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DEVELOPING A CLOUD INTEGRATED LIFE CYCLE COSTING ANALYSIS MODEL THROUGH BIM

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ABSTRACT

Advancing interoperability between design team applications has been a major challenge for advocates of open standards. The buildingSmart alliance and Open Geospatial Consortium Inc in the U.S. have developed and implemented an Architecture, Engineering, Construction, Owner Operator, Phase 1 Testbed that streamlines communications between parties at the conceptual design phase to establish an early understanding of the tradeoffs between construction cost and energy efficiency. The results of this Testbed combined with an on-going collaborative R&D project 'Inpro' co-funded by the European Commission to identify business and legal issues of Building Information Modeling in construction were used as theoretical propositions underlying a 2010 Delphi survey. This paper presents the results of one questionnaire of that overall study. It is anticipated that these results will contribute to (i) identifying the most appropriate applications for advancing interoperability at the early design stage, (ii) detecting the most severe barriers of BIM implementation from a business and legal viewpoint, (iii) examining the need for standards to address information exchange between design team, (iv) exploring the use of the most common interfaces for exchanging information, and (v) investigating the industry's perception on whether the development of a Cloud based BIM Life Cycle Costing would be of significant use to the Irish and UK construction industry. The rationale for this research is to refine the results of the initial questionnaire, AECOO-1, and Inpro R&D projects in order to determine if a prototype based on developing a cloud integrated LCC model through BIM could be generated in the UK and, Ireland and if so, what would be the legalities of implementing such a project.

Keywords: Cloud Computing, BIM, Information Exchange, Interoperability, LCC

1. INTRODUCTION

The Delphi technique is not a procedure intended to challenge statistical or model-based procedures, against which human judgment is generally shown to be inferior: it is intended for use in judgment and forecasting situations in which pure model-based statistical methods are not practical or possible because of the lack of appropriate historical/economic/technical data, and thus where some form of human judgmental input is necessary (Rowe and Wright 1999). This paper is based on earlier research carried out by the author in respect to information extracted from a Delphi survey's initial questionnaire (Redmond et al. 2011), which was divided into three categories: (i) Business process, identifying the need and capabilities of combining application performance interfaces on accountancy, project management, and Building Information Modeling (BIM) applications, (ii) Cloud computing capabilities focused on such topics as, obstacles and opportunities for the growth of cloud computing based on literature extracted from Armbrust et al. (2009), and (iii) Cloud based business opportunities, questioning the expert panel on whether they viewed the Cloud as a cost benefit to one's firm and can these benefits be an essential contributor to business growth for Small to Medium Sized Enterprises. Cloud computing was conclusively recognized as an essential component for enabling

integrated BIM and it was highlighted for its ability to increase access to higher quality information resulting in faster business decisions. The notion of sharing three network accessible services through a cloud platform received substantial support from the expert group. However, this study identified (i) Building Performance and Energy Analysis (BPEA), (ii) Quantity Takeoffs for Cost Estimation, and (iii) Requests for Information (Communication Projects Delivery and Decision Support) as the main three areas of business for advancing interoperability. This concept of concentrating on three specified services at the captured stage within a project was the catalyst to analyze projects such as, 'Testbed AECOO-1' (Hecht and Singh 2010), and the 'Inpro project' (Sebastian 2010). The objective of this paper is to present independent views from a panel of experts on developing a cloud integrated LCC analysis model through BIM based on the content of these projects and the results of the initial questionnaire.

2. THE SURVEY

The panel comprised of residents based in the U.S. (50% - 7 respondents), UK (36% - 5 respondents), with Australia and France both represented by an individual (14% - 2 respondents) totaling 14 experts. The experts were from varied backgrounds such as, researchers within the manufacturing industry, quantity surveyors, a cloud developer, CEO of a research and development company, a lawyer, architect and BIM application developer. The methodology used for the questionnaire was designed on quantitative and qualitative research (open and closed-ended questions). The attitudinal research focused on subjectively evaluating the opinion, view of the respondent towards a particular object. The exploratory research was used to diagnose the situation, screen alternatives and discover new ideas. The structure of the survey comprised of the following sections:

Interoperability for BIM software: This section of the questionnaire comprised of questions based on Testbed AECOO-1 and the Inpro projects. The starting question requested the experts' opinion on whether the outlined process for advancing interoperability for BIM software should be focusing on Building Performance Energy Analysis, 5D BIM cost estimating software, and information exchange. The second question queried the need for increasing interoperability standards in the BIM marketplace. Testbed AECOO-1 had effectively identified the need for communication that was represented in its appropriate parts along the entire lifecycle so every software application would become interoperable. The Inpro project and Smith (2007), emphasized that by using open standard BIM there was no need to start from scratch as a large amount of systems was already available.

Contractual issues: As this section related to the legal entities associated with BIM, the Inpro project was used. A rating scale of 1 to 5; with 1 being the highest; was used for both questions. The first question listed statements based on the most severe barriers of BIM implementation from the business and legal viewpoints and the second question followed with statements based on the type of contractual terms that should be included in a BIM based project to facilitate open and neutral collaboration processes.

Information Exchange: Being a part of the three key processes for advancing interoperability; the information exchange section comprised of two questions formatted to; (i) likert scale, and (ii) rating scale. The first question requested the opinion of the expert by ranking the statements relating to using the industry's most common exchange file mechanism Industry Foundation Classes (IFC) STEP and IFC eXtensible Markup Language (XML). The second question was structured with two statements taken from Testbed AECOO-1 examining the need for having an open exchange data model and whether Information Delivery Models (IDMs) – used to define what building information is required to achieve a particular specialty analysis and Model View Definition (MVD) - used to express information requirements of a particular IDM are required for incorporation into specifications. The remaining questions were taken from literature such as Hecht (2008), questioning the use of Sensor Web Enablement in relation to BIM, and CISCO and Johnson Controls (2008), analyzing whether BIM Facilities Management (FM) would be greatly enhanced by Building Automated Systems (BASs).

Developing a BIM LCC system: This part of the survey was marked with specific individual statements investigating if such a system could be developed. The first question focused on the development of a BIM LCC system that would integrate Senor Web Enablement and BASs. The second question related to the use of IDMs for quantity takeoffs and energy analysis business

processes, which were then used to define MVDs – standards based subsets of IFCs; as the most efficient solution for integrating 3D models with scheduling and costing for LCC. The final question targeted the experts interest in participating in a pilot project in Ireland directed at developing a prototype model based on advancing an. integrated BIM software that analyses energy performance through the use of 5D cost estimation and information exchange.

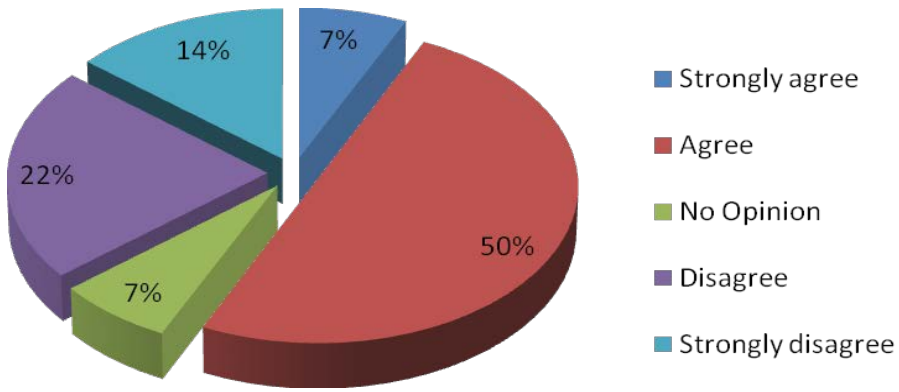
3. INTEROPERABILITY FOR BIM SOFTWARE

3.1 Advancing interoperability for BIM software

The results indicated that 57%, representing 8 respondents, felt that the three most favorable services for advancing interoperability for BIM software are (i) BPEA, (ii) Quantity Takeoffs for Cost Estimation, and (iii) Request for information. However, 36% disagreed and one individual had no opinion. The question itself tested the idea that the most beneficial stage to advance interoperability is at the conceptual stage and that the three main business areas that are most likely to require interoperability are as previously stated. The open ended answers recognized several different approaches to advancing interoperability such as one respondent's view that data transparency and quality, spatial co-ordination, understanding of data in a spatial context, and management of the supply chain data are the main business processes. Another respondent identified Request For Information (RFI) workflows, quantities and estimating, and quantities by location for scheduling. There was also a respondent who correctly pointed out that building performance is not only about energy, but it is also about comfort and future services provided by buildings. Probably the most significant statement was 'there are dozens of other processes enhanced by BIM and hundreds more we haven't even imagined. These three are important, but only the tip of the proverbial iceberg'. In summarizing the result of this question over half of the respondents agreed that the most favourable process for advancing interoperability for BIM software is (i) BPEA, (ii) Quantity Takeoffs for Cost Estimation, and (iii) Request for information.

Figure 1: Advancing interoperability for BIM software, in response to the question:

'In your opinion are the following three processes the most favourable option for advancing interoperability for BIM software (i) BPEA, (ii) Quantity Takeoffs for Cost Estimation, and (iii) Request for information or alternatively suggest your most favoured option.'



3.2 Increasing interoperability standards in the BIM marketplace

The notion that the market is increasingly demanding that open standards are more broadly applied to BIM technologies; so that each partner in a project can comfortably adapt their internal processes; received a majority positive indication of 93%. Only one respondent disagreed which clearly identifies

that the way forward for interoperability for BIM is to engage in open standards. The second statement; relating to viable software interoperability in the capital facilities industry requiring the acceptance of an open data model and the use of service interfaces contained within provider's software; obtained a positive 72% and negative 14% with another two respondents indicating no opinion. This 72% can be seen to support the National Building Information Modeling standards view that an open data model would provide an industry-wide means of communication enabling every software application used across the lifecycle to become interoperable. The Testbed AECOO-1 maintained that within a design project, there is little need to share all aspects of the design between project participants, and what is relevant is to exchange elements of design between the lead architecture firms or lead general contractor and subcontractor with specific areas such as lighting, energy usage, building cost and Heating Ventilation, and Air-conditioning (HVAC). The expert panel projected a mixed response to this statement with only 57% agreeing. The 43% of the expert panel that did not entirely agree with the Testbed AECOO-1 model was because some of the experts are inclined to believe that all information should be shared no matter what process stage the project is reviewing. The next statement was designed to clarify the need to have interoperable applications shifting away from legacy systems. Testbed AECOO-1 had identified the ability to having multidisciplinary project teams that work together with data sharing tools and common information models thus achieving better and faster results. The response from the expert panel clearly agreed with this concept delivering a positive response of 93% and only 7% having no opinion. The final statement referred to the idea that by using open-standard BIM, designers do not need to start from scratch as a large variety of building typologies systems and subsystems are available as the basis of their design. This enables buildings with high architectural quality to be designed, produced and delivered according to systematic procedures which allow effective control and value optimization for the clients and end users. Only 43% of the expert panel agreed with this concept, 36% had no opinion and 21% disagreed. The open standard content was meant to represent a model server and open communication platform for information sharing. It is possible that the expert group confused this with Open Source Software where co-operation is promoted between the user and owner of a software product by removing obstacles imposed by the owner, such as copyright law. The overall conclusion of this section depicts that there is a need to share information through open standards with an industry demand for applications to become more interoperable.

Table 1: Increasing interoperability standards in the BIM marketplace, in response to the question:

'The following statements relate to increasing interoperability standards in the BIM marketplace; please indicate your opinion on these statements.

Increasing interoperability standards	*Strongly Agree*	*Agree*	*No Opinion*	*Disagree*	*Strongly Disagree*
• **The market is increasingly demanding that open standards be more broadly applied to BIM.**	14%	79%	0%	7%	0%
• **Viable software interoperability requires the acceptance of an open data model.**	22%	50%	14%	14%	0%
• **Within a design project, there is little need to share all aspects of the design between project participants.**	21%	36%	0%	43%	0%
• **Multidisciplinary project teams that share tools and information achieve better results than using traditional applications.**	36%	57%	7%	0%	0%
• **With open-sourced BIM designers can plug into an existing variety of typologies, systems and subsystems.**	7%	36%	36%	21%	0%

4. CONTRACTUAL ISSUES

4.1 Barriers of BIM implementation

The barriers were categorized into five main issues and structured in a rating scale format. The first barrier signified that there is a lack of immediate benefits of BIM for the stakeholders. This produced a response of 50% disagreeing and 36% agreeing indicating that the expert panel partially sympathizes with the stakeholders need for Immediate Return on Investment. However, the 50% level of disagreement demonstrates that there are immediate benefits to BIM possibly referring to its ability to identify early cost savings. The next barrier highlighted the issue of changing roles, responsibilities and payment arrangements resulting in 50% agreeing, 21% disagreeing, with no opinion at 29%. The Inpro project claims that there is a lack of clarity over the changing roles and responsibilities; for example is the architect still the lead designer in the integrated design and engineering? Who is in charge of the total quality of the design? Who assures that all interface problems (clashes) are solved and that the model is fully secured? These are just some of the issues and the results of the expert panel showed a 50% acknowledgement of this barrier and 29% unsure which demonstrates that this is an issue that needs to be resolved. The barrier associated with the uncertainty of the legal status and intellectual property rights of the model generated a high (79%) agreement with this statement of which 22% of the panel ranked it as a number 1 (the highest barrier) and only 14% disagreed. The major issue relating to this barrier is to what extent anyone can claim ownership of the intellectual property; if the model is deemed to be collaborative work, then ownership may not be vested in a single party. Eastman et al. (2008), acknowledged that there are no obligations to adopt an alliance or integrated contract for BIM, however if stakeholders intend to achieve open collaboration, they should opt for an integrated contract. The following barrier; concerning the inadequacy of the existing contractual frameworks, including the agreements on liability and risk locations; presented a response of 62% agreeing and a no opinion of 23%. There are major concerns with who is liable for information in the digital model and how the users are protected and this may be the reason for the 62% of the expert panel agreeing with this barrier. The final barrier referred to the lack of consensus on the protection of information in conversion and interoperability and against loss and misuse of data. The response received a mixed reaction from the panel with 43% identifying no opinion, 36% disagreeing, and 21% agreeing. The barrier itself is related to the notion that there is a requirement within the industry for an agreement on the standard of care and possible conflict resolution on data management as an integral part of the contract. The results of the survey are inconclusive possibly because there are already standards and agreements available for use of data management; however they are country-specific. The results of the 5 statements emphasized the major barriers to implementing BIM with the structure of a single model created by many disciplines as the main problem due to claim of ownership, who is liable, who is in charge of the total design, whether it should be an integral part of a contract, and can the stakeholders benefit of such a model.

Table 2: Barriers of BIM implementation, in response to the question:

'Please rank in order 1 – 5 (1 being the highest) which of the following is the most severe barrier to BIM implementation from the business and legal viewpoints, if other please specify.'

Barriers of BIM Implementation	1 (High)	2	3	4	5 (Low)
• **Lack of immediate benefits**	7%	29%	14%	36%	14%
• **The changing roles**	14%	36%	29%	14%	7%
• **Uncertainty of the legal status**	22%	57%	7%	7%	7%
• **Inadequacy of existing frameworks**	23%	39%	23%	15%	0%
• **Lack of consent on protection of information**	7%	14%	43%	22%	14%

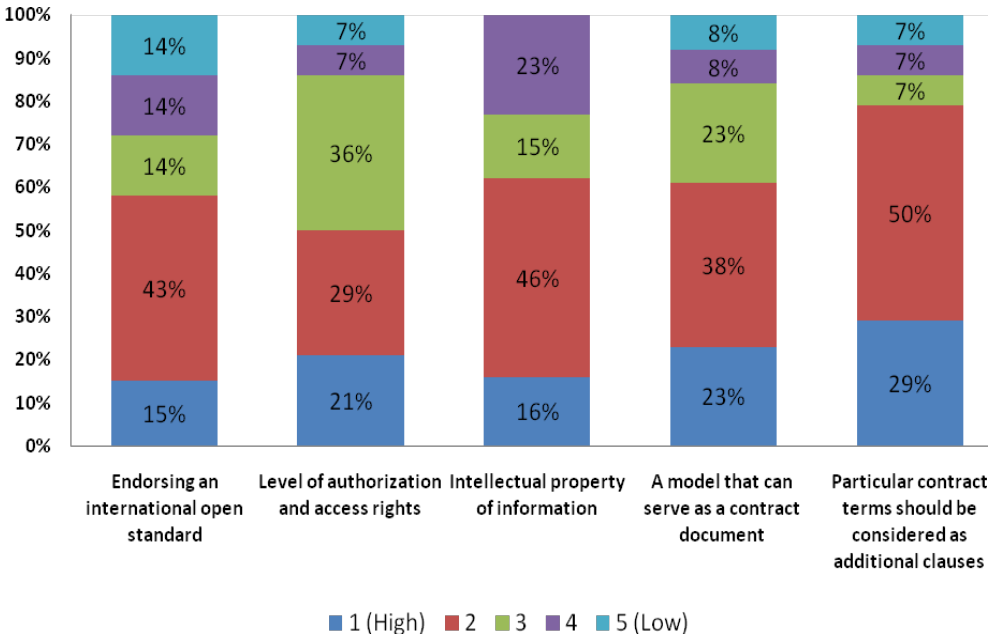
In response to the open-ended question requesting further barriers to be identified; the expert panel views varied. One expert claimed that there is a lack of understanding of how to use BIM and lean business methods particularly in a collaborative business arrangement; this view was supported by another expert who also considered the lack of understanding of how to effectively use BIM in a team environment as a major barrier. For one expert; the biggest challenge is the cultural shift that is needed as sticking to the status quo is the biggest draw for skeptics. The most significant statement identified the issue surrounding insurance: 'In the U.S. market integrated; teams are hamstrung by the lack of effective insurance products that protect the team as a whole, there is a huge market opportunity on the horizon for project insurance that protects the integrated team as a whole'.

4.2 Contractual terms to facilitate open and neutral collaboration

The previous question list of barriers analyzed the problems associated with implementing BIM. This question focuses on rectifying that situation and identifying the contract clauses needed. The question was formatted to rating scales 1 – 5 (1 being the highest). The first statement highlighted the contractual issue of agreeing on modeling protocols, sharing and integration of open technology and then proposing a solution: endorsing internationally accepted open standards. The expert panel rated this option 58% in favour and 24% against. The ability to have clauses relating to the workflows, level of authorization, and access rights in a BIM based decision-making virtual project received a response of only 50% in favor and a low 14% against. The highest no opinion of all the statements (36%) was in reference to this statement. This response was very much in line with the section 4.1 question relating to the level of clarity over the changing roles and responsibilities, where the results of both statements indicate a high no opinion and an average of 50% in favour. The concept of including a clause for the intellectual property of the foreground and background information and knowledge provided an average 62% in favour.

Figure 2: Contractual terms to facilitate open and neutral collaboration, in response to the question:

'Please rank in order 1 – 5 (1 being the highest) which of the following contractual terms should be included in a BIM based project to facilitate an open and neutral collaboration process, if other please specify.'



The Inpro project had perceived a possible solution for the legal status of such a model by enabling the model to serve as a contract document that is used between contractual parties, but is not to be submitted to permit-issuing agencies. This received a favorable response of 61%, 23% no opinion and 16% not in favor. The Inpro project identified that if this is not the case the model may

become a document which provides the visualization of the design intent from contract documents. This may also be the reason why the results reflecting the previous solutions have such a mixed response. The final statement emphasizes that depending on the selected contract form and procurement method, particular contract terms should be considered as additional clauses to the contract. The clauses identified were establishment of partnering and the legal entity of the enterprise, format roles and responsibilities, agreement on payment features, and dispute resolution using BIM. The survey supported these clauses with 79% of the expert panel agreeing and only 14% not. In summarizing the key issues identified, one expert stated 'integrated agreements only work if the team members trust each other, trusted business relationships emerge over time, it is naive to think we can "catch the magic in a bottle" via a contract'. The expert suggested that the best mechanism for creating such teams is the marketplace, and owners can promote the creation of such teams through effective Requests for Proposals.

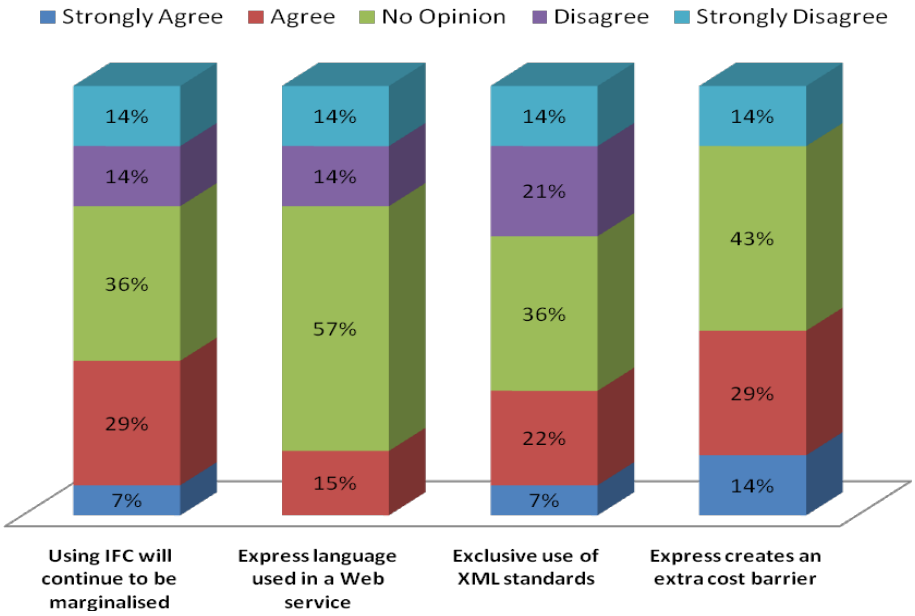
5. INFORMATION EXCHANGE

5.1 IFC XML – IFC STEP

This question allows analysis of statements based on whether the construction industry will pass files via Standard for the Exchange of Product model (STEP) or XML. The first statement perceives the computer language EXPRESS; which is one of the main products of ISO-STEP and used to represent conceptual or abstracted objects, materials, geometry, assemblies, process and relations as an foreign format for providers to maintain and stresses that it is not presently in their code product offerings and that IFCs will continue to be marginalized. The results showed that there were an equal number of experts who agreed to those who probably did not understand the statement with comments such as, 'I'm not sure what EXPRESS is but it sounds bad' (36%), while 28% disagreed. The following statement investigated the issue of using an EXPRESS language to pass information in a web service, and referencing it as a poor fit with insufficient mainstream market adoption. This statement received a high no opinion of 57%, 28% disagreeing and only 15% agreeing. The notion that the industry has already moved towards the exclusive use of XML standards with encodings such as Open Building Information eXchange made for web services integration to BIM software resulted in a no opinion and disagreement of 36% with only 29% agreeing.

Figure 3: IFC – XML, in response to the question:

'Please indicate your opinion on the following statements relating to IFC and XML, if other please specify.'



In review of the previous statements; the final statement summarized that XML is designed to work with web services and there is already available software standards to facilitate the adoption of existing AEC-based XML encoding and schema. The issue as to whether EXPRESS creates an extra cost barrier received a high no opinion from the expert panel (43%). However, 33% of the expert panel did agree in comparison to 14% disagreeing. The open-end question provided mixed comments from the experts, with one expert openly stating that they were unsure of what EXPRESS means. For those who did, the response varied from stating that XML is fine for a quick fix but is problematic for the long haul, to the identification from another expert that they are trying to incorporate agcXML (a set of XML schemas designed to automate and streamline the exchange of information) and IFC-compatibility. In summarizing the comments of one expert was 'a robust model such as EXPRESS needs to underpin a complex environment such as this, and there needs to be debates as to how data and process tools are implemented as web services, but you cannot escape the need to finish the modeling and design'.

5.2 Information exchange

This question posed a series of statements relating to information exchange and the concept of using semantic tagging, sensor web enablement and Building Automated Systems. The initial statement targeted the industry's requirements for software interoperability through exchange definitions, adoption of an open exchange data model and a common interface to the exchange data model for use by any participating application. The results were overwhelming in favor of this concept with only 7% both disagreeing and no opinion. The following statement reviewed the concept of using MVDs and IDMs for incorporation in specifications to be implemented in software. The majority of the experts agreed with this concept (76%). The notion of using semantic tagging in assisting the overall schema for building information in identifying (i) energy efficiency, (ii) manufacturer name, (iii) serial number, and (iv) warranty received 50% in favour but a split between no opinion (29%) and disagreeing (21%) equaled the positive response. In identifying if sensor web enablement (a type of sensor network on geographic information system that is especially suited for environmental monitoring) should be incorporated into a BIM model to optimize energy usage, the expert panel gave a negative indication with 36% of the panel having no opinion and 43% disagreeing, while only 21% were in favour. The final statement is similar in context to the previous statement (analyzing a system for facilities management) in reviewing whether a BAS for importing HVAC after hours and utility meter readings into accounting systems and automatically generating tenant bills that would greatly enhance a BIM Facilities Management system. The expert panel was more in favor of this concept with 46% agreeing, however 23% had no opinion and 31% disagreed, illustrating that neither of these FM systems indicated potential successful adoption.

Table 3: Information exchange, in response to the question:

'Please rank in order 1 - 5 (1 being the highest) your opinion of the following information exchange requirements, if other please specify.'

Information Exchange	1 (High)	2	3	4	5 (Low)
• **Adoption of an open exchange data model.**	36%	50%	7%	0%	7%
• **Incorporating IDM and MVD into specifications.**	29%	43%	14%	0%	14%
• **Semantic tagging assist overall schema for building information**	0%	50%	29%	14%	7%
• **Sensor Web Enablement incorporated into a BIM**	14%	7%	36%	36%	7%
• **BAS would greatly enhance a BIM FM**	15%	31%	23%	8%	23%

6. DEVELOPING A CLOUD BIM LCC SYSTEM

6.1 Developing a Cloud BIM LCC system

This direct question was a follow up to the previous section. It requested the expert panel to identify if it is possible to develop a Cloud BIM LCC that integrates sensor web enablement and BAS. However, as previously noted, the concept had a mixed reaction. The contribution factor to this uncertainty may not necessarily stem from the technical aspects but more from the need or viability of having such a system. In reviewing this concept; one expert listed the enterprises who are already engaged in this process such as Onuma Planning System (OPS), IBM, Siemens, and DASSAULT Systems. The expert respondent continues to clarify that only OPS purports to do this in a way that enables typical BIM users to leverage such ability and recognizes that there are other open standard oriented BIM servers in the works that will enable these processes. The final comment attached to this expert views was that 'the question is whether the Construction Industry is ready for the tsunami of change that will occur when this becomes economically viable'.

6.2 Data model for separate applications

This question focused on whether the option of using the MVDs and IDMs processes was the most efficient solution for integrating 3D models with scheduling and costing for LCC. The question was derived from the Testbed AECOO-1 existing case study in the U.S. and presumably because of this concept being relatively new; it may have needed more clarity, as the majority of the responses were unsure. Of the 6 experts who did respond 5 were in favor and 1 disagreed. The open-ended question identified that out of the 7 responses the majority of them were confused, however 2 experts did provide interesting feedback with comments such as 'eventually, but it may be worth progressing through an intermediate COBie (Construction Operations Building Information Exchange) style stage to keep the industry on board and to progress more quickly with smaller steps' and 'yes – we are also working on a stakeholders activity model – activity node tree with common activities to link independent MVDs'.

6.3 Pilot project

The final question of the survey focused on the interest of the expert panel in participating in a pilot project in Ireland directed at developing a prototype model based on advancing a cloud integrated BIM software that analyses energy performance of buildings through the use of 5D cost estimation and information exchange. In analyzing the elaboration section of this question; all of the expert's comments seemed positive to being involved with one suggesting that buildingSmart Alliance would be interested. The only conservative statement identified that it looks like a valuable project idea, but would need clarification on many aspects (context, funding, national approach versus European etc.).

7. CONCLUSION

The focus of the questionnaire, where results are reported in this paper, was the concept of developing a cloud integrated LCC model through BIM. The interoperability for BIM software section highlighted that the most beneficial stage to advancing interoperability is at the conceptual design stage with BPEA, 5D, and information exchange identified as the most favorable business processes. This section also suggested that the market is increasingly demanding open standards to be applied to BIM and that having multidisciplinary project teams that work together with data sharing tools and common information models achieve faster results in comparison to standard legacy systems. The contractual issues associated with BIM listed several barriers of which the uncertainty of legal status and intellectual property of the model was ranked as the highest, followed by inadequacy of existing frameworks, including the liability and risk locations. In solving some of the major issues related to facilitating open and neutral collaboration; the expert panel identified that depending on the procurement route particular contract terms should be considered as additional clauses; these included the establishment of partnering and the legal entity of the enterprise, format roles and responsibilities, agreement on payment features, and dispute resolution using BIM. The emphasis on standardized passing of information between systems recognized that only when every design software can read and

write to and from a centralized web hosted database, will this concept be achieved, which reiterates the notion of using an integrated model (Cloud Computing). The most disappointing factor of the information exchange section was the amount of uncertainty in relation to the questions, partially because the concept of using a marginalized IFC or a set of XML schemas designed to automate and streamline the exchange of information wasn't promoted effectively. However, the need for the construction industry to have software interoperability through exchange definitions was clearly evident, and it is this adoption of an open exchange data model and a common interface to the exchange data for use by any participating application that will allow the LCC model to succeed. The final section of the survey based on developing a Cloud BIM LCC system showed that certain elements of FM such as BAS and sensor web enablement are beneficial if used through web services but at the moment these tools are not generally viable and are very complex. In further analyzing the information exchange concept of IDMs and MVDs one expert issued caution but insisted that it would be worth progressing through an intermediate COBie style stage; with the industry on board focusing on small steps. By using this funnel system of questioning to identify a certain concept to be developed; the final question focused on whether any of the experts thought it would be worthwhile to be involved in developing such a model. There were numerous very keen responses however, the issues surrounding funding and context still need clarification but overall the idea has been deemed as valuable.

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