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BIM-ENABLED HEALTH AND SAFETY COORDINATION IN THE UK CONSTRUCTION INDUSTRY: ROLE OF THE PRINCIPAL DESIGNER

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ABSTRACT

The coordination of Health and Safety (H&S) during the design/pre-construction phase is often perceived as significantly important because of the ability to influence a reduction in the possibility of accidents and injuries. In the UK construction industry, the construction design and management (CDM) regulations are best placed to achieve this vision. Most importantly, the role of the Principal Designer (PD) is crucial, given their pre-construction phase responsibilities. The aim of the study is to critically evaluate the duties placed on PDs and examine the extent to which implementation of Building Information Modelling (BIM)-enabled H&S coordination enhances the discharge of duties performed by PDs. Primary data considered for this study involved the use of a questionnaire survey, while secondary data in the form of Statutory Instruments were scrutinised, thereby applying content analysis and drawing comparisons with the extent of discharge of duties.

The findings reveal that over 90% (i.e. 12 of 13) of the duties placed on the CDM-C in the previous regime correspond with those placed on the PD in the current regime. Secondly, of the nine duties that stand out in terms of BIM interoperability at Level 2, the study shows that four duties of the PD immediately benefit from adopting the BIM-enabled H&S coordination approach, namely: Regulations 11(1), 11(2), 11(4), and 11(5). In summary, the study deepens the understanding of the implementation of the CDM Regulations, particularly highlighting the role played by PDs during pre-construction.

Keywords: CDM Regulations, BIM, Health and Safety, Principal Designer.

INTRODUCTION

The UK construction industry continually suffers from a poor reputation because of the reported fatal and non-fatal injuries resulting from construction activities. Figures published by the Health and Safety Executive (HSE), clearly show that accidents and injuries are still a common occurrence (HSE, 2015). For example, during 2014/15, the UK construction sector experienced some 35 fatal accidents and 69,000 cases of non-fatal injuries (HSE, 2015). This outcome invites significant attention into the management and coordination of Health and Safety (H&S) in the UK construction sector. It is therefore unsurprising that regulations perceived to be the most influential have undergone major review over the last two decades or so. These regulations, widely known as the construction design and management (CDM) regulations, place several obligations on five specific duty holders, namely: the client, designer, principal designer (PD), principal contractor (PC) and contractor, in the context of the CDM2015 regime. Of the five, the principal designer (PD), whose duties were

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formerly performed by the CDM Coordinator (CDM-C) under the CDM2007 regime, plays a significant role with regards to H&S coordination issues. Ideally, the role of PD involves management and coordination of H&S from the initial design phase, hereafter referred to as the pre-construction phase.

Furthermore, the PD role is typically executed by a designer with overall control of the pre-construction phase (see Regulation 5(1)(a)). It is therefore of no surprise that the incorporating the use of Building Information Modelling (BIM) is a likely option. Besides, it is widely documented that BIM plays a vital role in the management of construction projects (e.g. Zhang et al., 2013; Wang and Chong, 2015), and its implementation is likely to majorly impact the pre-construction phase (Eadie et al., 2013). Indeed, the UK Government’s construction industry strategy 2025 clearly endorses BIM (see BIS, 2013). Within the same strategy, it is expressed explicitly that by 2016, all major public projects were expected to incorporate BIM Level 2, as a tool to enhance procurement of construction projects. Additionally, in the Government Construction Strategy 2016-2020, it is reported that, to realise the full extent of BIM Level 2, departments need to develop the necessary skillset and capabilities (IPA, 2016). It is against such a background that this paper argues that BIM-enabled H&S coordination complements the role of the PD. Even a study conducted by Ganah and John (2015) supports this view, and concludes that BIM can enhance current approaches towards H&S planning for construction site personnel. However, the depth of research that draws a linkage between BIM and CDM Regulations is limited. This study therefore fills this gap by considering BIM-enabled H&S coordination. This is achieved by first mapping the duties performed by the PD in the context of BIM and then determining their extent of discharge.

There are seven sections in this paper. After the introduction, a detailed literature review is provided which considers the role of BIM during the pre-construction phase and as a tool to trigger improved H&S outcomes; also highlighting the emerging gaps in knowledge. After a succinct discussion on the implementation of the CDM regulations in the UK construction industry, the research methodology adopted for the study is explained. The research results and findings are then presented and discussed, after which the conclusions of the study are outlined.

BUILDING INFORMATION MODELLING (BIM) IMPLEMENTATION AND HEALTH AND SAFETY

With the advent of BIM, it is reasonable to argue that the holistic management of construction projects across their life cycle, often triggers significant benefits (see Eadie et al., 2013). Perhaps, a more obvious benefit is the tendency for parties within the supply chain to engage at an early stage, thus triggering collaboration. For example, a study conducted by Eadie et al. (2013) based on ranking of BIM impacts by respondents who took part in a web-based questionnaire survey indicate that stakeholder collaboration was ranked highly. Bearing this in mind, it is unsurprising that there is a growing need to incorporate BIM on most projects and increasingly, it has become a major tool for collaborative project management as demonstrated on numerous occasions (e.g. Aranda-Mena et al., 2009; Zhang et al., 2013). It can even be argued that BIM triggers an integrated approach towards the management of construction projects (BIS, 2012), from inception to completion (BIS, 2012; Moulds, 2016), thus dealing with fragmentation challenges. Ideally, what this implies is that,
stakeholders have the ability to work in an integrated manner at the earliest possible opportunity, which in turn influences decisions taken during the pre-construction phase.

Sebastian (2011) defined BIM as technology frameworks that complement integrated collaboration during and throughout the project design lifecycle. Whereas, other researchers have explained that BIM presents an opportunity to improve the overall outlook of project safety, given its planning and design integration abilities (e.g. see Benjaoran and Bhokha, 2010; Zhou et al., 2011). Further, BIM can also offer behavioural and procedural changes as noted by Joyce and Houghton (2014) and Olatunji (2014). For example, the integrated system for safety developed by Benjaoran and Bhokha (2010) based on a BIM model, enhanced safety awareness and in turn triggered informed design decisions and changes. These studies on one hand demonstrate that BIM implementation may yield tangible results and plays a significant role towards securing improved H&S outcomes. Typically, when deployed on most projects, BIM is likely to offer timely sharing of information at varied levels as the BIM object develops (RICS, 2015). It is clear from the foregoing that several authors define BIM differently. This study adopts the holistic view as explained by Khosrowshani and Aryici (2012, p.615), whereby the BIM model triggers collaboration, interoperability and interdependence among stakeholders. At its most advanced level, the BIM model offers real time benefits and analyses of complex issues during the early pre-construction phase (Khosrowshani and Aryici, 2012); and offers information exchange at various levels (see e.g. Abanda et al., 2015).

In the main, drivers for BIM adoption to reiterate, include: (i) a reduction in the cost of assets and achievement of significant operational efficiencies; (ii) improved construction supply chains; and (iii) improved industry growth and outcomes (BIS, 2012). From a commercial point of view, it simply means that the supply chain will feed information into the system at the most relevant time and similarly, extraction of such information is readily available at the most opportune time. As such, use of BIM on various construction projects has been commended (see Bryde et al., 2013) and the consensus reached by various commentators, practitioners and researchers, is that BIM unifies and streamlines the design and construction process. It is therefore reasonable to infer that indeed, BIM is an exemplar; a tool which brings together a number of project stakeholders with prospects to improve the overall management of construction projects. The view that BIM is capable of improving communication issues and advocates for better and consistent management of projects is commonplace. For example, Moulds (2016), reported that there was a significant reduction in time, owing to the streamlined approach for undertaking various processes. Similarly, key issues and impediments were identified and resolved expeditiously, unlike previous paper-based method(s). In terms of the practicality of the design, BIM offered the opportunity to simulate the construction sequence and where practicable, the rework of design. Furthermore, in the same case study, Moulds (2016) reported that the model was also used for purposes of H&S, thereby communicating to the site teams, the sequence of construction and so forth. Even a study conducted by Bryde et al. (2013) considered the interoperability of BIM and the extent of its usage. The conclusion reached based on secondary data collected from 35 construction projects which employed BIM, shows a significant reduction in time and cost throughout the project lifecycle, corroborating the conclusions derived in Mould’s study. Whereas, Zanni et al. (2016) considered a BIM-enabled sustainable building
design process. Their results, based on a developed framework, having undertaken 25 in-depth interviews indicated that a BIM-enabled approach, complemented the use of other design software that took into account sustainability issues. This outcome demonstrates the adaptability of BIM to complement user/project requirements and needs.

Overall, there is compelling evidence which shows the tangible benefits of BIM adoption. In terms of BIM implementation in the UK construction industry, Eadie et al. (2013), considered BIM application across the project lifecycle. The conclusion drawn shows that BIM is most often used during the design and pre-construction phase, and to a lesser extent during the construction stage. This outcome demonstrates the influence of BIM in the early design stage. As such, it is viable to conduct a study interlinking BIM and CDM. This study therefore concentrates on the extent of discharge of duties performed by the PD given their likelihood to be performed during the pre-construction phase.

THE CONSTRUCTION DESIGN AND MANAGEMENT REGULATIONS

The construction, design and management (CDM) regulations were first introduced in the UK construction industry as the Construction (Design and Management) Regulations 1994 (CDM1994), on 31 March 1995, Statutory Instrument (SI) number 1994/3140. Briefly, they were introduced by the UK government because of two major reasons: (i) as a version of the transposition of a directive placed on EU member states (EU 92/57/EEC); and (ii) improvement of the performance of the construction sector in terms of H&S outlook.

However, after a decade, significant problems associated with the CDM1994 regime emerged and because of this, the CDM2007 (SI, No. 2007/320) replaced the CDM1994, with the intention to improve the overall implementation in practice, reduce bureaucracy and increase better understanding among others. The main concerns highlighted during the CDM1994 regime were: overly bureaucratic procedures; excessive paperwork; widespread misunderstanding of roles; and uncertainties across construction supply chains (e.g. Baxendale and Jones, 2000; Beal, 2007; Dalby 2007).

It is these concerns, as mentioned already, that ultimately culminated into introduction of the CDM2007 on 6 April 2007, to improve CDM implementation across the UK construction sector. In summary, the motivation for introducing CDM2007 was noted by Bomel (2007) as: simplification of the regulations; enablement of a flexible approach in terms of contractual issues; more focus on the planning and management of H&S issues; and simplification of competence assessment.

Although it was envisaged at the time that replacing the Planning Supervisor (PS) role with the CDM-C, would be beneficial, the results were not that impressive. It was reported on numerous occasions that CDM-Cs provided little input or in some cases no support in discharging H&S coordination responsibilities on most construction projects. For instance, a report prepared by the Specialist Engineering Contractors' Group (SEC), noted that the presence of the CDM-C on most projects was limited (SEC, 2010). Increasingly, the evidence on most occasions seemed to show that the same concerns still emerged under the CDM2007 regime (e.g. Dalby, 2007).
Whilst there were some improvements during CDM2007 regime era (Frontline Consultants, 2012a; Webster, 2013), a major evaluation still revealed numerous concerns because of industry commercial pressure (Frontline Consultants, 2012b). Additionally, it was observed that the CDM2007 was still surrounded with uncertainties in terms of: (i) misunderstanding of responsibilities (Dalby, 2009); and competency issues with regards the role of the CDM-C (ICE, 2011) and interpretation of the Approved Code of Practice (ACoP) (Frontline Consultants, 2012a). Following the Löfstedt report, which reviewed H&S legislation (Löfstedt, 2011), the main conclusions drawn recommended a complete overhaul of CDM2007, with the intention of: (i) ensuring that duties are expressed in a clearer manner; (ii) reducing bureaucracy; and (iii) providing appropriate guidance for smaller projects.

Most importantly, in response to Professor Löfstedt’s report, the HSE replaced the CDM2007 regime with the CDM2015 (SI, No. 2015/51) regime in the autumn of 2015. Major changes included: replacement of the CDM-C role with the PD role; inclusion of more straightforward provisions for domestic clients; removal of the competence provision; and simplification and alignment of the regulations to the EU Directive (EU 92/57EEC).

THE RESEARCH METHODOLOGY

The research methodology comprised the use of a questionnaire survey to investigate the extent of discharge of duties previously performed by the CDM-C, while an inductive inquiry was used to first: analyse the descriptions of the duties placed on the PD; then second, compare these duties with those formerly discharged by the CDM-C, given that they largely all align to the pre-construction phase. As such, a mixed methods research is conducted, whereby the results from the questionnaire survey partly inform those emerging from the inductive inquiry. In terms of the analysis, initially, the quantitative data is analysed using descriptive statistics, to determine the extent of discharge of duties. Further, the relative index (RI) analysis is used to rank the duties in terms of frequency of discharge. The content analysis is also performed to determine the extent to which the PD’s duties resonate with BIM in terms of interoperability.

Briefly, content analysis is defined by Bryman (2012) as an approach that seeks to analyse documentary evidence or text into quantifiable predetermined categories, systematically. With this in mind, it is considered as a reasonable method of analysis in this study given that the evidence is based on secondary data. Moreover, combining this approach with the descriptive statistics ensures that, the methods complement each other. Initially, organisations likely to perform the role of CDM-C were identified through a readily available professional membership body. Further, the PD’s duties were categorised according to the stage of discharge, in order to inform the level of BIM adoption and interoperability. A total of 48 responses informs the quantitative analysis, whereas the total number of duties considered across the CDM-C and PD is 26. AS such, use of the central tendency scores and the relative index analysis proved useful. It is however necessary to point out that employing parametric methods would have been possible if the data was less skewed. It was therefore determined that the central tendency scores would be useful at this stage.
RESULTS AND FINDINGS

Table 1 shows the extent of discharge of pre-construction phase coordination duties placed on the CDM-C, whereas, in Table 2, a comparison reveals the differences between duties placed on CDM-C those placed on the PD, of which there are no major differences in terms of description of duties. To clarify, CDM-C’s duties: 20(1)(b), 20(1)(c) and 20(2)(e) where expanded to realign better with the PD’s duties. The results show that, first, majority of the CDM-C’s duties correspond with those placed on the PD and the same thing can be said inversely. Second, the primary data results show that there are variations in the extent of discharge of duties, of which it is worth taking note of duties discharged the least in terms of frequency (i.e. yielding a mean less than 4.00).

From the above, it can be observed that the PD’s duties: 11(1), 11(2), 11(4) and 11(5), are discharged the least in relation to the primary data. Interestingly, they all invite improved collaborative working, therefore consistent with the BIM Level 2 ethos. Even, promptly providing preconstruction information is a duty which may strongly benefit from BIM adoption, although ranked 7 with a mean score of 4.04. The analysis further revealed that, of the 13 duties, some typically relate to the pre-construction phase, while others relate to the construction phase as noted in Table 3. Again, the same four duties placed on the PD highlighted above appear in the pre-construction phase, which confirms that the role of the PD can be enhanced with BIM adoption.

Table 1: Extent of discharge of preconstruction coordination duties

<table>
<thead>
<tr>
<th>Reg.</th>
<th>Description of duties</th>
<th>Median</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Error</th>
<th>Relative Index (RI)</th>
<th>Rank (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21(1)</td>
<td>Ensure notice is given to the Health and Safety Executive (or Office of Rail Regulation)</td>
<td>5.00</td>
<td>4.83</td>
<td>0.433</td>
<td>0.063</td>
<td>96.60</td>
<td>1</td>
</tr>
<tr>
<td>20(1)(c)</td>
<td>Liaise with the Principal Contractor regarding information required for the preparation of the Construction Phase Plan, contents of the Health and Safety File and any design development that may affect the planning and management of construction work</td>
<td>5.00</td>
<td>4.29</td>
<td>0.824</td>
<td>0.119</td>
<td>85.80</td>
<td>2</td>
</tr>
<tr>
<td>20(2)(f)</td>
<td>Handover the Health and Safety File to the Client at the end of the construction phase</td>
<td>4.00</td>
<td>4.23</td>
<td>1.016</td>
<td>0.147</td>
<td>84.00</td>
<td>3</td>
</tr>
<tr>
<td>20(2)(a)</td>
<td>Take reasonable steps towards identifying and collecting preconstruction information</td>
<td>4.00</td>
<td>4.10</td>
<td>0.881</td>
<td>0.127</td>
<td>82.00</td>
<td>4</td>
</tr>
<tr>
<td>20(2)(c)</td>
<td>Prepare where none exists the Health and Safety File and update/review for subsequent construction work</td>
<td>4.00</td>
<td>4.10</td>
<td>1.115</td>
<td>0.161</td>
<td>82.00</td>
<td>5</td>
</tr>
<tr>
<td>20(1)(a)</td>
<td>Give suitable advice and assistance to the Client regarding compliance with the Clients’ duties under the Regulations</td>
<td>4.00</td>
<td>4.04</td>
<td>0.967</td>
<td>0.140</td>
<td>80.80</td>
<td>6</td>
</tr>
<tr>
<td>20(2)(b)</td>
<td>Promptly provide preconstruction information to</td>
<td>4.00</td>
<td>4.04</td>
<td>0.988</td>
<td>0.143</td>
<td>80.80</td>
<td>7</td>
</tr>
</tbody>
</table>
### Document Content

#### Table 2: Comparison of the main duties of the CDM-C and PD expanded

<table>
<thead>
<tr>
<th>CDM-C Coordinator duties</th>
<th>Principal Designer (PD) duties</th>
<th>RIR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reg.</strong></td>
<td><strong>Description</strong></td>
<td><strong>Median</strong></td>
</tr>
<tr>
<td>20(1)(a)</td>
<td>Assist the client in complying with his duties under these regulations</td>
<td>9(4)</td>
</tr>
<tr>
<td>20(1)(b)</td>
<td>Ensure coordination of H&amp;S issues</td>
<td>11(1)</td>
</tr>
<tr>
<td>20(1)(b)(ii)</td>
<td>Application of the general principles of prevention</td>
<td>11(2)</td>
</tr>
<tr>
<td></td>
<td><em>Not Applicable (N/A) to the CDM-C</em></td>
<td>11(3)</td>
</tr>
<tr>
<td>20(2)(c)</td>
<td>Ensure designers comply with their duties specified in regulations 11 and 18(2)</td>
<td>11(4)</td>
</tr>
<tr>
<td>20(2)(d)</td>
<td>Ensure cooperation between the designers and the principal contractors</td>
<td>11(5)</td>
</tr>
<tr>
<td>20(2)(a)</td>
<td>Identify and collect preconstruction information.</td>
<td>11(6)(a)</td>
</tr>
<tr>
<td>20(2)(b)</td>
<td>Promptly provide preconstruction information.</td>
<td>11(6)(b)</td>
</tr>
<tr>
<td>20(1)(c)(iii)</td>
<td>Liaise with the PC regarding the design development, which may likely to affect planning and management of construction work.</td>
<td>11(7)</td>
</tr>
</tbody>
</table>
In terms of BIM Level 2 interoperability, nine duties standout and are considered to be highly linked with early design decisions, that is:

- planning, management and monitoring the pre-construction phase (Reg. 11(1))
- taking into account the principles of prevention during the preconstruction phase (Reg. 11(2))
- eliminate foreseeable risks (Reg. 11(3))
- ensure designers comply with their duties (Reg. 11(4))
- ensure all persons working during the preconstruction phase cooperate with the client, principal designer and each other (Reg. 11(5))
- assist the client in providing preconstruction information (Reg. 11(6)(a))
- provide preconstruction information to all designers and contractors (Reg. 11(6)(b))
- prepare the health and safety file during the preconstruction phase (Reg. 12(5))
- review, update and revise the health and safety file (Reg. 12(6)).

However, of the nine, as demonstrated from the content analysis and the descriptive statistics, four PD duties clearly stand to benefit from BIM Level 2 adoption, that is:

(i) planning, management and monitoring the pre-construction phase (Reg. 11(1));
(ii) taking into account the principles of prevention during the preconstruction phase (Reg. 11(2));
(iii) ensure designers comply with their duties (Reg. 11(4)); and
(iv) ensure all persons cooperate with the client, principal designer and each other (Reg. 11(5)).

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- ensure all persons working during the preconstruction phase cooperate with the client, principal designer and each other (Reg. 11(5))
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- provide preconstruction information to all designers and contractors (Reg. 11(6)(b))
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(ii) taking into account the principles of prevention during the preconstruction phase (Reg. 11(2));
(iii) ensure designers comply with their duties (Reg. 11(4)); and
(iv) ensure all persons cooperate with the client, principal designer and each other (Reg. 11(5)).

Table 3: Main duties of the PD categorised and expanded

<table>
<thead>
<tr>
<th>Regulation</th>
<th>RIR</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>21(1)</td>
<td></td>
<td>*Not Applicable (N/A) to the PD</td>
</tr>
<tr>
<td>20(1)(c)(ii)</td>
<td>12(3)</td>
<td>Assist the PC when preparing the CPP by providing necessary information.</td>
</tr>
<tr>
<td>20(2)(e)</td>
<td>12(5)</td>
<td>Prepare the H&amp;S File.</td>
</tr>
<tr>
<td>20(2)(f)</td>
<td>12(8)</td>
<td>Pass the H&amp;S File to the PC.</td>
</tr>
<tr>
<td>21(1)</td>
<td></td>
<td>*Not Applicable (N/A) to the PD</td>
</tr>
</tbody>
</table>

*duty either not directly applicable or placed on a different dutyholder
<table>
<thead>
<tr>
<th>Regulation</th>
<th>RIR</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11(1)</td>
<td>10</td>
<td>Plan, manage and monitor the pre-construction phase</td>
</tr>
<tr>
<td>11(2)(a)</td>
<td>10</td>
<td>Plan and manage items or work stages that are likely to take place concurrently or sequential</td>
</tr>
<tr>
<td>11(2)(b)</td>
<td>10</td>
<td>Estimate the duration for discharging duties to complete the work stages and take into account the general principles of prevention</td>
</tr>
<tr>
<td>11(3)</td>
<td><em>N/A</em></td>
<td>Eliminate any foreseeable risks to persons: undertaking construction work, maintaining the structure, and using the structure.</td>
</tr>
<tr>
<td>11(4)</td>
<td>9</td>
<td>The principal designer to ensure all designers comply with their obligations</td>
</tr>
<tr>
<td>11(5)</td>
<td>8</td>
<td>Ensure all persons cooperate with the client, principal designer and each other</td>
</tr>
<tr>
<td>11(6)(a)</td>
<td>4</td>
<td>Assist the client in providing preconstruction information</td>
</tr>
<tr>
<td>11(6)(b)</td>
<td>7</td>
<td>Provide preconstruction information in a prompt manner to all designers and contractors</td>
</tr>
<tr>
<td>12(5)</td>
<td>5</td>
<td>Prepare the health and safety file during the pre-construction phase</td>
</tr>
<tr>
<td>12(6)</td>
<td>5</td>
<td>Review, update and revise the health and safety file</td>
</tr>
<tr>
<td>12(8)</td>
<td>3</td>
<td>Pass the health and safety file to the principal contractor (PC) if appointment ends before project completion</td>
</tr>
</tbody>
</table>

**Duties discharged during the construction stage**

<table>
<thead>
<tr>
<th>Regulation</th>
<th>RIR</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11(5)</td>
<td>8</td>
<td>Ensure all persons cooperate with the client, principal designer and each other</td>
</tr>
<tr>
<td>11(6)(b)</td>
<td>7</td>
<td>Provide preconstruction information in a prompt manner to all designers and contractors</td>
</tr>
<tr>
<td>11(7)</td>
<td>2</td>
<td>Liaise with the principal contractor (PC) during the construction phase</td>
</tr>
<tr>
<td>12(3)(a)</td>
<td>2</td>
<td>Assist the PC in preparing the construction phase plan by providing preconstruction information from the client</td>
</tr>
<tr>
<td>12(3)(b)</td>
<td>2</td>
<td>Assist the PC in preparing the construction phase plan by providing information obtained from the designers</td>
</tr>
<tr>
<td>12(6)</td>
<td>5</td>
<td>Review, update and revise the health and safety file</td>
</tr>
<tr>
<td>12(8)</td>
<td>3</td>
<td>Pass the health and safety file to the principal contractor (PC) if appointment ends before project completion</td>
</tr>
<tr>
<td>12(10)</td>
<td>3</td>
<td>Pass the health and safety file to the client at the end of the project</td>
</tr>
</tbody>
</table>

*duty either not directly applicable or placed on a different dutyholder

**DISCUSSION**

The evidence so far shows that there are a number of PD duties which may benefit from BIM implementation and adoption, particularly at Level 2 in the context of H&S coordination. Although all duties placed on the PD may benefit from a BIM-enabled approach in one way or the other, nine duties standout (i.e. 11(1), 11(2), 11(3), 11(4), 11(5), 11(6)(a), 11(6)(b), 12(5), and 12(6)) given their likelihood to trigger early design decisions. Whereas, the four duties that would most benefit from BIM adoption are shown in italics, given the argument that they are the least to be discharged in terms of frequency. Moreover, the themes drawn from the regulations are consistent with the overall ethos of BIM, which is to trigger integrated collaborative working as re echoed by IPA (2016). Indeed, this work complements the findings established by Mzyece (2015), which revealed a lack of collaborative working during CDM implementation. This study therefore proves that BIM adoption with regards to the
duties placed on the PD may yield major tangible results; which in turn argues for a BIM-enabled H&Ś coordination approach. Crucially, the analysis also shows that over 90% (12/13) of the PD duties align with those placed on the CDM-C in the previous regime, which shows the reliability of the inferences drawn.

CONCLUSIONS
This study deepens the understanding of BIM adoption, particularly in relation to the role of the PD. Interesting insight considering the plausibility of the BIM-enabled H&Ś coordination approach is established. Results from the analysis indicate that BIM-enabled H&Ś coordination during the pre-construction phase is viable, and most importantly may improve the extent of discharge of duties in terms of frequency. Crucially, four main duties placed on PDs stand out which may strongly benefit from this approach. However, this is not to say that other duties do not stand a chance to benefit. As such, the importance of this study cannot be emphasised given central government’s clear construction strategy. The next stage of this study will be to develop a framework incorporating CDM regulations implementation in their entirety, while considering the role of BIM and testing the developed framework in industry.

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