AUTOMATED COMPLIANCE CHECKING SITUATION IN HEALTH AND SAFETY MANAGEMENT IN UK'S INFRASTRUCTURE SECTOR

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Abstract

Despite intensive research efforts in developing automated compliance checking (ACC) systems for improved health and safety (H&S) outcomes, existing research has mainly focused on the technical aspects and the building sector, whilst research focusing on the social and organisational aspects of ACC in the infrastructure sector is lacking. To address this gap, this study used a case study to explore the issues and readiness to implement ACC in H&S in a design organisation in the UK's infrastructure sector. The findings show there is low readiness with issues in four main aspects, where suggestions were proposed. This research contributes to the body of knowledge by identifying the gaps and proposing ways to achieve better readiness for implementing ACC in design organisations in the UK's infrastructure sector.

Introduction

The architectural, construction and engineering (AEC) industry is widely exposed to numerous health and safety (H&S) concerns (Anwer et al., 2021). Fatalities in the AEC industry are significantly higher than the all-industry rate in the UK. H&S concerns are especially prominent in infrastructure projects that are complex, dynamic and involve many workers and plant on site (Alhammadi et al., 2022).

In the design stage, safety by design has proven to play a key role in achieving better H&S outcomes in infrastructure projects by identifying H&S hazards during the design stage (Hardison and Hallowell, 2019). With the technological advancement in the AEC industry, there have been many digital tools developed to improve the industry's H&S performance, including knowledge-based systems, hazard visualisation, safety training, and automated compliance checking (ACC) systems.

Among these developments, ACC systems dealt with compulsory regulatory requirements and have shown promising results in improved H&S compliance (Zhang et al., 2013a). Despite some existing ACC research for H&S management that mainly focused on the technical aspect, little is known regarding the social and organisational aspects of implementing such ACC systems, which focuses on the readiness of ACC adoption, and inter- and intra-organisational factors affecting such readiness. To address this research gap, this study aims to explore the ACC situation in H&S aspects in the UK's infrastructure sector, using a design consultancy organisation as an example. Specifically, the objectives are to identify the gaps and issues, and evaluate the readiness of ACC for H&S at a design consultancy organisation in the UK's infrastructure sector and propose some potential improvements. As part of an ongoing project, this paper will outline the initial findings about the current situation, readiness and gaps in implementing ACC in H&S aspects in the UK's infrastructure sector.

The remainder of the paper is structured as follows. The next section presents the literature review related to the research objectives. The third section details the methodology used in this paper. Next, the results and findings are presented. The fifth section discusses the results. The last section concludes this paper with remarks for future work.

Literature review

Digitalisation in the construction industry

Digitalisation is the gradual process of widespread adoption of digital technologies to generate new revenue streams or to improve the value-generation capacity of existing business workflows (Bajpai and Misra, 2022). With the advent of the "digital revolution", digital transformation has been one of the key trends in businesses over the last few decades. In the AEC industry, digitalisation is also seen as one of the primary means to improve the industry's overall value delivery performance, and eventually "modernise" construction by today's standards.

With external factors such as changing market requirements, technological advancements, decreasing hardware and software costs, increasing complexity of projects, a new generation of digitally adept workforce, growth of start-ups, supportive and demanding trends (e.g., digital mandates) induced by governments, policymakers and clients, digitalisation in construction is progressing at a pace. This is also due to internal drivers such as the strategic rhetoric for digital transformation to be the main solution for inefficiencies, increased profitability expectations with efficiencies gained through digitalisation and building a "modern" company image.

To this end, several factors and adoption frameworks for digitalisation have been outlined in the literature. Many studies of technology adoption in construction use theories drawn from the established body of knowledge in information systems. The digitalisation adoption process has been studied from a socio-technical, organisational and psychological (individual) perspective (Sepasgozar et al., 2016). For construction organisations, among the many factors affecting digitalisation, external factors (e.g., legislation and regulation, mandates, and pressure from clients and competitors, market demand, and standards and specifications) (Aghimien et al., 2022; Liu et al., 2023) are important. Also, organisational factors (e.g., organisational culture, structure, leadership, and internal processes) (Zulu et al., 2023) are pivotal. Finally, availability of resources (human resources, hardware and software, organisational knowledge and experience, integration of different systems and platforms across the supply chain, standardisation of data, systems, and workflows) (Li et al., 2018) come to fore.

Automated compliance checking

ACC has been an area attracting global research interests and commercial development efforts for more than 60 years. In the ACC literature, most research efforts focused on technical aspects, including two main themes: target design model and rule representation.

Research on the target design model topic mainly focused on developing various lightweight data schema or data retrieval or query methods to extract useful data from the design model due to the difficulty of data exchange and filtration for ACC tasks. Examples include using graph databases to represent design information (Ismail et al., 2017a). Nevertheless, efficient retrieving and querying BIM model data remains a challenge. Methods that enable spatial query of Industry Foundation Classes (IFC) data are especially scarce.

Rule representation methods aim to represent building rules in a machine-readable form by interpreting and capturing rules. Early research developed decision tables, object-oriented and logic-based representations (Yabuki and Law, 1993; Fenves et al., 1995; Han et al., 1998).

More recently, researchers have proposed domain-specific languages to represent building requirements, including text-based languages (Lee et al., 2015; Sydora and Stroulia, 2020) and visual programming languages (Preidel and Borrmann, 2016; Kim et al., 2019). They both aimed to develop easy-to-use methods for domain experts to write codes that represent building requirements. Other researchers focused on semantic web technology-based methods, which used query or rule languages such as SPARQL (Jiang et al., 2022) or SWRL (Beach et al., 2015) to represent building rules. Nonetheless, most existing rule representations are not able to capture the full meaning of the building rules and the rule interpretation process still relies on some manual efforts (Zhang et al., 2023b).

Several studies have focused on rule classification and organisation to support rule representation. Solihin and Eastman (2015) classified building requirements into four classes based on their computational complexity. Zhang et al. (2022) proposed a more comprehensive four-criteria (i.e., semantic constructs, intensity, self-contained or linked explanatory, prescriptive or performance-based) classification to categorise building rules.

The recent advancements in natural language processing (NLP) and machine learning (ML) have made full automation of compliance checking possible. Zhang and El-Gohary (2017) used NLP techniques to automatically generate a logical representation of the building codes. Nisbet et al. (2023a) proposed a rule-based approach using RASE to automatically generate SPARQL queries for rule representation. Nevertheless, ACC based on NLP methods has not yet achieved 100% accuracy. Extra efforts are still required to review and check the results. Also, many methods can only deal with quantitative rules.

There have also been several studies assessing ACC implementation readiness and efficiency. For example, Beach et al. (2020) used questionnaire surveys to understand the obstacles of adopting ACC in the UK. Results showed that the top three challenges are: shared open standards for regulation clauses are lacking, no tool can be used for complete pre-submission checks, and difficulties of making brief and regulatory requirements contractually enforceable. They also provided a roadmap based on interviews with experts, highlighting that 1) there have been some interest in ACC adoption from the UK government and government commitment would be crucial; 2)ACC checking results should be used with expert review; and 3)ACC may be more suitable to be used for conventional projects instead of multi-use, complex ones. Zou et al. (2022) conducted a case study to assess New Zealand's offsite manufacturing industry's readiness for ACC implementation. They suggested that improving readiness of ACC requires assessing ACC systems in different scenarios, further improving technical maturity and promoting education and training. Their later research captured lessons learned from the implementation of ACC globally (Zou et al., 2023), which highlighted the relatively low readiness for ACC adoption and the importance of governments' role in promoting ACC adoption.

Automated compliance checking for health & safety management

There have not been many research efforts on using ACC for H&S regulations. One of the earliest ones were Zhang et al. (2013a) and Zhang et al. (2013b), where rule sets for ACC against Occupational Safety and Health Administration (OSHA) regulations were developed (Occupational Safety and Health Administration, 2023) based on existing safety in design best practices. These two studies selected geometry-related rule sets, such as workways and egress rule sets. Geometrical attributes were used for compliance checking, including the dimensions of holes in slabs and openings in walls. Similarly, Qi et al. (2014) developed rule sets for fall protection using both Solibri Model Checker (Solibri, 2024) and BIM Server as model-checking platforms. More recently, a study by Getuli et al. (2017) used parametric tables to represent Italian Construction H&S normative texts.

The literature shows that the studies regarding ACC for H&S regulations are limited, and they have mainly focused on the technical aspects. To the best of the authors' knowledge, there has been no practical implementation of the developed ACC systems on H&S aspects in the AEC industry. Especially, there has been no substantial research on ACC with respect to the Construction (Design and Management) Regulations 2015 (CDM), which are important H&S regulations in the UK's infrastructure sector and particularly no research on this from a social and organisational perspective.

ACC affecting parameters and success factors

Drawing on insights from prior scholars, the effectiveness of ACC for H&S regulations is subject to key factors. Kamara et al. (2002) highlighted "effective knowledge representation" as a crucial element, the need for standardised approaches, minimising inconsistencies, and fostering interoperability. Emphasising the importance of "oversight for performance-based criteria", Amor and Dimyadi (2021) stressed clear guidelines and human expert involvement to reduce subjectivity in H&S compliance assessments. This is echoed by Zhang et al. (2023a), where the importance of interpreting ambiguous clauses correctly was highlighted. Fuchs and Amor (2021) highlighted the challenge of "accuracy in information classification", suggesting the importance of mapping criteria against information models in ACC. Advocating for "adaptable information modelling approaches", Ismail et al. (2017b) and Nawari (2019) suggested fostering interoperability and collaboration in diverse construction projects. In addition, ensuring the "accurate generation of BIM data" is emphasised by Ismail et al. (2017b), who also suggest robust quality control should be involved to reinforce reliability in H&S compliance assessments. Beach et al. (2020) underscored the "quality and transparency of compliance information", urging advanced techniques in NLP and ML for ACC. Streamlining "quality assurance and control processes", as identified by multiple scholars, is another success factor for ACC. The process must involve strategic approaches to balance process validation and practical implementation, thereby enhancing the overall H&S compliance assessment (Beach et al., 2020; Amor and Dimyadi, 2021). Addressing these factors collectively can elevate the reliability, efficiency, and overall effectiveness of ACC systems tailored for H&S regulations.

Methodology

In this paper, the authors adopted a qualitative approach. An exploratory case study method was used to explore and gain a deeper understanding of the current issues and requirements of automated H&S regulatory compliance in the infrastructure sector. The exploratory case study method is suitable for this study as it allows more in-depth understanding of a scarcely researched topic in its own context (Yin, 2009). It also allows collecting and analysing both primary (interviews, questionnaire surveys) and secondary data (documents) (Eriksson and Nilsson, 2008; Zuo et al., 2013), which is the case for this study.

To achieve the research objectives, the authors targeted one organisation to 1) have a snapshot of the current issues, gaps and requirements in digital H&S management in the infrastructure sector, and 2) gain a more in-depth understanding of their digital H&S management processes and assess their readiness for ACC in H&S aspects. This organisation is a large multi-national design consultancy in the UK's infrastructure sector, which usually takes principal designer and designer duties as specified in the CDM regulations.

Primary and secondary data was collected, including data collected from a 5-month observation while working within the organisation and 50 questionnaire surveys answered by project managers (PMs) (or other senior employees working on 21 small- medium- or large-sized projects). Five individual interviews with CDM designer managers were also conducted to complement the data gathered from the questionnaires. In addition, one design risk management schedule (DRMS) and one H&S compliance audit document were collected for review.

All collected data was then analysed using thematic analysis to elicit the emerging themes. The thematic analysis process generally includes 6 steps, namely data familiarisation, coding, generating themes, reviewing themes, defining and naming themes and writing up (Braun and Clarke, 2006). The next section presents the results and findings.

Results

Based on the data analysis, the authors found that overall, some gaps exist in implementing ACC in the H&S aspects of the UK's infrastructure sector and some existing issues need to be addressed before ACC is ready to be implemented. This section first presents the general H&S management process of the organisation, followed by four themes that emerged from the collected data, namely regulation, technology, human factors and culture, and external environment aspects, as presented in Table 1 and detailed below.

General Design Risk Management Process

As a design organisation, the most important H&S management processes are those relating to the design risk management (DRM) process. In the organisation, the DRM processes generally include obtaining relevant pre-construction information, identification of constraints, production of a DRM schedule (DRMS) to identify hazard and risk levels, developing mitigations with an emphasis on hazard elimination or reduction, reviewing the DRMS, and handing over the residual risks register to the principal contractor. To facilitate the implementation of the DRM processes, there are some organisational-level guidance documents available, which are applicable to all projects regardless of sub-sector (e.g., highways, water) or project size. Some documents need updating, resulting in partial implementation and some fragmentation of processes on some projects. Based on the observation, how well the process is followed in practice and whether the actual processes comply with the CDM regulations mainly depends on the quality of DRM (the risks identified, proposed mitigations, whether the risk levels are addressed) and the process of reviewing DRMS. The DRMS is typically reviewed at an Integrated Design Review (IDR) with the CDM principal designer manager, Design Manager and design discipline leads. As such, the DRM processes heavily rely on DRM experts' competency (e.g., skills, experience, and knowledge). Although several lessons learned workshops are held periodically, more workshops would capture more tacit knowledge of the experts to assist the development of a unified and comprehensive digital CDM compliance checking tool, which will complement the current DRM system.

Table 1: Main themes and subthemes emerged

Themes	Sub-themes
Regulation	Understanding and interpretation of regulations
	Metrics for assessing compliance against regulations
Technology	Awareness of ACC and the required technical capabilities
	Related digital systems and technical capabilities
	Data availability for ACC
Human factors and culture	Competency and upskilling of employees (CDM duty holders)
	Standardisation for risk mitigation methods and severity ratings at an organisational level
	Culture and behaviour changes in safety by design and CDM compliance
	Awareness of digital technology and tools
External environment	External initiatives from government bodies and client organisations

Regulation Aspects

A good understanding of the CDM regulations is imperative in achieving CDM compliance. From the interview and questionnaire survey responses, staff within the design team have various levels of knowledge, experience and understanding of the CDM regulations. Employees who specialise in the CDM and DRM (e.g., CDM principal designer managers) have excellent knowledge, while some other designers only have a basic understanding of CDM regulations. It was also observed that some ambiguous expressions in the CDM clauses lead to differences in understanding and interpretation of the regulations.

A similar issue is that as the CDM regulations are performance-based and not very descriptive in nature, it is difficult to produce specific metrics that directly assess CDM compliance. Ideally, detailed metrics would help the design team understand what specific measures or aspects of hazard mitigation to pay attention to. This resonates with the suggestion by Amor and Dimyadi (2021) on providing clear guidelines. The current CDM Compliance Audit form refers to the general clauses provided in the CDM regulations, such as "ensure the client makes suitable arrangements for managing a project", which renders the interpretation subjective based on the auditor's experience. However, this subjectivity is alleviated as the CDM Compliance Audit makes reference to the check sheets in DRMS as evidence.

As such, first, for organisations adopting a similar approach, improving the granularity of their compliance audit forms will better support their ACC efforts by reducing the potential subjectivity in assessment. Second, improving the metrics and providing detailed duty definitions for the requirements to ensure standardisation in practice will be useful.

Technology Aspects

Generally, the technology for the key tasks of ACC (i.e., data retrieval from and semantic enrichment of BIM models, knowledge representation and natural language processing) is relatively mature, although no system has achieved ACC fully automatically. Within the organisation, although there are existing expert systems for H&S management, no ACC system or similar is currently in use. In addition, employees across the design delivery workstreams are not familiar with ACC nor the underlying technologies of ACC. Apart from several experts, they also lack awareness regarding what can be achieved using ACC and what level of automation can be achieved based on the organisation's current technological capabilities.

In addition, the questionnaire responses show that three main methods for H&S management on projects exist, with different levels of digital implementation and technical capabilities. These methods include 1) A spreadsheet based DRMS; 2) A spreadsheet based DRMS linked to hazard triangles on drawings with reference number; and 3) A GIS-driven digital CDM system, where the spreadsheet-based DRMS can be imported or exported. All three methods can be used on various sizes of projects, while the third method is mainly used on large projects. Technical skills and experience in developing digital DRM systems may be helpful for developing an

ACC system, as there are similar elements (such as functionalities for manipulating BIM information). Some of the data required for ACC may also be available in the DRM systems. Currently, new processes are in development across the organisation to cater for different project sizes.

Nevertheless, data availability seems to be an issue in automating CDM compliance checking. Although all projects must be CDM compliant, data required for ACC is stored across several standard forms used on the projects which are not directly linked. This makes it less efficient to demonstrate compliance, especially when considering the lack of definition and ambiguous nature of some of the clauses. Despite being complex to acquire, high quality data is crucial for successful implementation of ACC, as suggested by Ismail et al. (2017b).

Human Factors and Culture Aspects

DRM is an essential part of achieving CDM compliance. It requires competent CDM duty holders to make endeavors to finish the tasks to a high quality. From the interviews with designers and CDM managers and the authors' observations, the current situation and gaps are summarised, as follows.

First, some more junior members of staff may face challenges in fulfilling their tasks due to potential gaps in skills, experience, and/or knowledge. For instance, designers might encounter difficulty in identifying all risks or suggesting appropriate mitigation methods. This suggests a need for more support and efforts for training and upskilling some of the duty holders involved. There can also be inefficiencies in determining the competency of employees when appointing competent duty holders. It was noted that a new digital competency system had been developed to improve recording of the skills, experience and knowledge of employees which will improve the efficiency of the project personnel selection process.

Second, at a national and organisational level, the standardisation for risk mitigation methods and severity ratings for different risks should be improved. Various designers have employed diverse severity and mitigation approaches. This presents a challenge in compliance verification, particularly when considering automated checks. It was noted that work to address this matter is being championed by the organisation at a company and national level.

Third, it was observed that some designers tend to see the CDM compliance as mostly a safety related matter and do not fully understand the health implications engendered by construction work. There needs to be a cultural change at a national level to truly embracing the benefits of improving health and safety by design.

Fourth, there have been varied awareness and expectations of digital tools in H&S. Some have high expectations of such tools, thinking their functionality will be so powerful that most requests can be achieved. Others, however, are more skeptical about digital tools, arguing that the results produced by digital systems may not always be reliable and must be reviewed by experts. Regarding their expectations for ACC, they expect ACC systems to not only check compliance but also highlight where the non-compliance lies and suggest how to achieve compliance. In addition, Some CDM experts expressed their concerns regarding the use of digital technologies in CDM compliance, as such automation may result in the future generation of designers lacking basic knowledge regarding H&S risk identification and mitigation.

External Environment Aspects

There has been increasing support from the UK government in digitalisation generally and the H&S aspects in the construction industry specifically. The UK government published a new digital strategy in 2022, which set out the visions and continuous support the government will provide. The Health and Safety Executive (HSE) has established the Discovering Safety programme, where there have been a handful of projects focusing on improving H&S performance in the construction industry (Health and Safety Executive, 2023a). Fundings were provided for H&S technology companies to develop novel solutions via the Industrial Safetytech Regulatory Sandbox. Recently, there has been further funding secured for the HSE's Regulatory Technology sandbox to demonstrate use cases of ACC and help innovators bring new ACC products to market (Health and Safety Executive, 2023b). The HSE also recently commissioned ACC experts in the UK to deliver an ACC workshop for regulators, showing their great interest in ACC and their aspirations in achieving ACC.

There are also various initiatives driven by large client organisations in the UK's infrastructure sector, such as National Highways' Digital Roads 2025 initiative. They work with various industrial and academic partners to improve outcomes in the whole life cycle of their projects. In H&S aspects, this initiative aimed to achieve enhanced onsite safety using data and digital tools, reducing fatalities and proactively managing risk by the end of 2023. This highlights National Highways' commitment to future digitalisation in construction H&S.

Overall, the favourable external environment provides great opportunities for developing tools or systems for automated CDM regulatory compliance and client or internal process compliance.

Discussion

The results and findings of this research highlighted the current lack of readiness for developing and implementing ACC systems in H&S aspects in design organisations of the UK's infrastructure sector. There has not been much literature focusing on the social and organisational aspects of ACC. In comparison with the limited existing literature, findings of this research is consistent with previous findings in the UK construction sector in general, which mirrors similar earlier findings in New Zealand's offsite manufacturing industry (Beach et al., 2020; Zou et al., 2022). This relatively low level of readiness is attributed to various causes, including regulation, technology, human factors and culture and external environment aspects. In this section, the authors discuss the existing issues and suggest some potential solutions that could improve such readiness.

First, the difficulty of having unified interpretations of H&S regulations in general and CDM regulations in specific has hindered the development of ACC tools for such regulations. The possible confusion and multiple interpretations were highlighted in the recent HSE digital regulatory compliance workshop report (Nisbet et al., 2023b). To alleviate this issue, design organisations could initiate more detailed internal review meetings and workshops on the CDM regulations with the wider CDM team and with the assistance of the legal team. Such internal review meetings aim to 1) share knowledge related to the interpretation and practical CDM compliance experience; 2) agree on an organisational-level standard of unified interpretations for ambiguous expressions in the CDM regulations; 3) standardise some elements related to CDM compliance such as risk severity definitions (risk matrix); 4) better define the detailed matrix for CDM compliance checking; and 5) produce a "traffic light" system that highlights which CDM regulations can (or are easier to) be checked automatically.

More fundamentally, a CDM regulations review from the ACC perspective by regulators at the HSE could be helpful. This review could 1) analyse the previous incidents that are directly or indirectly occurring because of the lack of understanding of ambiguous expressions in the CDM regulations (e.g., so far as is reasonably practicable); 2) check if any clause needs to be updated; 3) revise clauses that are not very clear and/or provide official guidance and examples for those clauses; 4) suggest what changes can be made to make the CDM regulations both human- and machine-readable, which is aligned with the HSE's digital regulatory compliance agenda.

Regarding the technological aspect, design organisations could analyse technological capabilities to automate CDM regulation compliance, which will highlight the gaps and opportunities. This can be reviewed in line with digital DRM systems to identify information gaps, and how the DRM and ACC systems can help each other to achieve enhanced CDM compliance outcomes. Care should be taken to consider the different sizes of projects, as the suitability of the CDM compliance processes and methods may be different. In addition, existence of a multitude of digital systems, platforms, and initiatives used across different projects make it more difficult for standardising and integrating (both from a technology and process perspective) an ACC approach in practice. There seems to be a "noise" in digitalisation in the AEC industry, where many ongoing efforts and ideas, and external factors compete for attention and resources.

Nevertheless, the advancement in technology cannot guarantee the successful adoption of digital CDM compliance solutions alone. It faces similar challenges as adopting other digital technologies in the infrastructure sector, where changing the culture and people's behaviour is one of the most prominent issues. Design organisations should take the initiative to promote and highlight the importance and the value of the health and safety by design approach, with evidence from other pioneering organisations to demonstrate feasibility and incentives for designers to facilitate behavioural changes. Design organisations could also organise more specific training sessions for their employees to showcase the available digital innovations in this area. This would highlight what functions are achievable and/or only speculative, to calibrate the expectations from digital tools in general and ACC in specific. Senior managers should understand and communicate clearly what ACC means, how it is performed and what could be practically expected from such systems. This would also guide their subordinates' conduct.

In addition, despite the encouraging external environment for digitalisation in the infrastructure sector, developing a new digital solution in the commercial world requires business justification. Hence, such an ACC system needs to demonstrate its tangible benefits such as efficiency, productivity gain, and cost-savings for the design organisation. This needs to be supported by organisational investment and resources (e.g., testbed projects for pilot and feasibility studies). If the existing ACC systems around the world are proven to be efficient, government policy incentives or mandates could also help achieve digital compliance. Some government initiatives to review the regulatory framework and regulation clauses could also facilitate its digitalisation process. The current regulatory framework could be improved to provide more guidance on achieving improved H&S outcomes. Firstly, the UK BIM framework has little guidance and focus on H&S aspects (CIRIA, 2023). Currently, there is only PAS 1192-6 available (British Standards Institution, 2024), with ISO 19650-6 out for consultation. More comprehensive guidance needs to be provided. Secondly, the CDM 15 regulations are performance-based and objective-oriented documents where guidance on paths to compliance is lacking. Some design examples could be provided to further explain and clarify how the requirements could be met.

Conclusions

This research presents an exploratory single case study of a design consultancy in the UK's infrastructure sector to understand the issues, gaps and readiness for implementing ACC in its H&S aspects. The results show that the readiness for implementation could be improved.

The issues and gaps mainly lie in aspects that include regulation, technology, human factors and culture, and the external environment. Suggestions are proposed for the design organisations to raise employees' awareness of technological advancements and enhance organisational knowledge sharing, training, standardisation and facilitation of culture changes, especially related to the H&S management and CDM compliance domain. The authors also suggested that the regulatory framework and regulations could be reviewed by regulators to facilitate digitalisation.

This study is one of the first studies looking at the readiness of implementing ACC in the H&S aspect of the UK's infrastructure sector. Unlike most existing ACC studies that focus on technical issues of ACC systems, it studied ACC from a socio-technical perspective to understand the readiness and how to facilitate better implementation from social and organisational perspectives. The results would be helpful for design organisations in the UK's infrastructure sector towards better development and implementation of digital regulatory compliance tools for CDM regulations.

This paper has limitations. An exploratory single case study is conducted in this paper, which may not reveal the wider H&S management situation in the UK's infrastructure sector. Our future study will conduct more case studies in similar contexts and look at the topic from different analysis units (e.g., sectoral, supply chain, organisational, departmental, team and individual) to obtain a better assessment and understanding of the situation and propose more comprehensive suggestions to improve this situation.

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