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# Performance Barriers for Coordination of Health and Safety during the Preconstruction Phase of Construction Projects

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**Abstract:** The effectiveness of the prevention through design (PtD) approach to the management of health and safety (H&S) risks on construction sites is widely acknowledged. This approach underlies the construction, design, and management (CDM) Regulations in the United Kingdom that provide for a Principal Designer (PD) role with a statutory duty to plan, manage, and monitor the preconstruction phase of projects and to coordinate matters of H&S during that phase. Although there is a growing body of research literature on PtD practice, there is a gap in the general issue of the practical implementation of the CDM Regulations in general and the performance of the PD in particular. The purpose of this paper is to report research undertaken with the aim of plugging this gap. The part examined concerns the challenges that beset the performance of the PD role and the drivers behind such barriers. A qualitative research design was adopted using, for data collection, 14 focus group discussion sessions involving 89 participants with direct experience of practical implementation of the regulations. The research uncovered three broad categories of barriers to the performance of the PD role: inadequacies in the client's general approach to its duties; supply chain fragmentation and insurance challenges; and performance-related challenges stemming from limitations in PD technical competence and interpersonal skills. The research is the first study focused on the H&S risk management processes and the organizational and operational barriers to effective management and coordination of H&S matters by PDs. The research outcomes are of obvious relevance to H&S management practice in not only the United Kingdom but also European Union countries and other countries with similar regulations. As management of design H&S risks at the preconstruction stage is an inherent feature of the PtD concept, they could also inform PtD practice with respect to coordination of the work of the different design specialisms involved. **DOI: 10.1061/JCEMD4.COENG-12073.** 

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## Introduction

Ill health, injuries, and fatalities continue to plague the construction industry. Knowledge and understanding of the factors accountable for these problems on construction projects are critical to the development and implementation of pragmatic policies necessary for addressing them (e.g., Mitropoulos et al. 2005; Manu et al. 2010). Understandably, there has been research interest in the causation of construction industry accidents. Some scholars have indicated that while the triggers of occupational health and safety (H&S) risks are complex, two broad causal factors are often at play—proximal factors (for example, unsafe acts by frontline workers) and latent/underlying factors attributable to management and other preconstruction factors (e.g., Manu et al. 2010; Lingard et al. 2015; Gambatese et al. 2017). Recognition of the second category of causal factors has led to the adoption of the prevention through design (PtD) concept that challenges designers to initiate design solutions for construction projects that are inherently safe for the carrying out of construction site works (Gambatese et al. 2005; Lingard et al. 2015). The PtD concept has been given other labels in the research literature such as "design for safety" (DfS) (Goh and Chua 2016), "design for construction safety" (DfCS) (Toole et al. 2017), "construction hazard prevention through design" (CHPtD) (Hardison and Hallowell 2019), and "safety in design" (SiD) (Guo et al. 2021).

The fact that many accidents on site can be traced back to acts or omissions at the preconstruction stage came to the attention of the European Union (EU) and its European Council responded by adopting Council Directive 1992/57/EEC on the implementation of minimum safety and health requirements at temporary or mobile construction sites (TMCS). This directive requires the appointment of two types of coordinators for H&S matters on construction projects that will require more than one contractor on the construction site. The first type of coordinator, referred to as the preconstruction phase coordinator (PCPC), is to take responsibility for coordination during the design and project preparation stage of projects. The second type of coordinator, referred to as the construction phase coordinator (CPC), engages with the coordination of H&S matters during the construction phase of projects. EU member states are mandated to have national laws that require the appointment of these two types of duty holders on construction projects albeit with

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no details prescribed for the roles (e.g., the type of professional to exercise it or whether the two roles may be performed by the same entity). The EU TMCS Directive was very ground-breaking because it predated any significant interest of the construction research community in the PtD concept.

In 1994, the United Kingdom, then a member of the EU, transposed the Directive into UK legislation as the Construction (Design and Management) Regulations 1994 (CDM 1994). These regulations imposed statutory H&S duties on the traditional stakeholders of construction projects—clients, designers, and contractors. They also created the duty holders of Planning Supervisor and Principal Contractor with defined statutory duties to take on the performance of the roles of the PCPC and CPC, respectively. The UK's Health and Safety Executive (HSE), the national regulatory authority for H&S, has had to respond twice to concerns about preconstruction coordination of H&S matters, attempting to change the PCPC role for it each time. About 10 years after the CDM 1994 came into force, they were replaced with the Construction (Design and Management) Regulations 2007 (CDM 2007) that changed the label for the PCPC from Planning Supervisor to CDM Coordinator. Barely eight years after the CDM 2007, they were, in turn, replaced with the current regulations, the Construction (Design and Management) Regulations 2015 (CDM 2015), which changed the label for the preconstruction coordination role from CDM Coordinator to Principal Designer (PD).

Unfortunately, the changes to the preconstruction coordination role were not supported by research to understand their unintended consequences and their sources. After about six years of implementing the PD role under CDM 2015, a review of the literature outlined in the next section showed that there is still a dearth of research literature on it. To respond to this gap in the literature, research aimed at developing knowledge and understanding of the role was undertaken as part of a larger research project into the implementation of the CDM 2015 at the preconstruction stages of construction projects. Specific aspects of practice investigated were: Client's general H&S arrangements; assembly of project supply chain members with the right focus on health and safety; preconstruction information management; preparation of construction phase plan (CPP); preparation of Health and Safety File (HSF); and collaborative risk management.

This paper reports on the challenges experienced in practice in relation to the discharge of the PD role. It is structured in seven sections. The first section introduces the study. A summary of the underpinning literature review is provided in the second section. The third section outlines the role of the PD under CDM 2015. The approach and method followed in carrying out the study are briefly described in the fourth section. The results from the study are presented and discussed in the fifth and sixth sections, respectively. The paper ends with conclusions and limitations.

## Literature Review

As noted by many authors, e.g., Hare et al. (2006), the traditional view of responsibility for managing H&S risks on construction sites has been that it belongs to the contractor and its subcontractors. The PtD concept is the antithesis of this approach as its essence is that designers' design decisions on the features of a construction project define the materials, dimensions, and positions of project elements as well as the potential construction methods required to carry out the works. Such proposals inherent in designs can therefore affect the safety and health of individuals involved in constructing, using, maintaining, and eventually demolishing the constructed facility (European Construction Institute 1996; Goh and Chua 2016). In view of this, some scholars (e.g., Cooke et al. 2008; Lingard et al. 2015) point out that failure to address H&S risks at the preconstruction stage of the project development process would be contrary to the contemporary view of effective construction project H&S risk management.

Simply from the text of the EU TMCS Directive and its enactment as CDM 2015 in the United Kingdom, it is obvious that the PtD concept must be an important element of the approach to prevent H&S incidents on construction projects and mandated both pieces of regulation, although this approach is much wider than the application of the PtD concept. The regulatory regime takes into account the influence of not only design but also more general procurement decisions made at the preconstruction stage. For example, there is an expectation that the PD supports the client to assemble a project team that works in an environment of cooperation, coordination, and communication necessary to deliver the project safely (HSE 2015). There were therefore three prongs to the underpinning literature review: general H&S; the PtD concept and practice; and the CDM Regulations. The reviews of general H&S and the CDM Regulations have already been reported by Ndekugri et al. (2021, 2022), respectively. The review outlined here is limited to evolving PtD practice.

Over the past three decades, there has been sustained interest in PtD research in the construction industry. A review by Hardison and Hallowell (2019) grouped the literature into three categories: (1) the case for the PtD initiative in terms of the logic for its efficacy (C1) and case studies of real projects (C2); (2) methodologies for implementing the concept; and (3) hazard recognition tools for identifying hazards for proactive management during design and construction. In the review carried out as part of the research reported in this paper, it was realized that the second and third categories in the categorization by Hardison and Hallowell are so closely related that they can be amalgamated into a combined category for support tools under which there are subcategories for constructability review (C3); construction hazard assessment implication review (C4); policies and legislation (C5); qualitative tools (C6); and technology tools (C7). The qualitative tools are mostly subjective and based on experts' opinions as to how H&S risks can be managed effectively at the project design stage. The objective technology tools rely on certain information supplied about the design features in a computer environment to provide a visual representation of potential H&S risks inherent in the design, e.g., building information modeling (BIM) and immersive technologies. The latter review also found growing multipronged research interest focusing on the competence required for PtD practice. The prongs to this research strand are: skills (C8); knowledge (C9); experience (C10); organizational capability (C11); attitude (C12); practice (C13); and education and training (C14). The outcome of this subsequent review is summarized in Table 1, with the second row indicating the subcategories as numbered from C1 to C14.

The Table shows that there is now universal agreement among scholars on the efficacy of the PtD initiative. The review also showed that research on tools for PtD implementation started relatively early over two decades ago (e.g., Gambatese et al. 1997). However, until only recently, there was little research into PtD competence. Hence, some scholars have been advocating more attention on this aspect of PtD (e.g., Gambatese et al. 2005; Behm et al. 2014; Ibrahim et al. 2021; Ismail et al. 2021). Subsequent reviews of PtD literature (Ibrahim et al. 2022b; Samsudin et al. 2022) have been consistent with the review in this study on the key issues that have exercised the attention of construction H&S scholars.

The discovery by Morrow et al. (2015) of three types of designers, in terms of their views and understanding of H&S and their tendencies and behaviors in the design process, underscores the

**Table 1.** Summary of Publications on PtD

| Publications | PtD case | | Support tools | | | | | Competence | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | C10 | C11 | C12 | C13 | C14 |
| European Construction Institute (1996) | X | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Szymberski (1997) | X | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Gambatese et al. (1997) | X | — | — | — | — | X | — | — | — | — | — | — | — | — |
| Workcover (2001) | X | — | — | X | — | — | — | — | — | — | — | — | — | — |
| Gambatese et al. (2005) | X | X | — | — | — | — | — | — | X | — | — | X | — | X |
| Haslam et al. (2005) | X | — | — | — | — | — | — | — | — | — | X | — | — | — |
| Lam et al. (2006) | X | — | X | — | — | — | — | — | — | — | — | — | — | — |
| Cooke et al. (2008) | X | — | — | — | — | X | — | — | — | — | — | — | — | — |
| Aires et al. (2010) | X | — | — | — | X | — | — | — | — | — | — | — | — | — |
| Qi et al. (2011) | X | — | — | — | — | — | X | — | — | — | — | — | — | — |
| Dewlaney and Hallowell (2012) | X | — | — | — | — | X | — | — | — | — | — | — | — | — |
| Hadikusumo and Rowlinson (2012) | X | — | — | — | — | — | X | — | — | — | — | — | — | — |
| Hare and Cameron (2012) | X | — | — | — | — | X | — | — | — | — | — | — | — | — |
| Behm et al. (2014) | X | — | — | — | — | — | — | — | X | — | — | X | — | X |
| Lingard et al. (2015) | X | X | — | — | — | — | — | — | — | — | — | — | — | — |
| Lopez-Arquillos et al. (2015) | X | — | — | — | — | — | — | — | — | — | — | — | — | X |
| Toh et al. (2016) | X | — | — | — | — | — | — | — | X | — | — | X | X | — |
| NIOSH (2015) | X | — | — | — | X | — | — | — | — | — | — | — | — | — |
| Poghosyan et al. (2018) | X | — | — | — | — | X | — | — | X | — | — | X | — | X |
| Goh and Chua (2016) | X | — | — | — | — | — | — | — | X | — | — | X | X | — |
| Hardison and Hallowell (2019) | X | — | — | — | — | X | X | — | — | — | — | — | — | — |
| Manu et al. (2019) | X | — | — | — | — | — | — | X | X | X | — | X | — | — |
| Ibrahim et al. (2022a) | X | — | — | — | — | — | — | X | X | X | — | — | — | — |
| Poghosyan et al. (2020) | X | — | — | — | — | — | — | — | — | — | X | — | — | — |
| Adaku et al. (2021a) | X | — | — | — | — | — | — | X | X | X | — | X | — | X |
| Adaku et al. (2021b) | X | — | — | — | — | — | — | — | — | — | X | — | — | — |
| Guo et al. (2021) | X | — | — | — | X | — | — | — | X | — | — | X | X | — |

importance of such an enabler of cooperation, coordination, and communication across the multiple design specialisms needed on a project. Overall, the three-pronged reviews exposed a research gap in respect of the implementation of the CDM regulations at the preconstruction stage, especially what the PD does on a day-to-day basis to secure PtD, the barriers to performance of the role, and the drivers of such barriers. As described in the "Research Methods" section, this outcome of the review informed the research design.

## The Principal Designer Role

The statutory duties of the PD under CDM 2015 can be classed into three broad categories. The first category comprises the general duties under Regulations 11(1), 11(2), 11(4), and 11(5) to plan, manage, and monitor the preconstruction phase and to coordinate H&S-related matters during the preconstruction stage to ensure that, so far as is reasonably practicable (sfairp), the project is carried out without risks to H&S. These general duties include ensuring that designers adhere to the general principles of prevention and cooperate with each other and the client. Under Regulation 8(1), the PD must ensure it has the requisite skill, knowledge, experience (SKE), and, where the PD is an organization, the organizational capability (OC) to carry out the work. There is a growing research interest in what these attributes mean and how they may be validly assessed in practice (Manu et al. 2019; Adaku et al. 2021a, b).

The second category concerns the preparation, sharing, and use of information referred to in the regulations as preconstruction information (PCI), which is defined under Regulation 2.1 as comprising information in the client's possession or reasonably obtainable that is relevant to the construction work and the risks involved. Regulations 11(6) (a) and 11(6) (b) put on the PD a duty to assist the client to generate and disseminate the PCI to all relevant project parties at the preconstruction stage of projects. Regulation 11(7) requires the PD, for the duration of its appointment on the project, to liaise with the principal contractor (PC) to share the PCI for the effective management of H&S during the construction stage.

The third category is stated by Regulation 12(5) as a duty to prepare an HSF "which must contain information relating to the project which is likely to be needed during any subsequent project to ensure the health and safety of any person." The function of this document is to serve as a source of information relating to the project as well as the built asset that is likely to be needed during any subsequent construction work on the built asset to allow such work to be carried out safely and without risks to health (HSE 2015). On completion of the project, it is to be handed over to the client who must, in turn, hand it over to any new owner of the asset. The type of information to be provided in the document include as-built drawings, operations and maintenance manuals, location of existing services (particularly concealed services), safety hazards, and means of escape in an emergency. These pieces of information originate from multiple project participants who own them. There must therefore be enforceable arrangements that ensure that they are passed on for the purpose of assembling the HSF. Regulations 12(5), 12(6), and 12(8), together, require the PD to lead the preparation of this document and to keep it under review over the duration of the PD appointment on the project.

## Research Methods

The literature review found very little empirical research into the practical implementation of CDM 2015 at the preconstruction stage of projects, particularly the coordination of H&S risk management by the PD. As recommended by writers on research design for the investigation of social phenomena on which there has been little prior research (e.g., Creswell and Poth 2018), a qualitative research approach based on the lived experiences of the actors involved in

the management of H&S at the preconstruction stage of projects was adopted. Data were collected through 14 facilitated focus group discussions (FGDs). This data collection method was chosen because it accounts for individual viewpoints and experiences (Krueger and Casey 2015). The choice of method is also supported in this particular context by the discovery by Morrow et al. (2015) of three types of designers with different understandings of H&S and therefore different tendencies in behavior with respect to the H&S aspects of their design work.

The research informants were recruited by purposeful sampling with the support and facilitation of access by the construction industry's professional bodies and other influential organizations. Event management systems such as Eventbrite and online professional networks (e.g., LinkedIn) were also used to publicize the planned FGDs. In compliance with the UK regulation on data protection, a consent form, with a description of the purpose of the FGDs, was made available to potential participants to outline their experience of H&S management in construction and state their interest to participate in the research. The consent form also listed planned FGD sessions with specific themes for discussion. Potential participants were invited to identify the sessions of interest. Returned consent forms were vetted for the purpose of inviting participation from only individuals with significant relevant experience and knowledge. Selected participants were then allocated to the designated sessions.

The focus group size recommended in the literature is in the 4–12 range (e.g., Hennink et al. 2020; Carlsen and Glenton 2021). Some of these scholars advise that more information is gathered from two groups of four participants than from a single group of eight individuals. There were two drivers within the strategy adopted for deciding the composition of groups. The first driver was a desire to ensure that participants were from similar backgrounds to support open and frank discussion with some commonality of understanding. By having mixed groups, it was also sought to promote critical debate on experiences of the same phenomena by different CDM duty holders toward validation of collective norms and practices and identification of intergroup tensions. The composition of the groups was decided accordingly as follows: two FGDs of exclusively clients; two FGDs of exclusively PDs; two FGDs of exclusively designers; two FGDs involving a mixture of designers and PDs; one FGD of CDM support services; one FGD of PCs; one FGD for exclusively contractors; one FGD comprising a mixture of PCs and contractors; and two FGDs with participation from all categories of CDM duty holders.

A total of 89 participants attended the FGDs. Some participants attended multiple FGD sessions. The profile of the participants, which is summarized in Fig. 1, was as follows: 70% of the participants had more than 5 years of experience with the CDM regulations; about 90% of them had affiliations with most of the institutions and societies that exercise oversight over professional practice in the construction industry and the general H&S field. Their experiences included as CDM Clients, PDs, designers, client H&S Advisors, PCs, and contractors. All FGDs had the benefit of very active participation from HM Inspectors and other staff from the HSE.

| A. Professional background | Frequency (%) | B. Professional affiliation | Frequency (%) |
|---|---|---|---|
| Architect | 1 (1.1) | APS | 31 (21.1) |
| Quantity Surveyor | 1 (1.1) | IOSH | 64 (43.5) |
| Civil Engineer | 10 (11.2) | CIOB | 6 (4.1) |
| Health and Safety Practitioner | 58 (65.2) | IFE | 3 (2.0) |
| Project Manager | 8 (9.0) | IIRSM | 14 (9.5) |
| Structural Engineer | 1 (1.1) | RIBA | 1 (0.7) |
| Other* | 10 (11.2) | ICE | 10 (6.8) |
| | | RICS | 6 (4.1) |
| | | IStructE | 3 (2.0) |
| | | ICM | 2 (1.4) |
| | | Other** | 7 (4.8) |
| Total | 89 (100) | | 147 (100)*** |
| C. CDM role on projects | Frequency (%) | D. Years of CDM experience | Frequency (%) |
| Client | 11 (12.4) | 1-5 | 27 (30.3) |
| Principal Designer | 27 (30.3) | 6-10 | 15 (16.9) |
| Designer | 4 (4.5) | 11-15 | 11 (12.4) |
| Principal Contractor | 12 (13.5) | 16-20 | 17 (19.1) |
| Contractor | 6 (6.7) | 21-26 | 19 (21.3) |
| Other**** | 29 (32.6) | | |
| Total | 89 (100) | | 89 (100) |

Notes: APS = Association for Project Safety; IOSH = Institution of Occupational Safety and Health; CIOB = Chartered Institute of Building; IFE = Institution of Fire Engineers; IIRSM = International Institute of Risk and Safety Management; RIBA = Royal Institute of British Architects; ICE = Institution of Civil Engineers; RICS = Royal Institution of Chartered Surveyors; IStructE = Institution of Structural Engineers; ICM = Institute of Construction Management

*Includes indication of CDM roles instead of professional background.
**Professional affiliation indicated as HM Inspector
***Total frequency in excess of the total number of participants due to multiple affiliations by participants.
****CDM roles indicated as CDM Advisors (22) and HM Inspector (7)

**Fig. 1.** Demographic characteristics of participants in the FGDs.

A script for use by facilitators of the FDGs was developed in consultation with a research steering committee made up of eminent industry practitioners. The themes for discussion included the lived experiences of: the CDM client, the PD, and tasks performed within the role; designers and design integration; and participants in collaborative H&S risk management. The workshops were conducted and recorded on the Microsoft Teams platform over a period of five weeks between July 2, 2020, and August 3, 2020. Saturation on the issues of interest was achieved by the end of the 12 FGD session. The recordings were transcribed by external commercial transcribers. The resulting raw data thus produced was analyzed in two phases. The first phase was one of reading the raw data multiple times to derive concepts, patterns, themes, and ideas through the researchers' interpretation of the data in light of the research aims and objectives (Thomas 2006). The data were then loaded into NVivo version 12. The second phase involved: coding of the data from an iterative reading of the transcripts to gain insights into the main patterns embedded in the data; generation of themes using an inductive coding strategy; and development of higher-order themes through clustering of lower-level categories (Thomas 2006). The recording for each workshop was analyzed separately, although common themes and subthemes, e.g., collaborative risk management mechanisms and dealing with a client not willing to provide adequate resources, were tracked across multiple workshops.

## Results

Table 2 extracts and summarizes the outputs in an NVivo map that was constructed from the analyses of the data. At the center of the map were three nodes representing the main categories of challenges: Client-related challenges, supply chain fragmentation and insurance challenges, and performance-related challenges. The first category captures explanations of how the characteristics of the client and the manner in which the duties of the client's role are performed may be contributory factors to the challenges. The second category provides an understanding of how supply chain fragmentation issues and the availability of insurance cover could present obstacles to the optimal performance of the PD role. Finally, there are shortcomings in the performance of particular tasks within the PD role.

### *Client-Related Challenges*

These challenges largely border on inadequate appreciation of project H&S by clients or clients playing games with the regulations rather than acting in good faith. It was reported that many clients, particularly private and commercial types, often appoint PDs on projects as a tick box exercise and fail to provide them with the resources necessary for the performance of their roles. In an attempt to articulate the seriousness of the challenge, a PD in one of the PD's FGD workshop sessions stated:

> "It's almost like tick boxes, to say, by clients, yes, we've appointed somebody. And now because we've appointed you the PD duty is now lying with you. But the client doesn't understand what they've actually appointed, or who they've appointed or what to do. And it's almost like an extra cash cow for those PDs. The role is not performed. And that's probably partly some of the reason why the role is not as strong as it should be in the industry, or not as respected."

In some instances, clients fail to provide time and other resources to the PD role, an experience that occurs on both small and large commercial projects. This forces the PD to rely largely on designers to manage the H&S-related matters during the design process with limited PD inputs. This is similar to findings in Hong Kong by Rowlinson and Jia (2015) where they found out that the quality and quantity of H&S provisions on projects by private sector clients are often much less compared to their counterparts in the public sector due to the financial incentives and pressures exerted on such organizations by their financiers and shareholders. The problem of insufficient resources for the PD role is most acute with clients in the smaller or domestic projects, which often have limited budgets and therefore find fees demanded for providing the PD service very prohibitive. The outcome of these situations is failure to appoint the PD or appointing one likely to adopt a minimalist approach to the level of services to be provided. In one of the PD's FGD workshop sessions, a PD noted:

> "In my experience with smaller clients, the problem I usually have is the minute I say to them, well it's going to cost you 'x' amount of pounds because I need to do 'a', 'b', 'c', I lose the work. I do lose work for that. Because the clients have got,

**Table 2.** Challenges of the Principal Designer Role

| Category | Subcategory |
|---|---|
| Client-related challenges | • Client's appointment of parties to PD role as tick box exercise without ensuring performance<br>• Client failure to provide time and other resources to the PD role<br>• PD service fees are prohibitive to smaller clients and undermine the quality of the PD function<br>• PD appointment is not a priority for clients where effective PMs are appointed<br>• Clients cherry-picking PD services on projects |
| Supply chain fragmentation and insurance challenges | • Large design firms often refuse PD roles when not appointed as lead designers<br>• Project manager controls PD appointments and keeps PD away from the client<br>• Architects often refuse to take on the PD role<br>• Lead designers sometimes ignorant of the PD function on large infrastructure projects<br>• Architects refuse to take on PD roles for D&B projects at the construction stage because contractors often make changes to reduce cost |
| Performance-related challenges | • PDs not forthcoming with the risk register<br>• Quality of the PD role is often low when combined with other services on a project<br>• PD is inactive and fails to challenge designs properly at design review meetings<br>• PD role dynamic and often requires dynamic competence<br>• Different PDs (designers?) have different versions of the design risk register<br>• PDs often not involved in temporary works design |

if you like, an overview of how much money they need to spend to get this work done."

The existence of a strong project manager (PM) also often has the effect of the client downgrading the need for a PD. Furthermore, where a PD is appointed, some clients cherry-pick the PD services they consider necessary and are therefore prepared to pay for.

### Supply Chain Fragmentation and Insurance Challenges

In some instances, the quest for power, control, and dominance on projects by some client appointees undermines the effective performance of the PD role. For example, some large design firms refuse to take on the PD role when not appointed as lead designers, while in some cases, the PM keeps the PD away from the client so as to obstruct the needed support from the client. In sharing their experience of this phenomenon, a participant in one of the all-duty holders' FGD workshop sessions asserted:

"I have experiences with projects where the project manager is very often closer to the client than the principal designer and if you're appointed as the principal designer, your access to the client and your involvement in meetings can be very much limited and controlled by the project manager who doesn't necessarily value the principal designer role."

Further to the supply chain fragmentation and insurance challenges, inadequate confidence in competence as well as unwillingness to confront bad practices regarding H&S prevent designers, particularly architects, from taking on the PD role. The reluctance of architects to take on the PD roles was particularly pronounced on design and build (D&B) projects because of a common practice of contractors making significant cost-saving or time-saving modifications to preconstruction designs. Such decisions often undermine the quality of the original design and, in most instances, impact adversely on the H&S features embedded in the initial design. Hence, designers, particularly architects, involved in the initial design as PDs refuse to continue or take on such roles during the construction phase under such arrangements in order to avoid potential prosecution. Some participants reported some difficulty obtaining professional indemnity insurance for such work on D&B projects. A related manifestation was polarized positions on responsibility for temporary works design.

### Performance-Related Challenges

Interpersonal skills, leadership, and political skills are necessary attributes of the PD role to draw the best out of the preconstruction team regarding H&S risk management. However, some PDs are not proactive and dynamic enough in respect of identifying, eliminating, minimizing, and controlling H&S risks at the early stage of the project development process. Some PDs fail to raise adequate challenges to designs regarding H&S. A participant in one of the designer workshop sessions highlighted this problem thus:

"I don't often see PDs challenging designs. So I want to see some active involvement from them on giving suggestions of, have you considered doing this another way? That seems to be missing. So when we have PDs involved with our side of the business, very often they are just doing the preconstruction information, the Health and Safety File, and they come along to the pre-start meeting. But it's not an active role. And that's what I want to see more of that they get involved in that challenging."

There are established methodologies, terminologies, and tools for most management functions on construction projects. For example, there are well-established methods for producing cost estimates and programs for tendering or progress monitoring and control purposes. These methods are supported by published codes of practice and widely used textbooks. The existence of such resources for supporting estimating and project planning and scheduling has had the consequence that students studying for the built environment professions develop common knowledge and understanding of these functions that are carried forward into practice. From the feedback from the workshops, the position with H&S risk management in respect of design could not be more different. This feedback suggests that practice and tools used in risk management from an H&S perspective vary considerably. This shortcoming was most loudly articulated with respect to risk registers and briefing documents for which participants used different labels. These differences manifest themselves as differing expectations on the parts of PDs and designers regarding the use of design risk management tools and the H&S content of briefing documents, thus creating tensions within the relationships between PDs and designers.

A related factor is that Regulation 5(1) (a) of CDM 2015 requires the PD role to be performed by the designer with control of the preconstruction phase (preferably the lead designer). The idea was to embed the PD role in the design function (HSE 2014). However, it appears that, in practice, when the PD role is taken on with other responsibilities such as design, the quality of it is undermined. This is because other aspects of the construction project, such as aesthetics and cost that are often prioritized by clients, crowd out H&S on the PD's priority list. A designer in a combined PDs and designers' FGD workshop session stated:

"So, what I have noticed is that the PD role when it is done as a combined service, very often you are not going to get the quality of PD service that you actually need. The role gets undervalued."

Furthermore, a critical issue regarding the performance-related challenges is the noninvolvement or inadequate contribution of PDs to temporary works design. Temporary works are considered one of the riskiest aspects of construction and contribute to significant injuries and fatalities in the construction industry (Carpenter 2021; Jin and Gambatese 2020; Grant and Pallet 2012). However, the view from practice indicates very little engagement with temporary works by PDs, particularly its design, even though Regulation 11 (7) requires the PD, for the duration of their appointment on the project, to liaise with the PC to provide support in the form of providing information for the effective management of H&S (which includes design and management of temporary works) during the construction stage.

## Discussion

The general implementation of the regulations with respect to the role of the PD has already been reported elsewhere (Ndekugri et al. 2021). The main findings reported are that on a day-to-day basis, the PD carries out a variety of tasks that can be classified into four basic functions: (1) ensuring cooperation, coordination, and communication of H&S issues across the supply chain; (2) managing the preparation and sharing H&S information; (3) making the client aware of its CDM obligations and supporting their performance; and (4) assistance to the client with assessment of the competence of supply chain members with respect to H&S. A consequence of the multiplicity of competences required of the PD has been that the

vast majority of PD appointments are of organizations, although the role may also be undertaken by an individual.

This paper reports the analysis of feedback from the workshops on the challenges to the performance of the PD role. The research literature (e.g., Goh and Chua 2016; Lingard et al. 2019) highlights the great influence that clients can exercise over occupational H&S outcomes. However, a clear message from the feedback from the workshops was that deficits in the ways clients comply with their obligations are at the root of the drivers of the challenges of the PD role. This section focuses on the implications of the findings on the barriers against the optimal performance of the PD role.

Social and practice theory posits that policy interventions intended to achieve specific outcomes are usually implemented in an environment that includes significant unacknowledged conditions and that interaction of the policy implementation actions with these conditions produces unintended consequences in the form of challenges detracting from the achievement of the outcomes anticipated by the intervention (Feldman and Orlikowski 2011; Nicolini 2012). This theory not only explains the challenges of the PD role identified in this paper but also points to the sources of the barriers. A particular barrier is the assembly of a project supply chain that undermines the PD role. The theory of group power dynamics is applied to develop an understanding of not only how such situations can be created but also how to avoid them.

Any remedial responses must take into account major policy review developments consequent on the Grenfell Tower fire disaster in 2017 that claimed the lives of 72 people. In response to the Hackitt Report into the disaster (Hackitt 2018), a Building Safety Act 2022 (BSA) has been passed to create an enhanced building safety regulatory regime that is bound to have implications for the PD and other roles under the CDM regulations (Her Majesty's Government 2022a).

### Group Power Dynamics and the PD Performance

Regulation 8(4) requires every duty holder to *cooperate* with "any other person working on or in relation to a project . . . to the extent necessary to enable any person with a duty or function to fulfill that duty or function," while Regulation 11(1) puts on the PD a duty to "plan, manage, and monitor" the preconstruction phase and *coordinate* H&S matters during this phase. Regulation 11(5) requires the PD to ensure "that all persons working in relation to the preconstruction phase cooperate with the client, the principal designer, and each other." The essence of the duty of coordination is that each duty holder must take into account the potential mutual interaction of its decisions and acts with those of other duty holders. *Communication* is therefore an essential requirement for the operational environment envisaged by the regulations. An appropriate communication system is one that ensures that each participant knows, at the right time, not only the potential impact of the activities of other participants on its own activities but also how its activities will impact others. Cooperation, coordination, and communication (the three Cs) are therefore at the heart of the regulations, with the expectation of the PD in the lead on H&S management at the preconstruction stage (HSE 2015).

A shortcoming of the performance of PDs concerns barriers to the teamwork required by the three Cs agenda. The PD needs sufficient technical knowledge and skills in relation to design as an understanding of the different design areas is necessary for the ability not only to enter into conversation with the other designers on an informed basis but also to question any of their design decisions (Ndekugri et al. 2021). But possession of even the highest level of technical skill and knowledge would not be enough for the PD because the PD role also requires certain soft skills to work collaboratively and to lead other duty holders performing tasks outside the PD's expertise. However, possession of appropriate competencies does not always guarantee the right PD performance because, as explained in the next paragraph, there may also be issues of power imbalances within the project team that impact negatively on performance.

Theories of dynamics of power in groups, principally those espoused by French et al. (1959), Kipnis et al. (1980), and Yukl and Tracey (1992), suggest that the exercise of power by team members may result in power imbalances that could undermine team effectiveness. Power in this context refers to the probability that a person can carry out his or her own will despite resistance (Kim et al. 2005). The observed ineffectiveness of the PD can be explained by reference to two of five bases of power recognized by the group power dynamics theory of French et al. (1959). First, the expert power of one party over another is a function of the latter's perception that the other party possesses superior knowledge and experience of the joint task. For example, the appointment of a PD less qualified and experienced than the lead designer inevitably creates a power imbalance that explains a common observation in the workshops that, on many occasions, the PD does not possess enough design expertise to challenge the designs of the other designers.

Second, the exercise of power may also undermine the effectiveness of the PD through legitimate power, which is a function of how one party believes that the other party has the lawful authority to influence the performance of the joint task. There may therefore also be a power imbalance emanating from the allocation of formal authority within the group. For example, having an interventionist PM or a lead designer with ostensible authority to represent the CDM client could undermine the PD role. It was a common concern that there have been too many instances where the party with the authority did not pay sufficient attention to the importance of the PD role. The influence of legitimate power is most acute where the main contractor is also the PD, not an uncommon arrangement with procurement by the D&B project delivery method. Even within the traditional procurement route, there is a common practice of design responsibility being passed onto contractors through performance specifications or express requirements for contractors to provide designs for defined portions of the asset being procured. Commercial pressures may compel the main contractor to accept the PD role. It was reported that, in these situations, the main contractor often subcontracts the PD role to a design professional or CDM Adviser outside the construction professions. Many design firms expressed reluctance to work under such subcontract arrangements because of the burdens of resisting contractors dominated by the cost imperative to the detriment of H&S. Many design firms also reported difficulties with their insurers declining to cover such arrangements.

### Duration of the Appointment

Many workshop participants reported experiences of some clients engaging PDs for only the preconstruction phases of their projects. This practice may have been encouraged by the provision in Regulation 12(8) that, where the appointment of a PD is terminated before the end of the project, the HSF file should be passed onto the PC who must take responsibility for keeping it updated and, at the end of the project, submitting it to the client. The qualification of the expected contribution of the PD by the phrase "during the preconstruction phase" also gives the impression that the role is limited to the preconstruction phase.

However, that the PD is generally expected to be appointed for the entire duration of the project is discernible from the provision in Regulation 12(6) that the PD is to ensure that the HSF is updated from time to time "to take account of work and any changes that have occurred." This inference is strengthened by the fact that, on even many traditionally procured projects, design often continues during the construction phase, e.g., new or revised designs necessitated by variations, and design of portions of the project left to be provided by specialist contractors during the construction phase. Regulation 12(8) is probably intended for traditionally procured projects where the design is detailed in every particular before commencement on site. Another situation where the PD appointment may not extend to the construction phase is where the client engages designers and a PD to carry out outline designs for the preparation of the employer's requirements on a D&B project. In such a project, the PD's appointment may be terminated at the end of the preconstruction phase unless a novation of the contract for the PD services is agreed upon between the client, D&B contractor, and PD.

### Temporary Works Design

Poorly designed temporary works have been responsible for many accidents on construction sites. In the late 1960s and early 1970s, fatalities from failures of temporary works caused so much concern that the government commissioned an advisory report that made many recommendations, and the most significant of which include the adoption of procedural controls and coordination between designers of permanent and temporary works (Grant and Pallet 2012; Carpenter 2021). Regulation 9(2) puts on the designer a duty, when preparing designs, to eliminate or reduce or control, sfairp, "foreseeable risks to health or safety of any person carrying out or liable to be affected by construction work." There can therefore be little doubt that the regulations put some responsibility on the designer to consider the implications of the design of permanent works for temporary works. Depending on the circumstances, the designer of the permanent works needs only flag the need for a specialist temporary works designer. Correspondingly, the statutory duty of the PD in relation to design covers not only permanent works but also temporary works. It therefore follows that, contrary to the feedback from the workshops, the client's arrangements for H&S risk management would be flawed without the PD's involvement in the temporary works design. The PD's input includes: advising the client to consider the capability to manage temporary works issues in the assessment of tenders from contractors and designers; setting out how effective coordination between permanent works designers and temporary works designers will be achieved; making arrangements for liaison with and between the various temporary works designers; and checking that the PC has made suitable arrangements in the CPP for the preparation of temporary works designs (Temporary Works Forum 2017).

### Insurance Implications

Some design consultants stated during the workshops that they do not provide services as PDs because their insurers decline to provide relevant professional indemnity insurance cover. This problem raises questions concerning whether the PD incurs liability in relation to the coordination of the designs by others. Whatever the answer to that question is, the facts of *Multiplex Construction Europe Ltd. v. Bathgate Realisations Civil Engineering Ltd. (formerly Dunne Building and Civil Engineering Ltd.) (In Administration)* [2021] EWHC 590 (TCC) provide some explanation for the insurers' apprehension of the risk of incurring liability. The claimant was the main contractor on a substantial construction project. It subcontracted the design and construction for certain works, including a slipform rig, to subcontractor SC1, who, in turn, subsubcontracted the design of the slipform rig to a design consultant (D1). An independent design consultant D2 was appointed by SC1 and D1 to carry out an independent third-party check of the design as required by BS5975, which was incorporated into their contracts. The fee for checking the design was only £3,978. The design of the rig was found to be defective and Multiplex replaced it at a considerable cost that it sought to recover in the tort of negligence against the insurers of D2. The contractor issued proceedings and obtained a default judgment against SC1 and D2, but SC1 was in administration while D1 was uninsured. D2 was insured but was in liquidation. The contractor contended that D2 owed it a duty of care and sought to recover its loss from D2's insurer. On a preliminary issue, the court held that no such duty was owed in the circumstances of framework contractual relationships. The similarities between the role of the design checker in this litigation and that of a PD drawing only a minuscule fraction of the project costs as fees are only too obvious. The risk of disproportionate liability may be addressed through net contribution clauses in relevant consultancy agreements, but these have their controversies. Integrated project delivery using a single policy that underwrites the liabilities of supply chain members provides a better solution (Ndekugri et al. 2013; Zhu et al. 2020), but this practice is still to be adopted to a significant degree.

### Policy Implications

The BSA serves as a foundation for the development and implementation, by appropriate departments and agencies of government, of secondary legislation on specific matters. Of the interventions made, those most relevant to the issues in this paper include: (1) a new regulatory framework for greater competence of a widened panoply of duty holders involved in the design, construction, and occupation of a building; (2) a gateway system to ensure that checks for specific safety-related outcomes are met at defined points before the following stage can be commenced; (3) a golden thread of information going right from the inception of the idea to procure to the occupation of the building over its entire lifespan; and (4) holding duty holders more to account (Her Majesty's Government 2022b). The new regime imposed competence and information requirements, in addition to those under the CDM 2015. The reform is focused on higher-risk buildings, which are defined in the legislation as buildings at least 18 meters in height, or which consist of seven or more stories, and with a minimum of two residential units. The research reported here could not therefore be timelier as it will inform policymakers on the strengths and shortcomings in the current CDM system that should be entrenched or addressed in the new regulatory regime and the need for harmonization to avoid inconsistencies and silos of laws for particular types of projects.

### Contribution/Value

A finding of the literature review was that policies and legislation as tools for implementing PtD have been one of the least investigated subjects. The few studies focused on: analysis of H&S policies and legislation adopted by EU member states and their effects on accident rates on construction projects (e.g., Aires et al. 2010); effect of H&S regulations on design engineers' PtD thinking (Behm and Culvenor 2011); and national policies to promote PtD initiatives in the construction industry (NIOSH 2015). A related review of the literature on the CDM 2015 (the UK implementation of the EU

TMCS Directive) carried out as part of the larger study found only commentaries on the letter of the legislation and individual expert practitioner experience of the regulations, reports from surveys of the implementation of the regulations funded by the HSE to support their policy review responsibilities and a few academic publications on aspects of the regulations (Ndekugri et al. 2022). Similarly, Guo et al. (2021) studied project participants' perceptions of the knowledge, attitude, practices, and challenges of the PtD regime enshrined in the New Zealand Health & Safety at Work Act 2015 (NZHSWA 2015), which does not expressly provide for an overarching role for the coordination of H&S risks at the preconstruction stage equivalent to the PD under the UK regulatory regime.

These reviews therefore expose a gap in the research literature in relation to the PD role. This gap has been partially closed by Ndekugri et al. (2021) who identified the details of what PDs do on a day-to-day basis. The research reported in this paper closes the gap further by uncovering and analyzing the barriers against the performance of the PD role. The PtD concept is addressed primarily to designers to consider the implications of their designs for H&S during construction. Design coordination is an important aspect of general PtD practice: coordination between different components of design avoids ignoring some H&S risks on account of poor interface management. There is also coordination between designers and constructors and installers to ensure that their work methods and general arrangements adequately address residual H&S risks notified by designers. The PD role under CDM 2015 and the corresponding role under the TMCS only make explicit what is inherent in the general PtD concept. The paper therefore also makes a contribution to the general PtD practice in relation to barriers to its coordination element.

### *Research Limitations and Implications for Future Research*

There are three main limitations to the research. First, most of the feedback on the client's perspective was from major public infrastructure organizations, who have fewer resource constraints than private commercial clients, other duty holders, and H&S consultants. Second, the exploratory nature of the study implies that the relative strengths of the identified barriers to effective coordination cannot be assessed. Third, at the time of writing, as part of the response to the Grenfell disaster, there were on-going consultations between industry and the government on the changes to the preconstruction coordination role in the procurement of higher-risk buildings. Recommended research to build on this study therefore includes: quantitative investigation of the extent of the barriers, particularly from the perspective of commercial clients; more detailed examination of coordination of the design of temporary works; and how the insurance sector can provide products more supportive of the preconstruction coordination role.

## Summary and Conclusions

This study has discovered three interrelated categories of challenges to the PD role under CDM 2015 Regulations: (1) client-related challenges consequent on the statutory compliance behavior of the CDM client; (2) supply chain fragmentation and insurance challenges to effective cooperation, coordination, and communication; and (3) shortcomings in the ways in which the PD role is performed on the particular project. The literature review found very little research into the operational and organizational implementation of the EU Directive on which the UK site safety regulatory regime is based. The research reported here therefore not only adds new knowledge on PD practice in the United Kingdom but also provides valuable lessons for preconstruction coordination of H&S under the EU regulatory regime and PtD practice.

The barriers to effective coordination of H&S risks at the preconstruction stage of construction projects emanate from many sources, including the lack of commitment of the CDM client to its H&S duties and poor leadership of the overall H&S function. Appointing a PD with appropriate competence and making sufficient time and resources available would not be enough. The client must also pay attention to assembling a project team that can operate in the environment of cooperation, coordination, and communication essential to the effective management of H&S risks at the preconstruction stage. Such a collaborative environment is best achieved through procurement by the integrated project delivery approach and the development of insurance products supportive of collaborative working.

The principal research question from this study that needs to be answered in future research concerns how the compliance behavior of CDM clients who adopt a minimalist approach to their CDM duties can be improved. There is also a need for comparative empirical studies into the barriers operating against coordination of the management of H&S risks at the preconstruction stage of projects in EU countries. As the PtD concept must entail similar coordination, practice on this facet of the PtD concept outside the United Kingdom and the EU also needs empirical investigation.

## Data Availability Statement

Some or all data, models, or coding that support the findings of this study are available from the corresponding author upon reasonable request.

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