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Highway infrastructure and Building Information Modelling in UK

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Abstract

Section:

Traditional methods of design are becoming less relevant and prevalent, due to institutionalising of Building Information Modelling (BIM) within statutory regulations and the huge amount of data that BIM presents to practice; especially in 3D models. This can be seen in the A1 Dishforth-to-Barton road infrastructure improvement scheme which comprises the A1 Dishforth-to-Leeming and A1 Leeming-to-Barton schemes. The traditional method of design was central to the A1 Dishforth-to-Leeming scheme and BIM central to the A1 Leeming-to-Barton scheme. So this report presents a comparative study of the traditional and BIM methods in relation to the A1 Dishforth-to-Barton improvement scheme through the perception of key professionals involved in this project. A qualitative research study was conducted through the use of an open-ended questionnaire intended to bridge gaps in perceptions and understanding of both methods. Judgemental sampling technique was used to select experienced respondents who understand and participated in the A1 Dishforth-to-Barton road infrastructure improvement scheme. The study reveals an incontrovertible complementary nature of both methods and that the realisation of the 2016 mandate appears doubtful due to lack of standardization, training and level of awareness. It is highly recommended that a statutory incentivization framework for BIM be conceptualised and considered for implementation to attract and encourage small scale participants. Of high priority is the subsidization of in-house training by local authorities and localized joint ventures by smaller companies for specialist training.

Keywords: building information modelling (BIM) infrastructure planning roads & highways

1. Introduction

Building Information Modelling (BIM) has existed for over three decades in the architectural, engineering and construction industry. However, the adoption of BIM within the transportation sector in particular and the UK construction industry in general has been quite gradual. Increasingly, firms within the transportation sector are also beginning to see the relevance of BIM in infrastructure project delivery, as a means of enhancing their competitive advantage, in consonance with its enormous benefits of infrastructure to physical, natural and human systems (Maloney, 2015).

According to the BSI (2010), BIM provides a well-organised approach and collaborative environment for information sharing in the delivery of projects. BIM is currently being used in transportation infrastructure delivery by the UK Highways Agency (which is renamed ‘Highways England’ in April 2015), as a tool

and process to outweigh the disadvantages associated with traditional methods of working, to provide improvement in infrastructure project delivery time and mainly to prevent the occurrence of additional costs. The primary logic while delivering quality work is to minimise capital cost, future maintenance fees and time as well as meeting the requirement for three-dimensional (3D) BIM on all procured construction contracts by 2016 (CO, 2011). The utilisation of BIM methods will become compulsory for all government projects within the UK by 2016.

Many authors are of the view that adopting BIM affords clients the opportunity to see their projects in 3D representation and other improvement schemes prior to the completion date. Thereby they can eliminate all or most omissions that occur during the use of traditional methods. Other perceived benefits include effective and quality data, improved collaborative working, improved site planning, reduction of clashes on site and an enhanced understanding of construction methodology. Hence, the general perception is that BIM provides greater benefits for the advancement of design and a collaborative working environment. This in turn has meant that traditional methods, that have been extremely useful for project delivery previously, are increasingly perceived as becoming archaic or superseded. Hence, this paper is a comparative study of the traditional and BIM methods with particular reference to the A1 Dishforth-to-Barton (A1D2B) infrastructure improvement scheme. The idea is to examine the actual acceptable levels of BIM in relation to the traditional methods and thus examine the complementary nature of both methods.

The A1D2B scheme comprises the A1 Dishforth-to-Leeming (A1D2L) and the A1 Leeming-to-Barton (A1L2B) (Figures 1 and 2). The A1D2L section construction began in 2007 and was finalised in 2011. This section consisted of new highway structures that were designed in part through the use of BIM and through traditional design means. However, the A1L2B section, on which construction began in 2013 and is due to be completed by 2017, is being delivered exclusively through the use of BIM.

To compare and contrast the two elements of this infrastructure project, this paper is subdivided into five additional parts namely literature review, methodology, discussion of results, conclusion and recommendation.

2. Literature review

Traditional engineering design methods have evolved significantly through the use of information communication systems such as AutoCAD, one of the key products of Autodesk; essentially for two-dimensional (2D) drafting. The traditional method would normally consists of designs (both calculations and drawings) delivered by hand. This process has been the prevalent approach in performing calculations and

drawings for many years. The limitations of this method and subsequent improvement in IT systems have led to the development of BIM. Before expatiating on the literature, it is important to present briefly the case study referred to in this work, in which all the selected respondents have had some current or former experience with the A1D2B highway infrastructure improvement scheme.

The A1D2B scheme was split into two sections, comprising the A1D2L and the A1L2B. The improvement scheme was split because of the UK government's spending review of 2010, which reduced expenditure within the construction industry. The construction of A1D2L section of the scheme started in 2007 and was completed in 2011. This section has new highway structures designed and constructed using the ideology of BIM in one of its sections and the other using purely traditional methods. However, the construction of the A1L2B section started in 2013 and is to be completed by 2017. The structures in this section are currently being constructed and BIM is being implemented throughout the design and construction stages of this part of the project.

The objectives of the A1D2L improvement scheme were to reduce the high levels of accidents, congestion and to enhance journey time reliability by upgrading the existing A1 containing a large number of grade crossings to dual-/three-lane motorway standard junctions between Dishforth and Leeming Bar.

The objectives of the A1L2B improvement scheme are similar to the A1D2L improvement scheme.

Undoubtedly, computer aided design (CAD) has improved the traditional design methods; improving the ability of the designers to provide a variety of perspectives that were not possible using hand calculations and drawings alone. CAD drawings can be easily relayed (i.e. from one drawing to another); but largely dependent on the authenticity of the data and the experience of the individual sharing it (AI Hattab and Hamzeh, 2013). As a traditional method, CAD can incur the risk associated with miscommunication, request for information (RFI) and processing time (BuildingSMART, 2010). These are the areas that often determine the levels of user satisfaction and thus provide a significant area for improvement in the use and capabilities of CAD. The main issue with traditional methods is the processing time and subsequent cost involved with the process (BuildingSMART, 2010; PV, 2013). Time saved using CAD is significant when compared with the traditional hand-produced calculations and drawings. Moreover, traditional methods have often been susceptible to errors that are easily eliminated with the use of CAD (Paper2dwg.com, 2015). Put simply, CAD can produce drawings more quickly than can be created by hand. Utilising a hand-drawn process, correct and consistent information sharing is central to workflow; however, this is time consuming and ultimately expensive (Grabowski, 2010). It is important to note that

several factors can affect the hand-drawn process time; primarily amongst these are: Information Technology (IT) experience and RFI (Paper2dwg.com, 2015).

As a way forward, especially in overcoming issues associated with risks mentioned above, the BIM was developed and is now the chosen protocol for projects in the UK. This protocol is used in accordance with a variety of Autodesk software to provide a fully operational proposed project as virtual 2D or 3D imagery prior to construction. This is to eliminate the kinds of problems that have previously occurred on projects where BIM has not been considered; to provide clients and parties with a model that contains all relevant information that can be used by a variety of professionals with clarity and without delay.

The adoption of BIM has heightened since the UK government announced in 2011 that all construction projects are to be delivered utilising BIM, especially in 3D (CO, 2012). According to BuildingSMART (2010), BIM utilisation can prove to be highly efficient as a means of providing an information-sharing environment among stakeholders and as a means of eliminating excessive printing and storing of documents. This is very positive for the design team as the data required is readily available to all involved and an overall view of the project's development is also accessible.

These advantages notwithstanding, Joyce and Houghton (2014) argue that BIM is still many years away from being the single, data-rich, cloud-based asset model. This is simply due to the costs of implementing BIM and the fact that some organisations within the industry lack the financial means to adopt BIM. Anecdotally, it is noted that this can result in these firms seeing a reduction of workflow when BIM becomes fully operational. However, Grabowski (2010) maintained that the software for BIM can easily be exported to CAD formats, which make the contribution of smaller firms easy and valuable at design stages. Thus, BIM is able to provide the most up-to-date information on a project: cost schedules, analysis of design clashes and 3D representation of the proposed project, which is certainly equal in utility and value in comparison with thousands of drawings (Carter, 2013; Eastman, 2008; Foulkes, 2012). Furthermore, BuildingSMART (2010) advocated that BIM can decrease cases for RFI and higher processing time by having the information all in one place for all users to access. This is exactly what the industry needs, a system where all data are in one place, for all parties to access the information anytime and anywhere. This prevents delays in accessing information, resulting in faster processing times. However, if the information entered is not correct, this may have a significant effect on its users. This therefore highlights the importance of verifying the data produced thoroughly before it is entered into the BIM and any data altered outside the BIM must be re-entered to ensure consistency and accuracy. Hence, education on BIM across the industry is necessary as currently no standardised practice of BIM utilisation exists; although this in itself is telling of the efficiency of the process. This is particularly true as the current software for BIM cannot interface

with other programs efficiently and thus impedes interoperability (the ability to exchange and use information in a large heterogeneous network).

In the UK alone, the lack of interoperability is estimated to cost £100 million a year due to waste processes of poorly structured information sharing (BuildingSMART, 2010). This suggests that since the raised awareness and utilisation of BIM in the UK, traditional methods are unable to innovate and adapt. In some projects, however, it is still essential to adopt traditional 2D CAD drawings; especially for firms that have not invested in BIM, in order that they can contribute to projects and to make cost estimations. This way of working can still provide a positive cost improvement overall as both approaches are being utilised. For the companies that have adopted BIM methods, 2D CAD formats are compatible with BIM and can be imported and exported to the required software (Eastman, 2008).

Rundell (2006) counterargues that using the traditional approach, cost estimating, for example, can require an increase of up to 50–80% in a cost estimator's time. However, utilising BIM offers a huge transformation through its shared digital resources, cost estimations, quantifications and accurate measurements that can be directly generated from BIM (Sabol, 2008). It is important to mention here that costing can sometimes impact on a project life cycle. The project life cycle consists of various stages such as the planning, designing, constructing, operating and maintaining of the facility once completed.

Meadati (2009) maintains that in the traditional process, data exchange in each of these stages is often in 2D; repeatedly risking misunderstanding that results in delays, cost increase and RFI. According to Talebi (2014), traditional methods used across the life cycle are disorganised and often responsible for many of the difficulties through the project life cycle phases. This can be seen as the main complication with this process as it is difficult to monitor information on the overall project. Introducing BIM, therefore, can show a virtual model that includes all elements from every discipline, which provides all bodies involved, – that is, the client, engineers, architects, contractors and so on, the ability to interact efficiently across the life cycle of the project compared with traditional approaches (Carmona and Irwin, 2007).

However, Thompson and Miner (2007) argue that a fully accessible BIM still requires accurate data input to ensure that whoever is using it has the most up-to-date information. This would allow everyone to access the model anytime, anywhere and have the latest information throughout the life cycle of the project. However, this creates questions such as who checks the accuracy of information? How do you ensure that the most recent data are regularly entered? This is why it is important to have BIM standards and training available to promote the use and provide guidance on implementation and management across the life cycle of the project.

Azhar *et al*. (2009) were of the view that the early design phases of a project are crucial stages in ensuring sustainable and positive carbon performance decisions are made. Schueter and Thessling (2008) earlier argue that the traditional methods are generally inadequate in executing a sustainable approach and analysis at the introductory stages of project design. This is simply due to using the traditional software – that is, CAD lacking integrative capacity, which creates an incompetent mechanism for the analysis of environmental systems or factors at the design stage. BIM provides users with such capacity and multidisciplinary data that create the opportunities to assess information on sustainability issues and the environmental impacts that a project could have on its surroundings. However, Quinn *et al.* (2015) have stated that professionals using BIM can undermine and underestimate the data that are entered, regardless of the collaborative working that BIM provides at the design stage, and that it still lacks a means of coordination and proper data exchange as no data sharing standards are available.

3. Methodology

The philosophy behind this study is to obtain accurate and in-depth opinions on the traditional and BIM methods of design in relation to highway infrastructure. All respondents involved work within the highway infrastructure sector in the UK. This qualitative research approach was adopted because the views of highly experienced professionals on this subject must be obtained in a comprehensive manner. A non-probability sampling strategy was therefore required. Non-probability sampling is often used when the number of potentially experienced respondents who understand the subject matter cannot be identified with adequate certainty and the fact that the information being solicited within the purview of the case study is limited to a small number of individuals (Dawson, 2009; Kumar, 2010). In this case, the non-probability sampling strategy adopted was purposive or judgemental sampling. The main consideration with this sampling approach was the judgement on who is most suitable or best positioned in providing the best information to achieve the research objectives of the study.

The basic criterion for selecting respondents within the study population was their involvement in the delivery of the case study presented in the literature review, which in this case is the A1D2B highway infrastructure improvement scheme. Hence, their experience within this case study would underpin the responses provided in the fieldwork.

The data collection method has been the use of an open-ended questionnaire. A copy of the questionnaire and summarised results of survey can be found in the Appendix of this paper. The questions asked were prompted by the gaps established by the literature review. These questions are carefully listed (in italics) and discoursed accordingly in Section 4. The anticipated numbers of respondents were about 10; at the time of writing, however, about 80% response rate was

achieved. The responses received were confidential and the respondents' anonymity guaranteed.

4. Discussion

Compared with traditional methods, do you think BIM will give cost saving and better risk control?

Seven out of eight of the respondents agreed that BIM in the long term increases savings and results in better risk control. However, six respondents were also of the view that BIM appears more expensive in the short term. Thus, the purview of the experts engaged in the delivery of the road infrastructure projects (used as case study) suggests that the traditional method is beneficial in the short term and BIM in the long term. Although, not directly related to the question asked, one of the respondents mentioned that the risk management between disciplines is improved using BIM due to the extensive availability of data, which clearly enhances team spirit and collaborative working. These assertions concur with earlier assertions in the literature review made on cost estimation and cost improvement using BIM.

This view contradicts some existing literatures; especially of Rundell (2006) who argues that the traditional methods do not provide any cost savings. However, the assertion that there are long-term benefits from BIM is in line with cited literatures; specifically Sabol (2008). It is important to add that one of the respondents mentioned that ‘Technology is always moving and we must embrace it’. This comment concurs with the comment made by Sabol (2008) regarding the benefits of BIM technology. Nevertheless, the same respondent maintained that ‘BIM should be seen as a traditional method’ because BIM has been around since 1962 (Table 1).

From the preceding responses provided for this particular question it is clear that the findings are consistent with current theories and, most interestingly, this feedback is from practitioners who understand both methods (traditional and BIM) with first-hand industrial experience having utilised them on the A1D2B improvement scheme. However, respondents to a certain degree are in agreement with the literature review for the reason that if BIM was utilised completely, the A1L2B improvement scheme would have more benefit compared with the traditional method. Thus, for the long-term application, BIM has been ascribed as most suitable by respondents. These responses would be of great value to clients and companies, who are currently trying to determine the kind of approach to use and thus could potentially impact project delivery significantly. The next question has an impact on the quality of data and its processing using both the methods.

Do you think that introducing BIM has improved quality of data, checking and analysing compared with traditional methods?

Comparing both methods across the improvement scheme, seven out of eight respondents were of the view that clash detections, quality of data, checking and analysing all improved under the use of BIM. However, respondents who suggested that BIM improves quality of data checking and analysis also mentioned that traditional methods could be used to properly check designs (Table 2).

This suggests that although BIM has been utilised on the A1L2B scheme, traditional methods are still used to check designs because it provides an extra check or backup especially when the computer software is susceptible to fault and not foolproof. Therefore, by using both methods to check designs, the chance of errors could be minimised and reliability enhanced. This finding corroborates Thompson and Miner (2007) in that the information inputted into BIM still needs to be of high quality and accuracy. In order for the BIM to improve the quality of data checking and analysis, the information that is entered must first be correct.

Another interesting point worth noting is the fact that one of the respondents mentioned that 'BIM model needs to be accessible on standard hardware devices and that file sizes must be sufficiently small for accessibility purposes as current file sizes are too large'. However, the assertion that BIM provides the platform for automated clash detection concurs with several literatures like those of Carter (2013), Eastman (2008) and Foulkes (2012). Comparing both schemes it was clear that BIM was the preferred option due to its clash detection abilities. However, traditional methods were still used alongside BIM when it comes to design data checking – clearly suggesting that the traditional methods could complement the use of BIM. The next question borders on the pace of infrastructure delivery using both methods.

Using BIM do you think there is a considerable improvement in the pace of infrastructure project delivery?

Two of the respondents maintained that in the long term BIM will improve the pace of infrastructure project delivery. About seven respondents argue that BIM is still not fully understood – which may require a considerable amount of time for proficiency across board (Table 3). To these respondents, BIM seems to be more beneficial compared with the traditional methods when considering the long term factors such as knowledge, training and understanding the process must come first before BIM can be fully appreciated. This brings to mind again the argument presented by Thompson and Miner (2007) that BIM requires the entering of accurate data to avoid time delays.

From the findings it could be inferred that BIM does not necessarily alter the way professionals do their work but it can be seen to provide guidance as to the best approach to improve the pace at which infrastructure projects are delivered. In practice, delivery within the timescale specified is important to prevent additional

charges and BIM could provide this if understood. The next question borders on the adaptability of both methods to environmental and sustainability issues.

From an environmental and sustainability design paradigm, has the use of BIM improved the quality and pace of project delivery over traditional methods?

Results relating to this question were again very useful and showed a common pattern between the respondents. About five out of eight respondents agreed that BIM provided a model preview of the project prior to the construction stage, with the inherent potential to display any effects the project may have on the environment (Table 4). This would in turn result in more sustainable design by identifying issues before construction. Alongside this perceived benefit of BIM respondents were categorical that there is an improvement in environmental and sustainability design using BIM. However, one of the respondents argued vehemently that traditional methods are still used within the framework of sustainable design such as Ecotect and Green Building Studio (GBS) and that BIM can export to traditional methods. This further corroborates the argument that traditional methods could complement BIM. However, BIM improves the pace and quality of projects by having all data in one model.

In relation to the existing literatures, however, it can be seen that the respondent's comments concur with Schueter and Thessling (2008) on sustainability and traditional inadequacies. There can be no doubt about the fact that similar characteristics exist between the literatures used in this study and respondent's thoughts. For example, the majority of the respondents stated that BIM improves environmental and sustainability design which shares the same theme as Azhar *et al*. (2012), who stated that BIM can achieve sustainable analysis. Another example of concurrence is a comment by Autodesk (2015) regarding the ability of BIM to assess information for sustainability purposes. However, one respondent pointed out that the traditional methods such as Ecotect and GBS are used alongside BIM to ensure that the projects gain LEED merits because those particular software packages are solely designed for those purposes and the BIM does not seem to have specific tool or process for this apart from a model preview. The findings, from a contextual point of view, would agree with the fact that quality and pace of project delivery is being improved due to the use of BIM and its model previewing.

The results show that BIM does provide more benefits than traditional methods across the whole infrastructure improvement scheme and utilising BIM could change the way design is carried out on projects. Clients that demand BIM utilisation obviously see its benefits. However, as mentioned in the previous section, traditional methods can be used to complement BIM as some traditional software packages are designed for specific tasks, such as environmental and sustainability design, and can be imported or exported to BIM. The next question is intended to test communication and collaborative working improvements under the utilisation of both methods.

Would you say communication and collaborative working has improved utilising BIM compared with the traditional approach?

All the respondents were of the view that BIM makes communication more effective and working across disciplines has improved compared with traditional methods (Table 5). It clearly enhances clash detection notification and can highlight potentially serious issues at an early stage. This finding is supported by BIM Task Group (2015) that BIM encourages a collaborative environment that allows data exchange across the design team, thus preventing work becoming superseded by developments as all the latest information is entered in one location. The comparison between the two methods has provided some clarity as to whether communication and collaborative working is improved through the use of BIM.

The consistency with the findings is in agreement with most literature used in this study. Comparing the benefits and improvement between the two schemes and the approaches used, BIM certainly outweighs traditional methods in terms of communication and collaborative working. These findings show that BIM improves communication and collaborative working that are key factors to any project. The next question is intended to compare the productivity of both methods.

Would you say that the use of 3D modelling has had a positive impact compared with traditional 2D detailing methods (for instance, has productivity and efficiency of technical drawings and specifications improved)?

More than half of the respondents (seven out of eight) agreed that 3D modelling improved productivity and efficiency compared with 2D methods. This was due to the 3D modelling methods being able to show a 3D representation of the project rather than 2D plans, which were sometimes hard to interpret by clients and inexperienced practitioners. However, (three out of eight) respondents also stated clearly that in the short term, 2D traditional methods were more beneficial as 3D resulted in more work (Table 6). This shows that 3D in the long run provides users with more benefits in terms of productivity and efficiency. The timescale of the project determined the preferred method – that is, project to run over many years may benefit from the use of 3D and BIM compared with a small house conversion.

However, CG (2015) mentioned that 3D BIM can be broken down into 2D and 3D elements. Looking at the responses it is clear to suggest that 3D is a preferred option on the improvement scheme due to its enhancement capabilities when productivity and efficiency are major requirements and if certain areas are required for analyses these can be exported to 2D. In terms of the future potential, 3D modelling has and will definitely improve the way professionals work.

Do you think the request for information (RFI) process is easier to manage using BIM methods compared with traditional methods?

Some respondents were of the view that with BIM, the RFI process is easier (Table 7). These suggest that the RFI process is more efficiently managed through BIM as all the information is within the BIM. This would seem to suggest that the waiting time for information is reduced since RFI can be resolved by simply viewing the model and data available. This corresponds to Grabowski (2010), who reaffirmed that poor data exchange results in RFIs being created using traditional methods. However, utilising BIM, according to the respondents, makes managing RFIs easier by having all data in one model for anyone to view. It could also anticipate or prevent problems, embodied in potential later RFI, if the data within the BIM were incorrect or were not entered. These comments also connect to the BuildingSMART (2010) statement that traditional methods lack the capability to prevent RFIs from occurring.

It is important to mention here that these responses are a function of the experiences that respondents have had using both the BIM and the traditional methods on infrastructure improvement schemes. However, the findings seem to suggest that these professionals prefer the BIM approach in managing RFIs due to the fact that the data are being shared within a model as opposed to several drawings that would require explanation. The next question ascertains the views of respondents in relation to the 2016 mandate by the UK government.

Taking into consideration the government mandate for all construction projects to be delivered using BIM by 2016 and given your experience, do you think traditional methods are inferior to BIM and are you in support of the 2016 mandate. If yes/no please explain why?

According to all the respondents who have used both methods on the improvement scheme, the traditional methods are not inferior to BIM (Table 8). The justification for this is that traditional methods have been around for many years before BIM. The traditional way of designing will always exist as long BIM maintains an association with the method and through the fact that 2D CAD still provides advantages throughout the transportation infrastructure sector that can be used in relation to BIM. Another common point that all the respondents agreed to was that issues that arise using traditional methods are rectified within BIM resulting in an easier way to deliver work and overcome problems. In relation to the UK government mandate only two respondents stated that the 2016 mandate would be achieved at some point but not by 2016. The suggested reason for this is that BIM is only in its early stages of development and that if it is to become the chosen method then it should be more widely introduced across the sector. This finding clearly contradicts the statement made by the CO (2012: p. 16) in their construction strategy document that made clear that all UK construction projects will be delivered using BIM by 2016. The contradiction occurs because the respondents do not have faith in this mandate and that the traditional methods are still utilised fully or alongside BIM on projects, which suggests that both approaches can be used together and that in some cases BIM is less favourable due

to the additional work and effort required in the short term. With the pressures emanating from this mandate, one wonders what happens if this mandate is not achieved and what measures are in place across the UK to ensure BIM is fully utilised by 2016?

Do you think the 2016 mandate is feasible?

All the respondents (Table 9) unanimously agreed that this mandate is not feasible by 2016. The main reasons put forward for this are the fact that the traditional methods still having a huge impact on the industry; there is a lack of industry-wide BIM standards; companies are reluctant to invest in BIM due to the short-term returns on investment and the poor knowledge and awareness associated with BIM.

The unfeasibility of the mandate is primarily due to the fact that the traditional methods are still dominant within the transportation sector and are heavily uses BIM. Although BIM is utilised, due to the low level of knowledge and understanding of the method, anything that is deemed to have an impact on time and cost will be carried out using the traditional methods instead. Traditional methods are more fully understood. The next question borders on training and knowledge of BIM in relation to the 2016 mandate.

Do you think the general level of training and awareness of BIM is commensurate with the expectations of the 2016 mandate in the UK?

All the respondents are strongly of the view that the level of training and awareness of BIM is not commensurate with the 2016 mandate (Table 10). These responses directly relate to questions 9 and 10 in agreeing that the traditional methods are still dominant due to their ease of use and the 2016 mandate is not feasible considering the level of awareness the industry has in regard to the BIM method.

The responses present a contradiction to Rooney (2014) who stated that the UK leads in the training and education of the practitioners of BIM. That assertion does not necessarily mean that the UK is on target to achieve the 2016 mandate. Additionally, these findings would show agreement with the survey conducted by Malleson (2013), which showed that 39% of respondents were utilising BIM; further evidence that the 2016 mandate is not feasible that the level of training and awareness of BIM is not on a trajectory that may meet with the mandate. Clarification on the level of training can be seen and can be deemed insufficient with regard to the mandate.

Going forward would you say that traditional methods should be superseded by BIM and that BIM is the future for effective delivery of infrastructure projects in the UK?

With the majority of respondents (seven out of eight) agreeing that traditional methods are still an essential part of design, it can be suggested that traditional methods should not be superseded by BIM. Three out of eight respondents suggested that BIM is more beneficial on larger projects compared with small projects (Table 11). This in the short term, at the industry stands, would prove correct as traditional methods can be utilised far quicker in smaller projects. However, learning and applying BIM will result in advantages outweighing the disadvantages, in the short term and long term according to one respondent. From the respondents who use both methods it was suggested that traditional methods will still be an essential part of the design process and have been utilised with BIM where necessary on the infrastructure improvement scheme.

As mentioned before, the responses simply provide clarity on BIM being the future of the construction industry. Several responses can be seen to suggest that traditional methods are still an extremely important part of the design and in some cases outweigh the advantages of BIM.

5. Conclusions and recommendations

Contrary to popular expectations that BIM would completely overshadow the traditional method of design in a very short time, it is revealed from responses in the survey carried out here that the BIM provided great improvements and benefits compared with the traditional methods, in some areas on long-term projects. Interestingly, all the respondents maintained that the traditional methods are still preferred and that they provide a significant input on infrastructure improvement schemes. Furthermore, BIM improves and clarifies the inherent weaknesses of traditional methods and simplifies the difficulties encountered using traditional methods. This therefore presents the complementary nature of both methods; – that is, both the traditional methods and BIM should supplement one another in practice. However, the realisation of the 2016 mandate is doubtful due to lack of standardisation, training and the level of awareness. It is highly recommended that a statutory incentivisation framework for BIM be conceptualised and considered for implementation to attract and encourage small-scale participants in the UK construction industry. Of high priority is the subsidisation of in-house training by local authorities and localised joint ventures by smaller companies for specialist training in BIM. This would enhance the sustainable integration across all levels of stockholders and participants in the UK construction industry.