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COLLABORATIVE PUBLIC WORKS CONTRACTS USING BIM – AN OPPORTUNITY FOR THE IRISH CONSTRUCTION INDUSTRY?

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In Ireland, large and progressive contractors are claiming significant benefits in construction management efficiency through the implementation of BIM (Building Information Modelling). While these contractors note that the cost benefits to the project budget alone justify the implementation of BIM in the field, they are acutely aware that in 2011 the UK Government has mandated the construction industry in the UK to use BIM on all public projects by 2016. In the Republic of Ireland however, in 2007, the Government introduced the Public Works Contracts (PWC) suite for the procurement of all public sector works. After 8 years of working with the PWC suite of contracts, these contracts have now been widely identified as being unfairly balanced in favour of the Employer and as being a barrier influencing the prospect for recovery of the construction industry in Ireland. A recent Irish Government agency report recommended a review of the current contract for Public Works by both Government and Industry stakeholders with a view to implementing any changes required to ensure fair and reasonable terms for all parties involved. This review has called for the PWC to be revised to include a more collaborative and co-operative approach. This paper will consider the experiences of other jurisdictions in adopting collaborative construction contract practices through BIM and will propose how the industry in Ireland can leverage BIM to create a more integrated and collaborative environment for the purpose of delivering better project outcomes for the key stakeholders involved in construction projects.

building information modelling (BIM), collaboration, professional relationships, public works contracts.

I INTRODUCTION

The Irish construction industry is currently at a crossroads, faced with reduced fees, increased responsibilities and higher client expectations. All professionals working in this fragmented broken industry need to adapt their working procedures in order for the industry to return to prosperity. [1] The construction industry in Ireland is currently in a state of recovery. Those who have not been forced out of the industry during the recent recession now need to adopt leaner working practices. There is a renewed optimism among the contractors and professionals who were forced over the past seven years to operate with very lean overheads, breakeven margins and in some cases operating on a below cost basis. The Irish government replaced the previously used GDLA 1982 contract with a new suite of PWCs

developed by the Government Construction Contracts Committee (GCCC). This form of contract promised “to bring cost certainty and value for money” by the transfer of risk on the basis that “a high level of comprehensive quality information should allow for a high level of risk to be transferred” (GCCC Guidance notes, April 2006). In many cases this has not happened. [2]

The very nature of the Irish Construction Industry is one of adversity among its stakeholders, where information is closely guarded and knowledge is seen as power. This confrontational behaviour must come to an end if the potential of BIM is to be fully realised, as open collaboration among project teams is fundamental to the core understanding of the overall BIM solution for the industry. [1] Instead of the traditional “us and them” attitude between the client design team and the contractors who tend to

pull in different directions on a project, a new way of working together will have to be established.

The overall purpose of this paper is to examine if BIM can be incorporated into the current PWC suite of contracts to improve collaboration and to benefit all of the vested parties.

II METHODOLOGY

The authors' primary data collation methodology involved an extensive survey that was designed and distributed to both a private and public sector sample, in order to gauge the level of support for the introduction of BIM to assist in offering a more rewarding and collaborative approach of doing business. An online questionnaire was created with seven questions, which was originally piloted by a number of industry and academic BIM experts. After a number of changes were incorporated, it was then distributed by email to a number of AEC representative institutions within Ireland. This generated responses from consultants, clients and a mix of small to large contracting enterprises. The responses to the survey will complement the papers research aim as it provides a snapshot of the current level of use and capability of the Irish AEC sector to embrace BIM technologies on public works projects. This will provide the platform for the authors' recommendations on moving towards a more collaborative suite of contracts, in order promote the adoption of BIM. A number of interviews were also conducted in order validate the results of the survey.

III COLLABORATIVE CONTRACTS

In the UK, reports, such as the Egan report (1998) [3] identified the traditional fragmentation of the industry as the cause of many of the industry's problems. Eastman et al (2011) [4] highlighted that currently the facility delivery process remains fragmented and it depends on paper based communication with errors and omissions in these documents causing delays, financial burdens and friction between all parties involved. Wong and Fan (2013) [5] estimated that the cause and effect of this fragmentation has ultimately lead to greater inefficiencies, mistakes and delays which have accounted for \$200 billion of the \$650 billion spent on construction in America annually. Such alarming figures have now resulted in new developments in Information and Communication Technology (ICT) that will further impact on every level of construction industry and society in the next ten to twenty years [6]. Gannon et al (2013) [7] outlined that the lack of construction productivity can be overcome through BIM and Integrated Project Delivery (IPD), as it offers the opportunity for positive changes to be made during all phases of the project lifecycle.

Haron, et al, (2009) [8] pointed out that collaboration and integration among the project team members and stakeholders is needed in order to enhance value and that integrated practice in the construction industry is identified as one of the solutions that could be used to minimise the problems associated with fragmentation in construction. IPD seeks to improve project outcomes through a collaborative approach of aligning the incentives and goals of the project team through shared risk and reward, early involvement of all parties, and a multi-party agreement. [9] The key to a successful IPD is assembling a team that is committed to collaborative processes and is capable of working together effectively. Though IPD and BIM are different concepts, there are still great synergies that can be achieved by combining both processes. BIM is essential to efficiently achieve the collaboration required for IPD, as the combination of BIM and integrated teams allows the project to be defined and coordinated to a much higher level prior to construction start, enabling more efficient construction and a shorter construction period [10]. This was detailed by Gerber and Kensek (2010) [9] in contracts, such as, the ConsensusDOCS 300 Integrated Form of Agreement in order to facilitate the effective collaboration between construction project participants who use BIM. Such contracts offer the opportunity for the Irish AEC Sector to see first-hand how a similar approach could possibly be embraced.

IV ADOPTION OF BIM OUTSIDE IRELAND

The adoption of BIM across the global construction world continues to grow with USA, Finland, Norway, Denmark, UK, Germany, Singapore and Korea all currently in the process of developing BIM guidelines. Large owners, including the General Services Administration (GSA), the U.S. Army Corps of Engineers (USACE), require BIM deliverables on all major projects (GSA, 2006). VTT in Finland, Rambøll in Denmark and SINTEF in Norway are the major research organisations in BIM in these countries, as outlined by Wong et al (2009). In Finland, it is required for the use of IFC BIM models on all its projects, with Norway using the Directorate for Public Property and Construction Management for IFC BIM to facilitate the flow of information through whole life cycle. Denmark has a mandated use of 3D/BIM for tender and, an electronic handover of information to the client (Government Construction Client Group, 2011).

BIM in Asia has shown significant growth and momentum and shows no signs of slowing down. The main organisation governing the construction industry in Singapore is the Building and Construction Authority (BCA). The BCA have developed a roadmap for BIM that pushes its

construction industry to be using BIM widely by 2015, which include developing BIM submission templates to ease the transition for the industry from CAD to BIM [11]. To incentivise early BIM adopters, it introduced a \$6-million BIM Fund in June 2010 to cover costs on training, consultancy, software, and hardware with Singapore universities encouragement.

The Dodge Data & Analytics Smart Market Report for the Business value of BIM in China (2015) predicts a 108% growth for contractors who will be doing over 30% of their work in BIM. This report also forecasts a 200% increase of architects at a high BIM implementation level in the next two years. [12]

In Hong Kong, the Government attaches great importance to sustainability. BIM has been applied during various stages of building development. The Hong Kong Housing Authority (HKHA) is one of the BIM pioneers in Hong Kong, Mak (2011) of Housing Dimensions states "Our goal is full implementation of BIM in all new HA projects by 2014/15 [13]. BIM in Australia is gaining traction as reported by McGowan (2013) [14] with the National Building Information Modelling Initiative (NBI) report, commissioned by the Built Environment Industry Innovation Council, and have advocated that both the government and the industry to begin to embrace BIM.

V USE OF BIM IN THE UK

The UK Government is pushing ahead with the adoption of BIM and, in order to deal with the legal issues arising, the Construction Industry Council (CIC) has produced a BIM Protocol (CIC/BIM Pro 1st Edition 2003) which has been drafted to enable the production of building information models at defined stages of a project. The UK has issued in tandem with their level two BIM initiative a suite of connected frameworks and guidelines. This includes a number of PAS documents which offers best practice for information management for the capital/delivery and operational phase of construction projects using BIM. CIC have also released best practice guides that deals with those aspects of BIM which relate to Professional Indemnity insurance and legal frameworks in order to facilitate and promote the use of BIM. These documents are complimented by 11 Regional BIM hubs whose primary focus is to raise awareness and facilitate the early adoption of BIM processes and working methods throughout the UK's construction industry.

One of the most important documents is the CIC BIM Protocol which is intended to be expressly incorporated into all direct contracts between the employer and the project team members [2]. The

Protocol has been drafted for use on all common construction contracts and supports BIM working at Level 2. The Protocol identifies the specific obligations, liabilities and associated limitations on the use of the models. It does this by breaking the document into eight clauses and two appendices. All parties involved in the use, production or delivery of Models on the Project (the "Project Team Members") are required to have a BIM Protocol appended to their contracts. This will ensure that all parties producing and delivering Models adopt any common standards or ways of working described in the Protocol and that all parties using the Models have a clear right to do so.

Perhaps from an Irish perspective the fact that the overarching response from insurers has been that there are no issues with level 2 BIM which are sufficiently serious as to require coverage restrictions for consultants which use it, offers encouragement. In examining the UK Framework it is concluded that in order to work at Level 2 that little change is required to the fundamental building blocks of copyright law, contracts or insurance. This is encouraging from an Irish perspective, as our current contracting arrangements are not considerably different to the UK despite the current suite of PWC forms of contracts not being designed to encourage risk allocation or collaboration [15].

VI BIM IN IRELAND

To assist in the recovery of the construction industry here, the Forfás report (2013) stated that in order to maintain competitiveness, Irish construction firms must comply with evolving building/product regulations and exceed international industry standards, with the use of BIM based integrated project management. An action proposed by the Forfás was to work with industry organisations to promote the use of BIM and develop the appropriate technical skills amongst Irish construction firms so that they can successfully compete in markets where BIM is widely adopted or is a requirement. Deeney et al (2013) explain that through replacing traditional cumbersome working practices with a virtual model that performs more efficiently, delivering more valuable information and, most importantly, reducing costs can help improve working procedures therefore assisting the industry to return to prosperity. Fraser (2013) believes that as a small, open, innovative economy with a strong ICT sector, the adoption of a BIM approach in Ireland may stimulate the Irish economy while also finally enabling the government to realise the benefits originally promised by the PWC suite of contracts.

The benefits are clear but for the adoption of BIM in Ireland to move on, the process needs leadership. At the moment it is difficult for the government to

promote BIM and prioritise a sector which is still seen as one of the main culprits of the economy's demise. There is a need for the industry and various governing bodies to realise that there's inevitability about BIM [16]. It's important that the public sector recognises the benefits that BIM can bring. They should take a strong position, just like they have taken in the UK, which would be immensely beneficial to our economy and to the companies who compete in international markets that they have that capability [16]. McAuley et al (2013) state that by following in the UK's footsteps and implementing BIM, it could help to create a more interactive and intelligent Government estate. The authors warn that though BIM will not answer all of the Irish governments concerns; it will offer a chance for the Irish AEC and FM sectors to take a step in the right direction towards a more sustainable future.

Enterprise Ireland has been particularly proactive with its BIM implementation programme. This includes the BIM Enable and BIM Implement funded programmes designed to financially support Enterprise Ireland clients' upskill in BIM Level 2 training and avail of expert consultancy service to assist in strategic use of BIM in their businesses.

In addition to these programmes, Enterprise Ireland recently sought tenders in mid-2015 for their BIM Innovation Capability Programme (BICP), which BICP has at its core a requirement for the preferred bidder to consult with both industry and academia to gauge the capability and readiness of the industry to embrace BIM. At the time of writing this paper the preferred bidder was not announced.

Complimenting these operational BIM initiatives, Enterprise Ireland are seeking to form a BIM Implementation Forum, which will have both public and private representation to assist in the development of a strategic BIM programme for Ireland.

The Construction IT Alliance (CITA) remains very proactive in promoting BIM, with its programme of domestic events, CITA BIM Gathering international conferences, CITA Skillnet training programme and CITA MSc in Construction Informatics. In more recent months the invitation by the UK BIM 4 Communities group to join the 11 UK Regional BIM hubs saw the formation of regional BIM Hubs in the east, south and west of Ireland.

Irish educators are currently very active in the delivery of BIM programmes both at undergraduate and post graduate level, with many programmes supported by the Irish state through the Springboard and Skillnet's funding programmes.

Although the UK is at the forefront of BIM implementation in Europe, the Irish and UK markets

cannot be directly compared simply due to their size difference. Norway, for example, is similar in scale and happens to be well advanced in implementing BIM in both Public and Private sectors.

VII CASE STUDY NORWAY

Norway is considered one of the world's earliest adopters of BIM (according to McGraw Hill Construction's The Business Value of BIM for Owners Smart Market Report). [17] The civil state client Statsbygg has been insisting on the use of BIM on its construction projects since 2010. The Norwegian Homebuilders Association (NHA) has encouraged the industry to adopt BIM and IFC. A number of Norwegian contractors have spent vast amounts of money implementing BIM systems and ICT integration support for their production of a number of mixed-use residential units. [18] SINTEF in Norway is the leading organisation conducting research within the field of BIM. It is part of Erabuild which is a network of national R&D programmes, focusing on sustainable tools to improve construction and the operations of buildings. [19] Norway is among the first few countries to develop IFD (International Framework for Dictionaries) standard in the building construction regime which is an initiative for global application. At present, 22% of AEC / FM entities throughout Norway have used or have fully implemented BIM or IFC-enabled BIM software. [20]

VIII OPINIONS ON THE CURRENT IRISH PUBLIC WORKS CONTRACT

In an attempt by the Irish Government to ensure a greater cost certainty on public works project a Capital Works Management Framework (CWMF) was introduced in 2007. This is a series of documents which collectively describe the operating environment, procedures and processes to be followed for the delivery of capital works projects. It incorporates contractual provisions, guidance material and technical procedures covering the public works project lifecycle from inception to final project delivery and review. The aim of the CWMF is to ensure that there is an integrated methodology and a consistent approach to the planning, management and delivery of public capital works projects, with the objectives of greater cost certainty, better value for money and more efficient project delivery. Within the CWMF the Irish government published a new suite of public sector contracts (PWC). The new forms sought to reflect the latest thinking in project and risk management, and, recognise the development of new procurement methods, such as design and build. These new forms also aimed at supporting the certainty of out-come in terms of cost, quality and programme.

Though at the beginning these contracts met the Governments objectives, as they produced low tender prices, this was seen as more of a result of the difficult financial times that the construction sector found itself in. In a recent review of these contracts it was found both employers and contractors were forced to adopt an overly litigious approach. Other problems included that these contracts facilitates an adversarial approach, as well as an unfair transfer of risk to contractors. According to O'Brien (2013), the current RIAI and PWC contracts do not work and certainly do not currently encourage collaborative behaviour. [21]

Fraser (2014) [2] is of the opinion that the current suite of PWC suite of contracts were conceived and drafted in a completely different economic environment compared to today, and the adoption of BIM could now address some of the difficulties inflicted on the industry and the Irish economy by these contracts. The Irish Government must become the main driver if this process is to succeed and must also review current BIM initiatives and barriers in public sector procurement bodies in other countries. [1]

In order to investigate if other professionals within the public and private sectors shared the author's views a short survey was conducted, with the results detailed in the next section

IX Survey and RESULTS

The short pilot survey was conducted to refine pertinent questions about the current PWC public works contract and the possible changes that could be made to it. Ten experts were chosen from across the AEC sector. At the end of the survey they were also given an opportunity to suggest and steer the questions to ensure the survey reflected the true mood of the industry. The improved survey was reduced to seven questions with the opportunity to add personal opinion to each answer. Initially fifty names were selected from across the industry giving a broad opportunity to Clients, Consultants and Contractors opinions. A sample of fifty were invited which resulted in 35 responses were received, some providing very detailed personal opinions.

a) Cost Certainty

The sample was asked about their opinion on whether the current PWC public works contract has brought about greater cost certainty on public sector projects in Ireland. Only one respondent was under the impression that it had but at the cost of transferring the risk onto the contractor which would remove the onus on clients and consultants to be efficient. The majority however were not convinced. One respondent commented that the PWC was providing a "false economy" as the employer

believes the project to be one hundred percent designed and therefore completely priced. In reality though, the designs are often weak. The respondent contended that this resulted in many gaps in the design resulting in unidentified risk leading to claims and disputes. A common thread from respondents reported too many post contract variations and delays which were leading to conciliation costs procedures to be activated.

b) Value for Money

The author sought to determine whether the PWC public works contract provided value for money. The same issues arose with the cost certainty question and the overall answer was negative. The main points of opinion were again too many variations, claims and the fact that contractors were buying out the risk at over inflated premiums. One respondent believed that the client was achieving value for money but only after the project was complete and all disputes resolved.

c) Benefits of a Collaborative Ethos

The sample was asked on whether the PWC public works contract would benefit from inclusion of a more collaborative ethos to improve project outcomes. All of the respondents were in agreement that clearer collaborative approach was required rather than an adversarial one. They believed this method would always produce better outcomes. Furthermore, early contractor engagement and a non-adversarial environment, where teams are working together, rather than against each other, were in favour. Feedback suggested that a change of attitudes from both sides is required and rather than risk transfer, risk sharing was the more preferable strategy to be achieved.

d) BIM and Collaboration

Participants were asked about whether BIM would help achieve a more collaborative outcome in an Irish context. It was felt by the sample that BIM on its own was not the answer, but that a collaborative contractual environment will allow BIM to be used correctly to optimise benefits. BIM provides a more IPD friendly approach by its inherent nature. The samples were of the opinion that an IPD and Lean BIM approach would deliver significant capital savings.

e) Lessons from UK BIM Protocol

A question was put to the sample in light of the UK authorities' adoption of BIM by mandating the use of Level 2 BIM capability on all central government infrastructure projects by March 2016 and whether there were lessons for the Irish Government in how they could implement such a scheme.

Some of the respondents were supportive of adopting a “copy exact” (PAS 1192) amendment that could be applied to the public works contract. It was noted that the UK has the best BIM framework internationally.

All of the research, lessons learned, standards and guidance are available to the Irish Government to simply pick up and use. One fear was that the adoption of a BIM policy based on PAS 1192 would be adopted piecemeal. From previous adoptions of UK initiatives by the Irish Construction industry, there seems to be a reluctance to take the complete policy in its entirety. The Construction Act is a prime example of this. It was one responders’ opinion that failure to adopt the UK model in its entirety is causing difficulties at present.

f) Adoption of an Amendment or New Dedicated BIM Contract

When asked whether the government should modify the existing contract with a BIM amendment clause or to draw up an entirely new bespoke BIM contract for public use, the majority opinion of the sample was in favour of a simple BIM amendment clause. One respondent felt that BIM protocol was designed for standard design and build contracts, which the PWC would fall into. The other side considered the notion of creating a bespoke BIM contract a waste of time and that the PWC contracts are unsuitable for BIM and would never encourage collaboration.

It was noted however that regardless of whichever side the respondents fell into, any changes to the existing contract, or the development of a new contract in the future, should involve the relevant and recognised professional bodies.

g) Opportunity to Achieve Better Project Outcomes

Finally it was asked was there an opportunity for the Irish public sector construction clients to improve project outcomes by adopting a more cooperative contractual approach such as two stage open book or IPD. The respondents were largely of the opinion that contracts where risk is fairly allocated, where reward is properly assigned, and shared across the team this will create an environment in which collaboration is mutually beneficial. Respondents called for a more collaborative environment compared to an adversarial type contract that currently exists. They called for a change in the mind-set by the client to recognise that all parties need to be involved early in project including the contractor. There was also a call to promote consistent approaches across all project types, so that the industry does not have to re-invent itself for each government project and also the introduction of Lean methodologies. They called for the submittal and acceptance of sub-economic tenders to stop, as

this practice only leads to heavy claims during the post contract period.

X CONCLUSIONS

This paper presented the requirement for a more collaborative approach to the public works contract and also explores the possibility of including a BIM amendment clause similar to that being implemented in the United Kingdom. The overall results of the research carried out in preparing this paper indicate the general view of the Irish AEC sample is that the current public works contract is not providing value for money, and due to incomplete design at tender stage, is not providing cost certainty. The Irish Government should also consider implementing a mandate for BIM on public works contracts over a certain value. Further work is required to develop the legal wording of a BIM amendment to the existing Public Works Contract and to determine contract implications and obligations for the Clients, Consultants and Contractors involved; however it would appear from the experience in the UK to date that consideration of the CIC Protocol would be a good starting point.

The authors are of the opinion that a more significant sample would render the same results. It is now time for the Irish Government to respond and instigate a more collaborative approach in the delivery of public works projects in Ireland. It is important the Irish Government are seen to remain in step with their international peers, including the need to respond to European Union calls for use of Collaborative BIM processes on publicly funded projects.

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REFERENCES

- [1] B. McAuley, A. V. Hore and J. Deeney, “Public / Private BIM: An Irish Perspective,” ARROW.DIT, Dublin, 2013.
- [2] S. Fraser, “How BIM can be adopted within public works contracts,” EngineersJournal.ie, Dublin, 2014.
- [3] J. Egan, “Rethinking Construction,” Construction Task Force, United Kingdom, 1998.
- [4] C. Eastman, P. Teicholz, R. Sacks and K. Liston, BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and

- Contractors, Hoboken: John Wiley & Sons, 2011.
- [5] K. Wong and Q. Fan, "Building information modelling (BIM) for sustainable building design, Facilities," vol. 31, no. 3/4, pp. 138-157, 2013.
- [6] N. Dawood and S. Sikka, "Development of 4D Based Performance Indicators in Construction Industry, Engineering, Construction and Architectural Management," *Construction and Architectural Management*, vol. 16, no. 5, pp. 438-458, 2009.
- [7] E. Gannon, C. Kasprzak and E. Nulton.
- [8] A. Haron, A. Marshall-Ponting and G. Aouad, "Building information modelling in integrated practice," *2nd Construction Industry Research Achievement International Conference (CIRIAC 2009)*, 2009.
- [9] B. Gerber and K. Kensek, "BIM and Architecture, Engineering, and Construction: Emerging Research Directions and Trends," *Journal of Professional Issues in Engineering Education and Practice*, vol. July, pp. 139-147, 2010.
- [10] M. Krippahl and A. Grilo, "Compatibility between design and construction building information models," *eWork and eBusiness in Architecture, Engineering and Construction*, pp. 447-452, 2012.
- [11] L. Khemlani, "Around the World with BIM," AECbytes, 9 May 2012. [Online]. Available: <http://www.aecbytes.com/feature/2012/Glob al-BIM.html>. [Accessed 21 July 2015].
- [12] D. D. & Analytics, "The Business Value of BIM in China," Dodge Data & Analytics, Bedford, MA 01730, 2015.
- [13] "BIM: Enhancing Construction Design and Workflow," Hong Kong Housing Authority, 19 August 2011. [Online]. Available: <https://www.housingauthority.gov.hk/en/about-us/publications-and-statistics/housing-dimensions/article/20110819/in-focus-bim-enhancing-construction-design-and-work-flow.html>. [Accessed 15 6 2015].
- [14] S. McGowan, "The BIM Express," *Ecolibrium*, vol. September, pp. 36-42, 2013.
- [15] B. McAuley, A. V. Hore and R. West, "Implementing Building Information Modelling in Public Works Projects in Ireland," ARROW.DIT, Dublin, 2012.
- [16] A. Hore and S. Hughes, "Boom Bang Bim," *Irish Building Magazine*, 5 May 2014. [Online]. Available: <http://www.irishbuildingmagazine.ie/2014/05/05/building-information-modelling-boom-bang-bim>. [Accessed 10 02 2015].
- [17] D. Carr, "Norway - A northern light of BIM," 2015. [Online]. Available: <http://www.building4change.com/article.jsp?id=2613#.VW7Lm89VhBd>. [Accessed 03 06 2015].
- [18] Norwegian Homebuilders Association (NHA), "BIM Manual 2011," [Online]. Available: <http://www.boligprodusestene.no/getfile.php/Dokumenter/2011>.
- [19] SINTEF, "Building Information Modelling used to Improve the Performance of Buildings over the life-cycle," [Online]. Available: <http://www.sintef.no/upload/smartbygg/digit alfm>.
- [20] A. Wong, F. Wong and A. Nadeem, "Comparative Roles of Major Stakeholders for the Implementation of BIM in Various Countries," 2007. [Online]. Available: <http://www.changingroles09.nl/uploads/file/f inal.KD.Wong-Nadeem>.
- [21] E. O'Brien, "Collaborative Contracting - The Way Forward," *Surveyors Journal, Vol.3*, p. 34, 2013.
- [22] McGraw-Hill, "The Business Value of BIM," McGraw-Hill, 2012.
- [23] B. McAuley, A. V. Hore, R. West and D. Kehily, "Addressing the Need to Reform Construction Public Procurement in Ireland through the Implementation of Building Information Modelling," Research Publishing Services, Dublin, 2012.
- [24] A. V. Hore and K. Thomas, "Advancing the Use of BIM through a Government Funded Construction Industry Competency Centre in Ireland," ARROW.DIT, Dublin, 2011.
- [25] S. Fraser, "New Forms Shift Balance in Public Works Construction Contracts," *Engineers Journal, Vol.61, Issue 6*, pp. 358-364, 2007.
- [26] S. Fraser, "Does Partnering offer a Solution to the Public Works Contracts Dilemma?," *Engineers Journal, Vol.61, Issue 7*, pp. 427-432, 2007.
- [27] S. Fraser, "BIM in Construction Contracts in Ireland," Hussy Fraser Solicitors, Dublin, 2014.
- [28] Construction Industry Council, "CIC/BIM Protocol," Construction Industry Council, London, 2013.
- [29] B. McAuley, A. Hore, R. West and D. Rowland, "Enhancing the Facilities

Management Process through the application of BIM as a tool for managing the Irish Public Sector Estates," *Corporate Real Estate Journal*, vol. 3, no. 2, pp. 119-133, 2013.