Available online at www.sciencedirect.com
ScienceDirect
Procedia - Social and Behavioral Sciences 138 (2014) 510 – 520
Procedia Social and Behavioral Sciences

The 9th International Conference on Traffic & Transportation Studies (ICTTS'2014)

The Implementation of Building Information Modelling in the United Kingdom by the Transport Industry

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Abstract

This paper evaluates the implications and repercussions in the Architecture, Engineering and Construction (AEC) industry of the implementation of the "Building Information Modelling" (BIM) technique, focusing in the design, building and management of transport infrastructure projects in the United Kingdom. It also aims to investigate the current tendencies of professionals, consultancies, contractors and government institutions towards this approach. It is essential to this research to determine the potential behind this technique in order to mitigate or eliminate common problems and inconsistent practices present when developing transport infrastructure projects, making use of the conventional computer-aided design (CAD) approach. On May 2011, identifying a window of opportunity, the UK Government established the Construction Strategy requiring "collaborative 3D BIM on its projects by 2016." Therefore, this research contemplates to determine how this new working approach contributes in terms of cost savings and environmental impacts, assesses challenges, limitations, advantages and drawbacks of its implementation in the industry, making an attempt to evaluate if the current tendencies are expected to meet the objectives set by the Government.The proposed research was undertaken by distributing a survey to a number of professionals who have been involved in transport projects making use of Building Information Modelling in the UK. Professional associations involved in design and construction of transport infrastructure were approached online and personally to take part in the research. Additionally, phone interviews were performed in order to confirm the results previously obtained and to increment the sample size.

Peer-review under responsibility of Beijing Jiaotong University(BJU), Systems Engineering Society of China (SESC).

Keywords: Building Information Modelling; transport projects; benefits and drawbacks; United Kingdom

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Peer-review under responsibility of Beijing Jiaotong University(BJU), Systems Engineering Society of China (SESC).
doi:10.1016/j.sbspro.2014.07.232

1. Introduction

1.1 Background to the study

Currently, Building Information Modelling is the climax of the evolution of the design, construction and management techniques to develop any conceived piece of infrastructure. If it is true that this approach has been present for several years in the construction industry in the United Kingdom and tremendous benefits have been perceived, there are still a variety of lessons that need to be learnt, especially by the transport sector that is just getting involved in its implementation. This knowledge is of particular relevance as the adoption of BIM will become mandatory in the UK by decree after 2016.

1.2 What is building information modelling (BIM)?

The Building Information Modelling approach is defined differently depending on the perspective from which it is observed and the outcome that is expected to attain. Krygiel and Nies (2008) claim that BIM is parametric and interconnected information about the entire building and a complete set of design documents stored in an integrated database, where any changes made to an object within the model are instantly reflected throughout the rest of the project in all views. Whereas Weygant (2011) states that "BIM is a technology" with the capability to improve the way in which infrastructure is conceptualised and constructed. Weygant asserts that like CAD (Computer-aided design) transformed construction projects that involved hand drawings; BIM is revolutionizing the conventional CAD approach. In the early stages BIM was distinguished by its capability to represent elements instead of lines, curves, arcs, etc but it has evolved into a powerful tool to perform "model analysis, clash detection, product selection and whole project conceptualization."

1.3 Maturity levels

The maturity levels of the BIM models shown in Figure 1, define the capability of the "construction supply chain" to function and to share data.

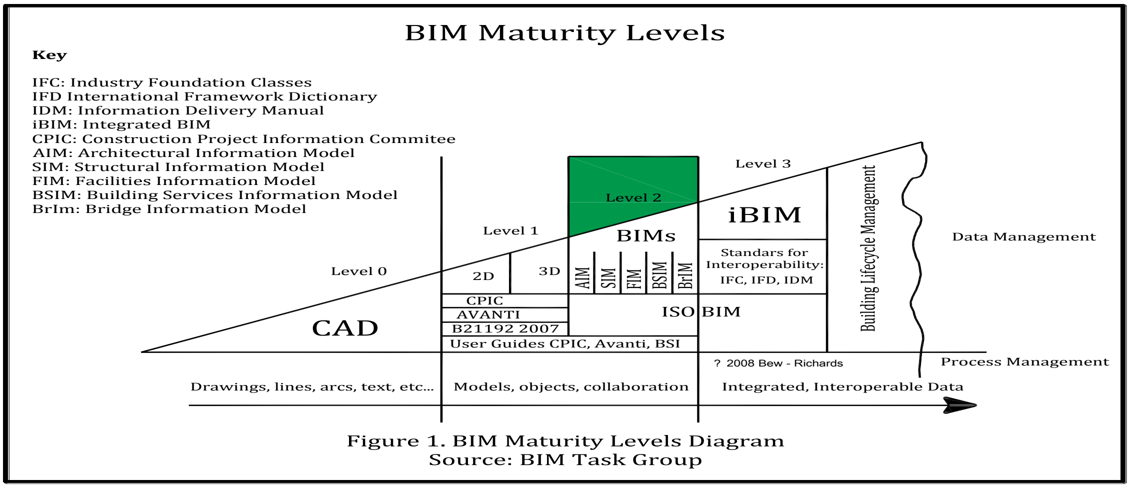

Fig. 1. Maturity Levels Diagram

1.4 Problem statement

Aiming for progress, it is paramount for the leaders of every country to make the most efficient use of the resources required to develop transport infrastructure such as qualified skills, capital, technology, time and raw materials, as these are scarce, therefore difficult to access and costly. Additionally, the development of these kinds of projects is known for having colossal economic and environmental impacts. Kymmell (2008) claims that "project economics are forcing the improvement of construction efficiency, and competition will rearrange the major player in the field."

Furthermore, the current traditional methodology to produce and interpret transport infrastructure projects faces a variety of inconsistencies and malpractices that tend to reduce the efficiency of the process, increasing considerably overall costs, environmental impacts and waste. The reduced "communication and collaboration" between the diverse working teams involved in the design and construction phases generated by the inability to share updated information and perform modifications in real time, the impossibility to identify errors automatically and to make adjustments that would be reflected immediately in the entire project can be highlighted. These conflicts are likely to produce errors that could lead to unnecessary and expensive work.

Kymmell (2008) claims that "the largest problem in the planning and construction of building projects is the incorrect visualization of the project information as the devil is in the details." Whereas Eastman et all (2008) claim that the actual "facility delivery process remains fragmented, and depends on paper-based modes of communication" where mistakes and exclusions in these types of documents usually create unexpected "field costs, delays and eventual lawsuits" among the different participants involved, causing conflicts, economic losses and setbacks.

1.5 Research question, objectives and hypothesis

What are the benefits, limitations and tendencies experienced by the architecture, engineering and construction industry with the implementation of the Building Information Modelling approach in transport related projects in the United Kingdom?

This paper evaluates the implications and repercussions experienced by the Architecture, Engineering and Construction (AEC) industry regarding the implementation of the "Building Information Modelling" (BIM) approach to design, build and manage transport infrastructure projects in the United Kingdom exploring the current tendencies of professionals, consultancies, contractors and government institutions. Furthermore it intends to discover the current level of adoption of BIM in transport related projects in the UK and the main reason for its adoption. It is of particular interest to identify and quantify the magnitude of the benefits, advantages, drawbacks and challenges of the implementation of BIM in transport projects. To achieve this, a direct comparison against the traditional CAD approach was carried out.

The hypothesis of the UK Government Strategy (2011) states that: "The Government as a client can derive significant improvements in cost, value and carbon performance through the use of open sharable asset information." The UK Government foresees to reduce costs of the construction services (supply chain) by 15% - 20%.

1.6 Potential benefits expected

Visualization: The most noticeable contribution from a 3D representation is the augmented capability to comprehend what is intended to be delivered (Kymmell, 2008).

Collaboration: The need to collaborate with BIM while utilising representations is definitely its maximum contribution. BIM is a fantastic approach that habitually creates a progressively optimistic participation of the individuals, who end up "enjoying the model" as the hub for their meetings, consultations, agreements, allowing to deal with basically any situation (Kymmell, 2008).

Elimination: Given that the implementation of BIM foments an enhanced capability to "visualise, communicate, evaluate and coordinate", a variety of improvements become tangible such as reduction of the overall length of the project, better comprehension of the project, synchronisation and better material utilisation. Construction disagreements, inconsistencies, "waste", and hazards will be diminished and as a result the "project cost" is very possible to experience a significant reduction (Kymmell, 2008).

1.7 Drawbacks and challenges of BIM

Collaboration and Teaming: Defining the approach that will be implemented to allow the satisfactory "sharing" of the information contained in the representations by all the people involved in the project is a considerable matter. It is required to consider that generally the different parties involved use different tools to create the designs and shifting these from one format to another is risky, bringing difficulties that might lead to mistakes (Eastman et all, 2008).

Legal Changes: This approach is introducing legal preoccupations to define who is the owner of the "designs, fabrications, analysis and construction datasets." Consequently confusion rises about who has to pay for these and who is accountable for their correctness (Eastman et all, 2008).

Changes in Practice: The largest change that organizations have to deal with when adopting BIM, is the need to learn how to work in collaboration around a common BIM representation (model) that will be used during the entire length of the project (Eastman et all, 2008).

Implementation: Migrating from the CAD approach to BIM goes beyond obtaining "software, training and upgrading hardware." It requires an entire and dramatic transformation of the organization that involves elevated costs, being this the reason this stage is particularly challenging for small and medium organizations (Eastman et all, 2008).

1.8. Factors influencing the use of BIM

A research carried out by McGraw Hill Construction found out that the main reason to implement BIM with 68% was to eliminate tedious drawing practices innate in the traditional CAD approach that lead to inefficient use of time. While 49% of the sample claimed that owners demanded it on the project and 47% because of BIM's ability to improve communication with clients. The parametric modification of the designs and the opportunity to reduce construction costs with 45% and 43% respectively occupied the 4th and 5th place of the list according to Harding (2009). It appears like the top 5 reasons to implement BIM have the common intention to improve the working process in order to maximise net profits.

1.9 The government construction strategy

The Government Construction Strategy was published by minister for the Cabinet office Francis Maude on 31 May 2011 stating that: "The Government will require fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic) on its projects by 2016." The strategy mandates the implementation of BIM at a minimum level 2 on all public projects irrespective of their project size.

2. Methodology and data collection

The approach undertaken to collect the required information to meet the objectives was a positivistic methodology given that surveys were utilised. Online surveys were chosen because these have the capability to reach a large audience in a quick and inexpensive manner, offering a relative low but reasonable response rate of 30% according to Ogier (2005). The survey was designed in a way that allowed gathering qualitative and quantitative information regarding particularities of transport projects developed using BIM in the UK. An effort was made to ask simple, easy to answer, straight forward questions to avoid the discouragement of the participants. The questionnaire was divided into 5 categories and comprised 30 questions of which 21 were multiple choice and 9 brief descriptions.

1. About the project.
2. BIM and your organization.
3. BIM training.

4. The benefits, advantages, drawbacks and challenges of BIM.

5. About the participant.

Bristol Online Surveys (BOS) were used to create the survey that was launched on the 21th of June 2013 and closed on the 25th of August 2013. Professionals working for British transport consultancies across the UK were contacted making use of their detail contacts found on their websites, inviting them to take part on the research either by completing it if they were suitable or by distributing it to their most appropriate colleagues. As an incentive, it was promised that the final results of the research would be made available upon request. Professional Institutions such as the Chartered Institution of Highways and Transportation (CIHT) with over 12,000 members and the Institution of Civil Engineers (ICE) with nearly 80,000 members worldwide were the perfect launching platform for this pioneer proposal, therefore they were approached via email in their hubs across the country. It was noticed that both institutions were eager to contribute to the project especially as it was for an academic research. Response times confirming whether they would be able to get involved in one way or another or not, usually oscillated between 2 days to 6 weeks. This response time would have represented a serious risk for the research if pertinent cautions were not taken.

As the development of this project was based in Leeds, UK the project was quite fortunate because on 16 July 2013 the CIHT Yorkshire & Humberside Branch organised a breakfast under the name “BIM for Infrastructure & Highway Engineering” held in the city centre of Leeds, where hard copies of the survey were distributed among members. It is worth to mention that although many individuals were not suitable to complete the survey as they had not been involved in transport projects using BIM, they were interested in providing recommendation and advice regarding BIM particularities that could be incorporated into the paper. The advantages of adopting BIM in transport projects were emphasized.

An alternative manner used to approach an appropriate audience was through the professional social network LinkedIn. Several invitations were posted on approximately 20 BIM and transport related groups that had at the time a number of members ranging from 113 to 20,030. This approach allowed getting in touch with suitable individuals irrespective of their location, which was considered a great advantage but also several questionnaires were responded by people who were referring to projects developed in different countries or regions such as Australia, United States and Honk Kong, these were obviously discarded.

While working on the data collection phase after having contacted via email a number of individuals, institutions and consultancies, a few professionals agreed to take part on a telephonic interview to complete the survey. It was perceived that overall those working in the construction industry in the UK are willing to participate in research projects and do not hesitate to provide their insights and experiences regarding BIM in transport, although the response times can be substantially long. In addition to this, participants would tend to get more easily involved and appreciate if the data collection process is fast and simple.

It is essential to stand out that this research put a great effort into reaching the right audience, and despite the fact that a large number of Institutions, transport consultancies and professionals involved in the AEC were invited to participate in this project by completing the BIM survey, the sample size turned out to be equal to 15, which is disappointingly low. This might be because this new methodology although has been present in the industry for some years now especially in the construction of structures such as buildings, it is in its very early stages in transport related projects. In addition, the number of transport projects built is relatively small compared to other kind of projects, this given their high cost to develop, usually constructed in stages or over long periods of time.

3. Comparison of BIM tools

It has been previously established that BIM is a way of collaborative working and by no means should it be considered merely software that can be acquired in order to implement the approach. This chapter analyses some of the features and attributes that make these packages unique. The information expressed in this chapter has been taken from the software developer’s websites.

AutoCAD by Autodesk is a computer-aided design (CAD) or a drawing tool that has the capability to deliver a great level of accuracy into the designs and it can be quite versatile, although its interface is also known for contributing to tedious and manual work that could lead to mistakes. It possesses a wide variety of commands to create as lines, arcs and polygons that permit to shape basically any form in two and three dimensions. It is widely used in the transport sector to represent road marks, traffic signs, transport infrastructure and provisions, site and location plans among others. It has been present in the construction industry for over three decades and it is considered to be the predecessor of the BIM technology.

Autodesk® Revit® software is especially designed to enable the BIM benefits and contains architecture, structural engineering and construction features that make it a very comprehensive piece of software. Some of the most exceptional characteristics Autodesk® Revit® has to offer are the ability to work with parametric components, bidirectional associativity through the use of viewports where “a change anywhere is a change everywhere” and conceptual design tools to model without restrictions “free-form” shapes. It has developed improvements in its point cloud (generated from 3D scanners) manipulation ability to represent complex surfaces or terrains. A variety of materials can be added to the model and photorealistic views can be created in order to improve the visualisation of the final product. In addition, it is possible to produce detailed material and costs calculations. This software is particularly outstanding for its capability to cope with complex situations where a variety of disciplines are involved or where several elements conflict with each other (space constraints). In transport is has been satisfactorily used in bridges.

ArchiCAD® by GRAPHISOFT® has been principally created for the architecture environment. It possesses relevant properties such as the MORPH™ tool that allows shaping any 3D element, constituted of nodes, edges and surfaces into the desired proposal. These elements suffer immediate reflection of every modification in floor plants, sections, elevations, 3D views and in the list of properties as these are changed. Furthermore it is quite convenient that when creating a BIM model, all the required “documentation and images are created automatically.” ArchiCAD® developers claim that they have brought the collaboration definition to a whole different level through the GRAPHISOFT BIM Server, described as “a first of its kind solution”, promoting and improving the sharing of information. Finally this software has the capability to implement in the model GDL (Geometric Description Language) which are similar to block libraries but have “intelligent building elements as 2D CAD symbols, 3D models and text specifications, presentations and quantity calculations”

Microstation is a 2D and 3D software with BIM capabilities that have been used across a wide range of sectors such as the “architecture, engineering, construction, and operation of utility systems. It has been applied for roads and rail, bridges, buildings, communications networks, water and wastewater networks, process plants, mining and more” argue its Bentley its developer. Format interoperability, geo-coordination, point clouds to capture accurate field conditions, hypermodeling to “automate” design generation and “annotation tasks”, connecting relevant data to the three dimensional model can be mentioned amongst the most representative features present in the package. Other key features are Graphical Design Simulation, which according to the developer are: “tools to analyse and visualise models based on their geometry or attributes including detection and resolution of clashes, animation and simulation of models based on project schedules, and display styles to enable real-time visualization and analysis of height, slope, aspect angle, solar exposure and shading.” In addition “lifelike rendering” and animation capabilities are offered by Microstation.

Although Tekla BIMsight (Trimble Company) was launched just in 2011, it has had a fantastic level of acceptance with over 160,000 professionals using it in over 160 countries, given its proven versatility, capability to detect errors and its friendly user interface. Unlike most other software, Tekla BIMsight is completely free of charge, which makes it very appealing, especially for students and those individuals who would like to get a better insight of the BIM methodology. Tekla BIMsight allows adding interactive notes to the model indicating warnings, conflicts suggestions and asking questions that will be observed by all the parties involved in the project. Automated clash conflict checks can be run in the models against previously established rules or regulations. In addition to this, files with documents, drawings or photographs can be added to the model connecting them to specific elements. The State route 99 project (consisting of “16-meter inside diameter bored tunnel 2.8 kilometres long”) running below Seattle’s city centre was developed by HNTB using Tekla BIM because of its capacity to model demanding situations that combine “civil engineering, structures, architectural elements, mechanical and electrical systems and traffic management.”

Vectorworks Architect, developed by Nemetschek Vectorworks, Inc is a versatile product that possesses compatibility attributes and an intuitive user interface. Among the most distinctive capabilities of this software the ability to work with intelligent elements in the form of complex shapes or building components can be highlighted. Making changes is simpler, “for instance, walls can be dynamically linked to the height of the story they occupy. Walls know about the wall they are joined to, and thus maintain a network of walls that can be drag-edited and reshaped. Additionally objects inserted into walls know the height, thickness, material layers, and other information about the wall.” A large variety of information such as urban planning, landscape architecture, geographic information system (GIS) data and building performance simulation analysis among others can be incorporated into the designs.

Vectorworks Architect disposes of a range of BIM objects such as equipment, furniture, walls, roof, columns, windows, stairs and others that can be loaded into the project at any given moment. Items can be created as well if they cannot be found in the BIM collection. To conclude, it is worth mentioning that Vectorworks Architect has extraordinary rendering capabilities that provide a high degree of realism to the table.

MagiCAD is a package that specialises in the calculation of building installations such as ventilation, heating and piping, sprinklers, electric, circuits and others represented through parametric elements. The designs are carried out using models of commercial products and elements; these contain dimensions and technical information that will allow performing the calculations. When working in a 2-dimension environment, a 3D model is created automatically, which provides the capability to work in 2D and move to 3D when it is required, or when a more realistic visualisation is needed. In addition, collision control tools allow verifying if there are installations conflicting with each other. Bills of materials are generated automatically for the buildings installations.

4. Cost and benefit analysis of BIM

4.1. About the project

The distribution of projects developed using BIM was the following: 7 projects in the railway sector, 2 projects in the underground, 2 more in highway projects, 1 bridge, 1 junction, 1 airport runway and 1 footway. As it can be noticed, it is impressive the great versatility offered by the BIM methodology, as it allows developing a wide variety of transport infrastructure projects. Of these 15 projects, 4 were developed between 2006 and 2009, 4 between 2010 and 2011 and 7 in 2012, which indicates a clear increment in the utilisation of this technique. It is relevant to point out that most of these projects (13) were defined as “improvements of existing infrastructure” whereas only 3 were “new projects” that happened to be developed by the railway industry. It is noticed that 9 of these projects were financed by the public sector, 4 made use of public-private partnerships (PPP) while the 2 remaining were funded by the private sector.

Regarding project costs, 11 of these projects had a budget of between £1m and £50m, being these minor-medium improvements of existing infrastructure. Larger constructions considered “mega projects” are major improvements of infrastructure such as the “London Bridge Station Redevelopment” and the “Underground Victoria Station” with investments of £50m and £700m respectively. New projects can similarly reach impressive amounts of capital such as the A63 Underpass in Yorkshire where £160m were required.

4.2. BIM and your organization

Of the corporations that undertook these projects only one had between 1 and 10 employees. Three employed between 100 and 500 individuals, four others had between 1000 and 5000 employees, one more had between 5000 and 10,000 while three deployed between 10,000 and 20,000 and other three more than 20,000. This information leads to believe that the majority of these companies are large multinational organizations with the technical, financial and human capability to acquire and test innovative technologies such as BIM.

It was perceived that these organisations implemented BIM for a combination of reasons. Six individuals agreed on the implementation of BIM for “client and legislation” requirements while three intended to increase the efficiency through collaboration. Other three required clash detection features during construction phase to avoid errors and rework. Other reason included the ability to utilise a single platform to capture many layers of information and to produce more flexible designs. Client better visualization through "intelligent" three-dimensional elements, reduction of information waste and threat to time and budget of projects were also included. A couple of responses indicated that their organisation aims to move the business forward and to be market leaders. It is observed that the second reason to implement BIM after the mandatory government requirement was the motivation to increase the efficiency of the design and construction processes, leading to cost savings and greater profits.

The general perception was that the BIM working environment was a radical change compared to CAD. It was said to be especially challenging to put into practice in the first project as working in full collaboration is an innovation that requires a substantial amount of information. New users claimed that the entire benefits were uncertain, they were impressed by the rendering capabilities and the realism presented by the models. Moreover this approach was considered quite expensive to implement as it requires costly equipment, software, training and loads of information. More experienced users encountered in BIM a useful tool to reduce project costs significantly.

As defined in the introduction, BIM is not software or 3D models that provide optimised visualisation of infrastructure or traffic simulation but a way of collaborative work that certainly offers some of the features just mentioned. Being aware of the packages utilised as part of the BIM approach is relevant to recognise their strengths and limitations aiming to provide further recommendations. Autodesk (Revit) and Bentley (Microstation, ProjectWise, MX ROAD) lead the market of this category of software with 5 projects each and 1 project developed by Vico-Trimble.

4.3. BIM training

Training is essential to unlock the full potential of the BIM technology, especially because in the AEC industry projects involve huge investments of capital, therefore there is limited room for errors; works must be performed correctly and fast in order to maximise efficiency, hence profit. It was noticed that while some companies are open to provide training constantly or as much as the employee requests (determined on a case by case basis) there are others that have established training programs of approximately 50 hours per year or the completion of one project. The results indicate that in average the training could reach an end after 6 months to 1 year. A participant said: "BIM champions do not stop learning; they still learn from peer to peer and training sessions. Reaching champion level takes at least 3 to 5 years of constant involvement in BIM projects."

It was perceived that quantifying the economic impact of training is a very complicated task because it might be too early at this stage as there are not many sources from where to get this data, and given that participants are not aware of this information. But independently of this, some agree that the average cost of training represents a significant expenditure of between £500 and £800 per day.

4.4. The benefits, advantages, drawbacks and challenges of BIM

Limitations and Disadvantages: Most participants concurred that the most important limitation is that there has to be a major change in the working culture of the AEC that cannot be accomplished overnight. The second most mentioned restrictions are the elevated financial costs inherent in this change and the time required (both required in advanced) in order to migrate from the traditional CAD approach to BIM. It was expressed that a significant inconvenient is the need to learn new software that is not needed for many projects (at least for now). It was recognised that the setup time is longer especially for simple jobs and that a large amount of information is required to commence a project. Furthermore it was noticed that drawing delivery is slow and the designs are limited by the user's abilities at first.

Challenges: The results show that changing people's perception that BIM is 3D modelling or just improved visualization is among the most important challenges the industry faces. It was perceived that it is essential to raise awareness about what BIM truly is and where can it lead the industry by setting up accurate information and courses aligned to the Government and the Construction Industry Council (CIC) best practice. Nearly every participant agreed that the main challenge was a change in culture and attitudes towards this new way of working, it is recognised that not everyone understands what is behind BIM. In addition, making everyone work in collaboration is a huge constraint as traditional techniques do not require this level of coordination.

Benefits: The most significant and evident advantage observed by the majority of the participants is the improved coordination generated through collaboration and communication that leaded to a more efficient (less waste) and accurate process. Earlier detection and clash reduction on site and less re-work increased the staff motivation. "It was very convenient to have all the data in one place" some agreed. The enhanced coordination of BIM helped achieve savings in time and capita, improving capital expenditure (CAPEX) and operating expenses (OPEX). Features that enhanced the visualization of the model allowing a better understanding of the concepts and early conflict detection were emphasised. Only one participant was not able to detect any benefits, claiming that having performed the project using CAD would had been faster, but stated that after all that particular project was a "pilot scheme and the objective was to learn on the way"

BIM vs. CAD: The following are some of the attributes and contributions of BIM, detected by the participants when comparing with the traditional CAD approach.

- Integrated 3D model across disciplines that enable coordination and clash detection.
- Clash detection tools and the capability to set parameters according to specification.
- Accessibility of "Intelligent" Elements.
- Savings on rework when updating elevations, sections and details.
- Less requests for information (RFI's) at construction site.
- Flexibility in design (ability to accommodate late changes).
- Interchange ability of design information between disciplines.
- Much better records left for future generations!
- Better drawing production with more confidence of accurate data.
- Single source of truth using Common Data Environment (CDE).

Perceptions of Implementing BIM: This section compares the perception of the participants regarding the improvement or worsening of implementing BIM comparing to the traditional CAD approach, six indicators have been used.

Faster work: 10 participants perceived that working with BIM allowed them to perform their duties faster by 52% in average, while 4 persons noticed an increment in the time to get the work done by 37.5%. It is sensible to have two groups with opposite perceptions as the first one represents the one that includes more experienced users; newer users are contained in the second group. It is important to notice that there is an 80% breach between these 2 groups.

Easier to Implement: The perception regarding this indicator is quite balanced and it is normal to have individuals who have used the CAD approach for years struggle when they first attempt to implement BIM, finding it 33.5% more complicated to apply as it involves more variables and a fully collaborative environment. It is important to stand out that once the participants were familiarised with the implementation of BIM, they found this approach 37% simpler than CAD.

Ability to Share Information: Although working in a new collaborative environment can be unconventional and complicated to achieve, nearly all participants (13) agreed that BIM enables an enhanced ability to share information between all members involved in the construction process from design to construction and management by 64%. Only one person believed that with BIM this ability to share information gets worse by 50%.

Clash/Error detection: Without any doubt, the clash detection capability of BIM is one of its more appealing attributes to reduce costly rework hence unnecessary expenses. 13 participants considered that this approach improved its predecessor's potential regarding error detection by 65%. It is supposed that the person who indicated that the error detection is reduced by 5% with BIM is not well informed or is a new user who is just starting to get involved in the approach.

Time Reduction of the Project: This indicator is unquestionably one of the main big rewards derived from an adequate implementation of the approach. It was noticed by 11 participants that the correct application of the features offered by BIM, eventually leaded to a reduction of the time of the project by 46.5%. Only 2 persons noticed an increment in the time of the project by 40%, again highly possible by their recently involvement with BIM.

Cost Reduction of the Project: Similarly, it is anticipated that a better coordination, error detection in the design phase, the possibility to accommodate late changes and time reduction among many others would produce the financial cost of the schemes to experience a significant diminution. 10 participants concluded that from their perspective the implementation of BIM in their projects help reduce the cost of the project by 47% while just 2 persons considered that the cost increased by 35%.

The results indicated that the perception of the participants regarding the time reduction of the project is directly connected to their perception concerning the overall cost reduction of the project and tends to have a linear relationship.

4.5. About the participant

It was possible to notice that although the BIM methodology in transport related project is recently starting to be implemented, there is a wide diversity of professionals involved in the approach from surveyors, draughtsman, civil engineers and architects to economists, chairmen and managers, proving that the process is more integrated than CAD where mostly technical professionals are implicated.

5. Conclusions

Irrespective of the small sample size utilised in this research, the objectives have been accomplished, as it has been possible to determine current tendencies concerning the implementation of BIM in transport related projects including challenges, advantages and the economic repercussion perceived in the overall project cost. A comparison with the traditional CAD approach was possible to determine that if the BIM technique is put in practice correctly, the advantages are astonishing, making worth the change and the initial investments especially if a significant workload is anticipated. Despite the fact that the AEC industry in the UK has been implementing the BIM approach in a number of construction projects for several years, currently the transport sector is in its very early stages. Nevertheless, the application of BIM in transport related projects is gradually increasing in number, partially because there has been tangible evidence of the advantages behind this technique, and additionally for the reason that is has been triggered by the Government Construction Strategy announced in 2011.

It was demonstrated that the adoption of BIM approach is a major challenge for the industry, principally because it is required a revolutionary modification (mainly cultural) in the way professionals have been working for years. The appropriate implementation of BIM offers a number of advantages that eventually will lead to the reduction of the time of the project, therefore a reduction of expenses shrinking the project cost. It is clear that comparing with the CAD approach (if implemented correctly), BIM delivers overwhelming advantages that are very likely to surpass the UK Government Hypothesis (15-20% cost reduction). The reduction of the time of the project is directly related to the cost of the project and the diminishment of carbon emissions. It is recognised that the implementation of BIM is a medium-long term transition, hence time will be required for the industry to get familiarised with the methodology before unlocking the full range of benefits offered.

An essential part of this digital change is recognised by the fact that the UK construction strategy is not just a command emitted to the AEC industry; it is accompanied by the responsible involvement of the government by providing a sequence of guidance, provision of information and the required support in every level to make the transition a success.

Acknowledgements

The opportunity of having undertaken the MSc in Transport Planning and Engineering programme offered at the University of Leeds 2012/13 and sponsored by the Chevening/BP Scholarship and the CONACYT Scholarship permitted to a great extent the possibility to produce this research. Furthermore, it is worth mentioning the valuable guidance and support that Dr. Haibo Chen provided throughout the project.

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