, it would allow more effort to be spent on the tendering process which in turn would allow greater definition of risk. The BIM details the project to a far greater level which allows greater confidence in pricing and analysis of risk to avoid rudimentary figures being added by contractors to cover unknown variables. Intelligent Contracts will be more transparent and afford greater determination of risk, therefore making it more straightforward to assign the risk through negotiation. This will simplify negotiations and place parties on a more level playing field. Traditional contract negotiations are facilitated through rigorous back and forth communications, which requires large resources and assumes each party is sophisticated and advanced as each other which is rarely the case.

The automation of the Intelligent Contract will add value and reduce minor dispute. Clash detection in this system would be far superior. An Intelligent Contract forces the execution of the contract. If parties wish to act illegitimately they will have to do so retrospectively which of course makes it harder.

By having a more logical and defined dispute procedure that would be initiated automatically and have higher management (or separate teams at the least) handle dispute resolution instead of the site-based teams, greater efficiency and momentum could also be created on projects. This could avoid what can sometimes be emotional negotiations at site level which can exacerbate issues and detract from delivery.

Making the Intelligent Contract act as a central data point that all data flows to, from the BIM model and program schedules etc, will result in the opportunity for real time analysis to take place which allows trends, clashes and potential problems to be flagged early. Intelligent Contracts will ultimately highlight situations earlier as it will rely on pre-agreed logic (at an organisational level) and not individual judgement. In any dispute or grievance, the audibility of data is considered paramount to correctly resolving the situation.

As the Intelligent Contract software will be central to all communications and contractual actions it will be able to provide a concise central auditable ledger of all communications and actions during the lifecycle of any contract. This is already seen in the flux.io workflow software. For larger or more complex projects, blockchain technology could compliment the validity of this process.

While the discussion covered the many merits of the Intelligent Contract process many obstacles for the concept were also raised. Some were obstacles, such as data security and industry confidence, while others were stipulated as pre-curators required for the technology to operate. Sophistication of the data available was a very evident undercurrent during these interviews as the point of quality outputs being reliant on quality inputs was reinforced time and again.

Separation of sensitive and/or commercial data for ‘bolt-on’ intelligent subcontracts would need to be considered in the data access protocols of any Intelligent Contract in order to maintain data protection.

The automation of contract clauses aren’t the only considerations for the Intelligent Contract. A major hurdle will be in translating and ‘digitising’ the scope of works and specifications in order for it to co-ordinate with the Intelligent Contract protocols. On any projects, these can be extremely complex and have a sheer magnitude of data. This is perhaps where a more advanced BIM environment would be required as the scope and specs could be mostly taken out of the BIM. Standardisation of specifications and construction methodologies would also help in building a database of acceptable protocols and any amendments for these standards can also be easily updated when they occur, with any consequences captured through analysis. By digitising the scope as well, clash detection can highlight where there may be contradictions within the contract documents and even shortcomings against legislative standards and specifications.

The extra emphasis and the effort required at the front end of Intelligent Contract projects would also require a cultural shift to having more evolved information early in the construction process. Ultimately, by producing a less complex and convoluted Intelligent Contract which is accepted more as a standard could mitigate this and could eventually speed up the process.

A major point for discussion during all interviews was that the required data to run an Intelligent Contract would go beyond what was potentially available within a BIM model. The consensus that, while BIM could provide data for the physical asset of a design, there are more variables needing to be considered during the construction phase.

The table below shows % of total construction contract value of what is measurable using BIM (note: this is generic and will vary dependant on project requirement) so will range based on an actual project. (Courtesy of Investa Property Group internal company investigation)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Included/Not Included in 3D BIM measure</th>
<th>%</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>Demo, Excavation, site retention</td>
<td>N</td>
<td>10%</td>
<td>5%-10%</td>
</tr>
<tr>
<td>B</td>
<td>Trade Works (Materials)</td>
<td>Y</td>
<td>45%</td>
<td>40%-50%</td>
</tr>
<tr>
<td>C</td>
<td>Trade Works (Labour)</td>
<td>N</td>
<td>25%</td>
<td>20%-30%</td>
</tr>
<tr>
<td>D</td>
<td>Prelims &amp; Supervision</td>
<td>N</td>
<td>13.5%</td>
<td>18%-23%</td>
</tr>
<tr>
<td>E</td>
<td>Project &amp; Design Management</td>
<td>N</td>
<td>1%</td>
<td></td>
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<tr>
<td>F</td>
<td>Design</td>
<td>N</td>
<td>2%</td>
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<tr>
<td>G</td>
<td>Margin</td>
<td>N</td>
<td>3.5%</td>
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<tr>
<td>Total</td>
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From this data, BIM only models ~45% of the total construction cost, so it would not be possible to fully automate claims based on the BIM status against programme alone.

“The BIM model would obviously have to be very sophisticated in that not only components, but also other influencing works be captured and related back to any payment claim from the model.” AA

Not only would every element have to be captured but each component/activity/task’s relationship, if any, to other cost items or components in the BIM would need to be considered. Every element could be broken up into procurement, delivery and install to allow stage payments for each cost item if required.

The extra sophistication of not only the BIM data but also the program and cost model will require any contractor to be more transparent due to the reliance on the accuracy of...
the program and BIM model to base payments on. This would be onerous on the contractor which could be an obstacle.

The alignment of payment claims to cost models would result in greater detail needed at the procurement stage. This will again be more onerous for the contractor and one would hope the value in doing so would be realised.

“It builds in a commercial necessity that identifies each task that needs to be carried out for payments to be made.” DR

This is no different to a traditional contract, but an Intelligent Contract will guarantee payment the minute the verification function has been met. This reduces the option for non-payment over a justifiable invoice. Monthly payments could still be maintained but the ‘inch-stone’ tick-off of components will occur more regularly which can give a far clearer picture of any project in a real-time situation.

This is common practice for the contractor to get ahead on cash flow to ‘fund’ the build. Banks are unwilling to release funds with no collateral due to the lack of security over a physical asset that the costs are related to. This is also due to the longer payment terms in the industry. An Intelligent Contract would help by optimising payments and reducing delay which would negate the need for contractors to continue this practice. It will create a more justifiable environment for payment which satisfies the bank and developer while the increase in payment speed would assist the contractor.

Table 1 shows that another factor is data analysis. Once the hurdle of requiring a high level of data capture has been achieved, tremendous value can be added through the analysis of data. Another participant, TT (AEC software developer from Flux technologies), gave an excellent example of what can be achieved through automating a process with high level data and analysis.

“A logistic schedule for structural steel delivery was produced based on where the user placed a crane on the site plan. This was obviously only set up once, so any change from weather or material/construction delay or merely to optimise crane location was able to be done immediately by simply changing parameters in the program.” TT

The value that can be added onto to the Intelligent Contract concept through the sophistication of data input it would demand would open the door to endless forecasting and optimisation opportunities that would add huge efficiency to any project. During all discussions, it became evident that the perception was that BIM has not become the indispensable tool that may be required for the Intelligent concept to succeed.

It seems that, while companies are ‘ticking the box’ of BIM usage for marketing and even some regulatory purposes, it’s true potential is not being harnessed and the goal of the BIM being used in asset operation at a large scale is a long way off yet.

Even when BIM is being used, if only some project stakeholders are involved in the process it negates the advantages BIM even during the design stage where clash detection achievable. Given that the reputation for innovation is not endemic in the Construction Sector, (McNamara, 2002) it is a shared opinion that the sheer magnitude of the industry makes it difficult for new innovations to be adapted. With that being considered, it is still clear that the attitude towards change and innovation is still lacking. The main driver for implementing any innovation within the industry seems to be more short term focused and demanding of immediate Return On Investment (ROI) in either cost, time or quality.

“For any innovation to be picked up in the construction industry, the benefits have to be very clear. If the benefits are tangible.” HC

Where organisations have implemented innovative practices or technologies, it appears to be the more agile, middle-tier players that have spearheaded change. This insight led to a more widespread discussion about who in the industry would be best placed to champion the Intelligent Contract concept. The opinion that the finance stakeholders in projects would be drivers for Intelligent Contracts due to the opportunity to de-risk the construction process through a more efficient and transparent contract mechanism was not surprising. The upside for a financier of having greater confidence and real-time analysis on the state of a project would mitigate many risks to an investment. The opinion that it developer/contractors would be best placed to implement an Intelligent Contract makes sense due to the openness and transparency of data required for the concept to succeed.

5 Conclusion and further research

The aim of this paper was to investigate the level of collaboration and sophistication of data required from BIM to operate the Intelligent Contract concept successfully through an interview process from a range of senior level construction professionals. The literature review highlighted the deficiencies in the industry’s current contract practices and the need for a new direction to enable collaboration to achieve greater project success throughout the sector. Collaboration has been highlighted time and again as the reason for the success of projects but the current tools and methods are not doing enough to instil this basic principle into the industry. The initial results of this ongoing study highlight that Intelligent Contracts should be the next logical extension to BIM whereby the contractual performance itself becomes automated or even semi-automated in order to address the deficient practice of manual contract administration which can lead to avoidable dispute. The collaboration of all parties with a rich flow of transparent information between them which would offer the right environment for the Intelligent Contract to thrive. However, Intelligent Contracts work best where they are of a short-term nature which is at odds with the complicated and long-running nature of construction projects. As multi-party contracts such as the NEC3 and PPC2000 offer the ‘hub and spoke’ system of contract architecture, Intelligent Contracts work best as an evolution of this model. The logical network of mini contracts would form one seamless organic contract that can offer assurances in one of the largest problems within the construction Industry, certainty of payment. The nature of the Intelligent Contract is that it is an ‘all-in or not-in’ arrangement and through provisions such as a project bank account, or even cryptocurrency and blockchain technology, the ‘pay when paid’ arrangement would become an instantaneous transaction where all relevant parties are compensated as soon as the terms of the contract are met. There is no delay in the payment ‘drizzle down’ effect through contractors to sub-contractors. Discrepancies between scope of the contract clauses would be mitigated due to the bolt on nature of an Intelligent Contract model. This initial research reveals that the automation of contract administration, made possible by linking the Intelligent Contract to BIM would offer accuracy and efficiency:

- The construction schedule could be a real-time tool directly warning of any possible contract issues from real-time data received;
- Variations could be predicted and identified earlier instigating notifications;
- The contract budget could be adjusted automatically and linked to the contract with notifications sent out to facilitate approval.

By offering a different approach that will demand transparency and collaboration therefore de-risking the industry, stakeholder will be able to operate in a more collaborative and transparent fashion leading to global supply chains and gains in efficiencies leading to more certainty over the delivery of projects. In traditional practice, every contractor and sub-contractor and even the client adds contingency to cover risk on
a project which carries a monetary figure. On large projects, this adds up to a huge sum. Due to this level of effort and risk, construction isn't seen as an attractive investment.

The benefits to be made from an Intelligent Contract would be truly disruptive to the contract practice of the sector. Greater administrative efficiency would reduce costs and lead to less minor disputes. Surety of payment would lead to additional small companies being able to operate with confidence in the sector. Transparency of contract terms would drive collaboration and make the industry more attractive to all stakeholders’ due to the greater definition of risk within any project. The input required from all players in the Sector would be onerous to make the concept a success. To create an environment where the sophistication of data exists from all stakeholders that will be the fuel for a central Intelligent Contract system, will require a huge step towards the digitisation of the industry. BIM has instigated this, but a tipping point must be reached in order for the industry to surrender to its inevitable switch over to the digital age. The Intelligent Contract will be more than just the reference document that current contracts are used as, it will be a tool to be used central to the construction process.

As the future direction, a phased based approach is the likely road-map and a semi-automated process could be developed using existing contractual procedures. The investigation of what processes in current contractual practices could be optimised through automation will be key to roadmap the path for the incremental steps towards a more automated future. Identification of the processes that would achieve the greatest cost/quality/time saving, while achieving confidence in the process, should make the concept more appetising for the industry.

6 References


