Developing Conceptual Framework for Prevention through Design (PtD) Implementation Based on Construction Work Design Management Regulations 2024 in Malaysian Construction Industry

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ABSTRACT

Occupational Safety and Health (OSH) is essential for protecting workers and is a key factor in determining project success and quality. Despite its importance, the construction industry consistently faces high fatality rates due to the hazardous nature of its activities and complex project characteristics. Between 2017 and October 2023, the Malaysian construction industry recorded the highest fatality rate among all industries, with 548 fatalities, surpassing manufacturing (427 fatalities). In response, DOSH introduced the Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024 to enhance safety standards in Malaysia. However, the process for its implementation remains unclear for construction stakeholders. This study aims to develop a conceptual framework for implementing Prevention through Design (PtD) in the Malaysian construction industry in compliance with the new regulation. By analysing the Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024, Occupational Safety and Health (Amendment) Act 2022, and the Guidelines on Occupational Safety and Health in the Construction Industry (Management) 2017, the framework outlines the timeline for PtD integration throughout various project phases. This framework provides clear timeline for construction stakeholders to adopt PtD and ensure compliance with the regulation. Future research is recommended to develop a more comprehensive and strategic process protocol for more effective PtD implementation and regulatory adherence.

Keywords: PtD, Construction work design management, Occupational safety and health, Malaysia, Construction industry

INTRODUCTION

The construction industry is a cornerstone of national development, playing a pivotal role in economic growth and infrastructure advancement, particularly in developing countries like Malaysia. Within this dynamic sector, Occupational Safety and Health (OSH) is not only critical for safeguarding the well-being of workers but also serves as a fundamental determinant of project success and overall quality [1], [2], [3]. However, despite its importance, the construction industry is often associated with alarmingly high fatality rates, primarily due to the inherently hazardous nature of construction activities [4] and the complex characteristics of its projects [5]. Notwithstanding, in Malaysia, this issue is particularly pressing, where the high fatality rate within the construction sector has raised significant concerns [6]. Statistical data from 2017 to October 2023 reveals that the construction industry recorded the highest fatality rate among all sectors, with 548 fatal incidents, compared to 427 in manufacturing [7]. Notably, 2018 marked the peak of these fatalities, with 118 cases reported, a rise from 111 in 2017. Although the overall fatality rate has shown a declining trend in recent years, it remains far from the zero-accident goal set by the Architecture, Engineering, and Construction (AEC) industry [8]. Accordingly, these tragic incidents often stem from underlying management deficiencies, including inadequacies in OSH management practices [9], [10]. To effectively address these challenges, it is crucial to investigate the root causes, particularly external factors such as policies and legislation [9]. In response to these pressing issues, the Twelfth Malaysia Plan (2021-2025) advocates for stricter regulations, including the introduction of the Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024, aimed at

improving OSH standards in the Malaysian construction industry. Therefore, this study aims to develop a conceptual framework to PtD implementation in Malaysian construction industry in compliance to the regulation. Fig. 1 shows fatalities in construction industry by year in Malaysia from 2017 to October 2023, meanwhile, Fig. 2 illustrates occupational fatalities by sectors in Malaysia.

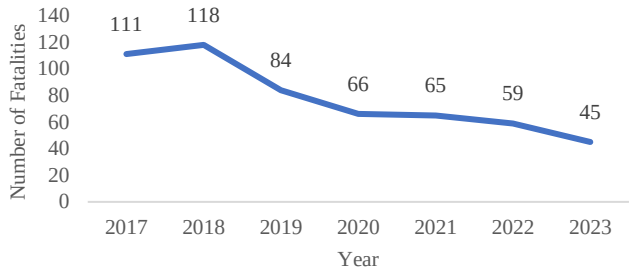
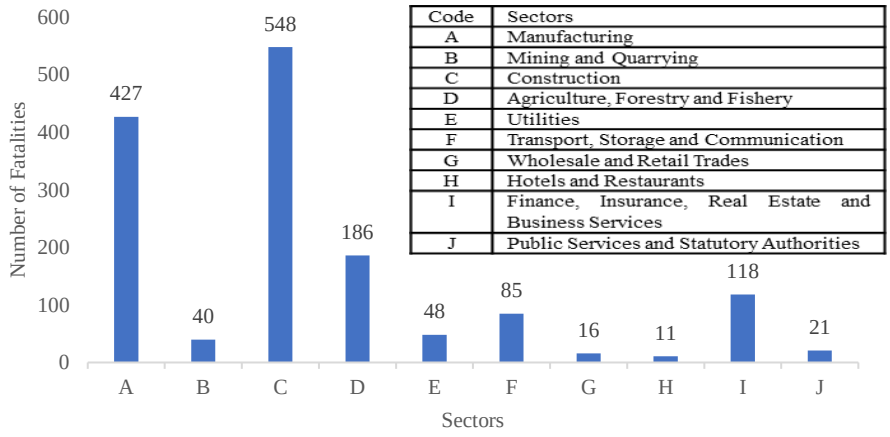


Fig. 1 Fatalities in construction industry by year in Malaysia from 2017 to October 2023



Code	Sectors
A	Manufacturing
B	Mining and Quarrying
C	Construction
D	Agriculture, Forestry and Fishery
E	Utilities
F	Transport, Storage and Communication
G	Wholesale and Retail Trades
H	Hotels and Restaurants
I	Finance, Insurance, Real Estate and Business Services
J	Public Services and Statutory Authorities

Fig. 2 Occupational fatalities by sectors from 2017 to October 2023

A. Objectives

The purpose of this study is to develop a comprehensive conceptual framework that facilitates the effective implementation of Prevention through Design (PtD) principles within the context of Malaysian construction industry that fulfil all legal requirements in Occupational Safety and Health (Construction Work) (Design and Management) (CDM) Regulations 2024. Specifically, there are two objectives of this study, which are:

1. To identify similarities of legal requirements in OSHA 1994, OSHCIM 2017, and CDM Regulations 2024.
2. To develop conceptual framework for PtD implementation in Malaysian construction industry.

LITERATURE REVIEW

In response to the critical need for enhancing OSH in the Malaysian construction industry, the Department of Occupational Safety and Health (DOSH) has integrated the Prevention through Design (PtD) concept into industry practices. This approach is inspired by similar frameworks in developed countries such as the United States (US), United Kingdom (UK), Singapore, Australia, and South Korea, where updated legislation has been enacted to delineate the responsibilities of all construction stakeholders, including designers, contractors, and clients, to ensure safety is prioritized from the pre-construction through risk reduction during design phase [11]. For instance, in the US, the ANSI/ASSP Z590.3-2021 standard offers a comprehensive framework for integrating safety into the design phase of construction projects [12]. In the UK, the Construction (Design and Management) Regulations 2015 impose a legal duty on designers to plan, manage, oversee, and coordinate OSH matters during the preconstruction phase [13]. Similarly, Singapore's Ministry of Manpower (MOM) enacted the Workplace

Safety and Health (Design for Safety) Regulations 2015, which clearly specify the legal responsibilities of developers, designers, and contractors in identifying all foreseeable design risks. Australia has also embraced this approach through its "Code of Practice: Safe Design of Structures," which is part of the Work Health and Safety Act and associated regulations [14]. Meanwhile, in South Korea, the Ministry of Land, Infrastructure, and Transport (MLIT) introduced the PtD process in 2016 [15], which is now operational through the Design Safety and Health Ledger System [16].

Accordingly, a notable example of PtD in action is the Port of Portland's Parking and Rental Car Center construction project, which won the PtD Award from the National Institute for Occupational Safety and Health (NIOSH), by incorporating PtD principles which effectively reduced fall risks, minimized the use of ladders, and enhanced worker safety through design features such as shatterproof glass and permanent guarding [17]. Therefore, following this global trend, Malaysia is advancing towards the implementation of PtD in its construction industry to improve OSH standards. This is being achieved through the enforcement of new legislation, including amendments to the Occupational Safety and Health Act 1994, the introduction of the Guidelines on Occupational Safety and Health in Construction Industry (Management) 2017, and the establishment of the Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024. These measures are aimed at embedding safety considerations into the earliest stages of construction projects, thereby fostering a safer and more sustainable industry.

A. Occupational Safety and Health Act 1994 (Act 514)

The Occupational Safety and Health Act 1994 (OSHA) serves as a cornerstone of workplace safety legislation in Malaysia, enforced by DOSH to protect the safety, health, and welfare of individuals engaged in work activities. This act applies nationwide across designated industries and establishes the National Council for Occupational Safety and Health, consisting of 15 parts with 67 sections that clearly outlines the responsibilities of employers, employees, and the government in maintaining high standards of workplace safety [18]. Moving forward, as expectations around workplace safety evolve, the effective management of OSH has become increasingly critical. Initially, under OSHA 1994, clients who issue contracts bear the responsibility of ensuring a safe and healthy workplace, along with providing welfare provisions for their employees and contractors involved in the project. Accordingly, it is essential for clients to proactively identify and address hazards and risks before issuing contracts, taking practical steps to manage them. Furthermore, contracts should comprehensively outline OSH requirements, including Hazard Identification, Risk Assessment, and Risk Control (HIRARC), and clearly define the roles and responsibilities of both clients and contractors. Additionally, the contract should specify how OSH hazards and risks will be managed at each stage of the project [19]. Nevertheless, in line with the movement towards the implementation of PtD in the Malaysian construction industry, the Occupational Safety and Health (Amendment) Act 2022 has been enacted to reinforce OSHA 1994. In this regard, Section 18 of this amended act emphasizes the responsibility of clients, designers, and contractors in assessing and managing safety and health risks associated with construction hazards. Eventually, this amendment supports the broader goal of integrating safety considerations into the earliest phases of project planning and design, thereby advancing Malaysia's commitment to improving OSH standards in the construction industry.

B. Guidelines on Occupational Safety and Health in the Construction Industry (Management) 2017

In an effort to implement PtD concept within the Malaysian construction industry, DOSH has introduced the Guidelines on Occupational Safety and Health in the Construction Industry (Management) (OSHCIM) in 2017, in reference to the Construction (Design and Management) Regulations in UK. Accordingly, OSHCIM provides practical guidance to clients, designers, and contractors on managing safety, health, and welfare when executing construction projects. It also offers a legal framework for individuals with responsibilities under OSHA (Amendment) 2022. Furthermore, the guidelines explain both mandatory legal obligations and recommended practices for project management to ensure compliance. All in all, the objective of OSHCIM is to identify and minimize all foreseeable design-related risks and hazards to the safety and health of construction workers, to the extent reasonably practicable [20]. For instance, in practice, the implementation of OSHCIM often involves appointing a principal designer (PD) and a principal contractor (PC) for construction projects with multiple designers and subcontractors. Traditionally, stakeholders have borne significant responsibility for OSH.

However, under the PtD approach, OSHCIM requires stakeholders to collaborate in identifying and mitigating OSH risks and hazards throughout the project's lifecycle.

C. Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024

Following to the introduction of OSHCIM in 2017, the Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024 (CDM) has been enacted on 1st of June 2024 by DOSH, which are part of a broader update to the OSHA. This regulation aims to enhance safety and health standards in the construction industry by embedding risk management from the design phase. Its primary purpose is to prevent accidents, reduce risks, and promote early hazard identification through the PtD approach. The regulation clearly defines the responsibilities of all stakeholders, clients, designers, and contractors, ensuring that they collaborate to identify, assess, and mitigate risks throughout the construction lifecycle. It also encourages better communication and coordination among stakeholders while holding them legally accountable for maintaining a safe working environment [21]. Ultimately, this regulation seeks to raise the safety standards in Malaysia's construction industry, aligning with international best practices and reducing the industry's high accident and fatality rates. Table 1 summarized the OSHA, OSHCIM, and CDM requirements.

Framework Development

Following to the identification of CDM legal requirements as summarized in Table 1, the conceptual framework is developed to achieve the study objective. Fig. 3 presented the conceptual framework.

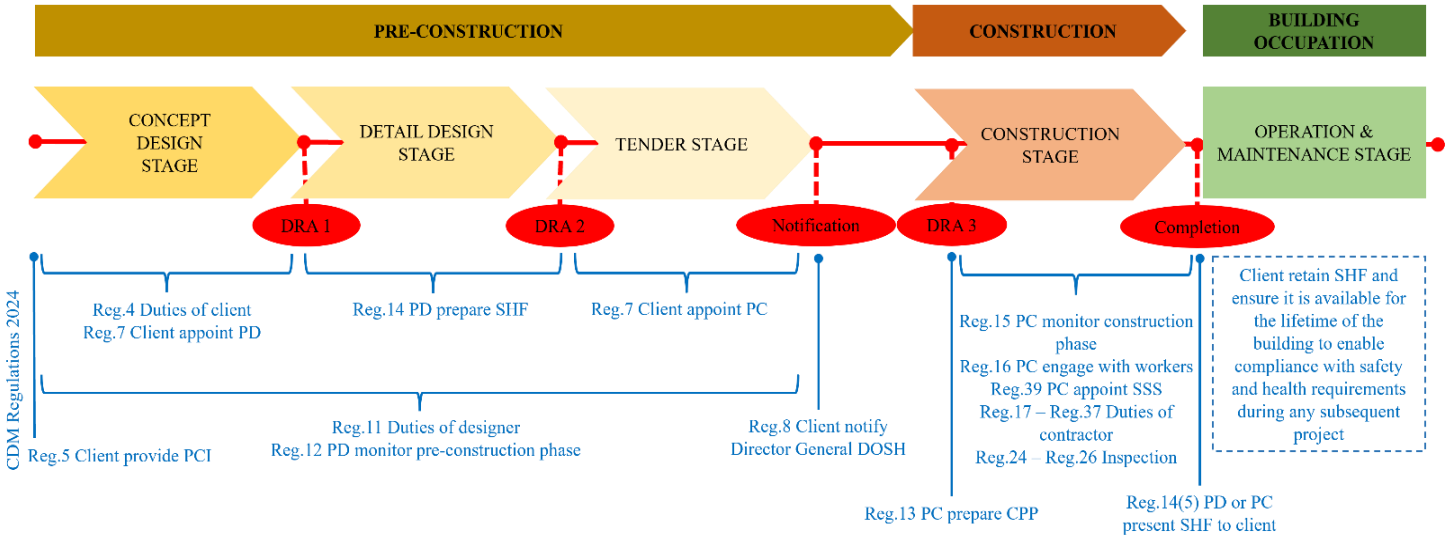


Fig. 3 Conceptual framework for CDM Regulations 2024 compliance in traditional procurement projects

Table I Similarities in OSHA, OSHCIM, and CDM Legal Requirements Throughout Project Phases

Project Phases			OSHA		OSHCIM		CDM	
Pre-construction	Concept design stage	Client initiate project	**Clause 15**	General duties of employers	**No. 2**	Duties of client	**Reg. 4**	Duties of client
			Clause 16	Duty of employer to formulate OSH policy	**No. 6.1**	Providing pre-construction information	**Reg. 5**	Providing pre-construction information
			Clause 29A	Employer to appoint OSH coordinator				

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Project Phases			OSHA		OSHCIM		CDM	
		Appointment of PD	**Clause 66**	Compliance to regulations with respect to the safety, health, and welfare of workers	**No. 3**	Client to appoint PD	**Reg. 7**	Client to appoint PD
		Notification	**Clause 5**	Minister shall appoint the Director General	-		**Reg. 8**	Client to notify Director General DOSH if construction work more than 30 days before the construction work begins
	Detail design stage	Prepare or modify design	**Clause 18A**	Duties of principal to ensure safety and health	**No. 4.4**	Duties of designer	**Reg. 11**	Duties of designer
							Reg. 38	May appoint safety and health assistance
		PD monitor pre-construction phase	**Clause 18B**	Duty to conduct and implement risk assessment	**No. 4.7**	PD to plan, manage, monitor, and coordinate the pre-construction phase	**Reg. 12**	PD shall plan, manage, and monitor the pre-construction phase
	Tender stage	Appointment of PC	**Clause 66**	Compliance to regulations with respect to the safety, health, and welfare of workers	**No. 3**	Client to appoint PC	**Reg. 7**	Appointment of PC
		Construction Phase Plan (CPP)			**No. 6.2**	PC to draw up CPP	**Reg. 13**	PC to draw up CPP
		Safety and Health File (SHF)			**No. 6.3**	PD to prepare SHF	**Reg. 14**	PD to prepare SHF
Construction	Construction stage	PC monitor construction phase	**Clause 18A**	Duties of principal to ensure safety and health	**No. 5.3**	Duties of PC	**Reg. 15**	Duties of PC to plan, manage, and monitor the construction phase
			Clause 18B	Duty to conduct and implement risk assessment	**No. 5.3(92)**	PC to plan, manage, monitor, and coordinate the construction phase	**Reg. 38**	May appoint safety and health assistance,
				Appoint a competent			**Reg. 39**	PC to appoint site safety supervisor (SSS)

Project Phases			OSHA		OSHCIM		CDM	
		Engagement with workers	**Clause 29**	safety and health officer	**No. 5.3(114)**	PC to consult and engage with workers	**Reg. 16**	PC to engage with workers to ensure safety, health, and welfare of workers
		Work on-site by contractor	**Clause 24**	General duties of employees at work	**No. 5.6**	Duties of contractor	**Reg. 17 – Reg. 37**	Duties of contractor and compliance to general requirements for all construction sites
		Inspection	**Clause 6**	Director General to appoint a person or an independent inspecting body	-		**Reg. 24**	Inspection of excavation
							Reg. 25	Inspection of cofferdam and caisson
							Reg. 26	Report of inspection
Building occupation	Operation and Maintenance stage	Completion	**Clause 66**	Compliance to regulations with respect to the safety, health, and welfare of workers	**No. 6.3(204)**	PD to pass the updated SHF to the client	**Reg. 14(5)**	PD or PC shall present SHF to the client

Framework Validation

The developed conceptual framework was validated by an experts panel. This study engaged two experts with in-depth knowledge of the CDM Regulations 2024 to ensure a thorough evaluation, which is considered sufficient for basic content validation in smaller studies [22]. The aim of the validation process was to gather feedback and assess the framework's reliability and accuracy in alignment with the CDM Regulations 2024. Accordingly, each expert critically reviewed the framework, provided feedback, and identified areas for potential refinement to improve its practical application in real-world construction projects. Ultimately, the expert panel recommended minor modifications. Fig. 3 presented the revised framework, which effectively addresses the essential requirements of the CDM Regulations 2024.

FINDINGS

Findings from the conceptual framework indicates that there are four critical requirements in order to comply with CDM Regulations 2024. These requirements are: Pre-Construction Information (PCI), Design Risk Assessment (DRA), Safety and Health File (SHF), and the Construction Phase Plan (CPP). Each of these requirements plays a pivotal role in ensuring that safety is integrated throughout the project lifecycle, marking a significant shift from traditional construction practices.

A. Pre-Construction Information (PCI)

The first critical step is for the client to provide the Pre-Construction Information (PCI) to the Principal Designer

(PD) prior to the design phase. According to the CDM Regulations 2024 and supported by international best practices in PtD, the PCI must consist of detailed and proportionate information relevant to the project's scope, risks, and safety and health considerations. This includes key elements such as:

1. Description of the project
2. Client's considerations and management requirements
3. Environmental restrictions and existing on-site risks
4. Significant design and construction hazards
5. The existing Safety and Health File

Therefore, the PCI, as stipulated in both OSHCIM Guidelines 2017 and CDM Regulations 2024, serves as a foundational document enabling the PD to integrate safety from the outset, ensuring that risks are managed and mitigated throughout the design and construction process.

B. Design Risk Assessment (DRA 1, 2, and 3)

In line with the framework's emphasis on risk management, the PD with the Occupational Safety and Health-Professional (OSH-P), must conduct three Design Review Assessments (DRAs) at different pre-construction phases, which are DRA 1 (Concept Design Review), DRA 2 (Detail Design Review), and DRA 3 (Pre-construction Plan Review). These stages of design risk assessment align with the PtD principles to mitigate possible risks and hazards during the design phases. Accordingly, the DRAs aim to systematically identify, assess, and mitigate risks in project designs by reviewing the PCI and adhering to the General Principles of Prevention (GPP). The recommended practice to perform these reviews are taking into consideration from DOSH Hazard Identification, Risk Assessment, and Risk Control (HIRARC) Guidelines 2008.

Therefore, by documenting findings and communicating risk control measures at each design stage through the DRAs, the PD ensures that safety is not only integrated into the design but also continuously monitored and reassessed throughout the project lifecycle. This approach addresses critical issues such as safe construction practices, building use, maintenance, and eventual dismantling or disposal of the building.

C. Safety and Health File

The PD is responsible for preparing and continuously updating the Safety and Health File (SHF) as the project progresses. This ensures that any design changes, new risks, or mitigation strategies are documented, creating a dynamic and comprehensive record for future reference. Accordingly, once the project finished, the PD will pass the SHF to the client and the client will then retain the SHF and ensure it is available for the lifetime of the building to enable compliance with safety and health requirements during any subsequent project or maintenance and dismantling of the building. Therefore, the SHF may contain all relevant documents, including the PCI, and DRAs output.

D. Construction Phase Plan

Parallel to the PD's responsibilities, the Principal Contractor (PC) must prepare the Construction Phase Plan (CPP) based on the information provided during the design phase. The CPP should be completed before construction commences and reflect any new risks, mitigation measures, scope changes identified during design reviews, safety and health arrangements for the construction phase, and site rules. Therefore, the successful improvement of safety and health management during construction phase will largely depend on the quality and effectiveness of the CPP developed for the project.

DISCUSSION

The conceptual framework underscores that the CDM Regulations 2024 place significant importance on embedding safety considerations at every phase of the project lifecycle, starting from the earliest design phases. This proactive approach aims to mitigate risks before they arise, ensuring a safer and more compliant

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construction process. Table 2 provides a detailed breakdown of the key steps required to implement PtD at each phase of the project, as mandated by the CDM Regulations 2024.

Table II Elaboration on CDM Requirements at Each Project Phases

Project Phases			Processes
Pre-construction	Concept design stage	DRA 1	DRA 1 is a Concept Design Review that review the conceptual design and identify critical risks associated with the selection of site and the proposed design of the building development. Initiated by client or appointing PD, where they shall look into the project overall perspectives including but not limited to: i. Site location ii. Public access traffic iii. Type of buildings surrounding iv. Landscape v. Other general constrains
	Detail design stage	DRA 2	DRA 2 is a Detail Design Review that identify and address hazards as they emerge from the development of the design, meanwhile, the issues raised during DRA1 should also be reviewed and resolved if possible. Initiated by PD with OSH-P, where detailed design, operations, maintenance, and repair review should look at a building's detailed architectural and structural design. i. The review should determine risks involved in the construction methods, access, and egress, and whether the design will create confined space or other hazards. ii. Risks related to maintenance and repair of a building such as cleaning methods should also be studied.
	Tender stage	DRA 3	DRA 3 is a Pre-construction Plan Review initiated by PC with OSH-C, where pre-construction design review should examine temporary works design and design by specialist contractors not covered during the concept and detailed design stage.
Construction	Construction stage		PC to ensure that adequate welfare facilities is provided. Ensuring workers receive proper training, and maintaining safety documentation. Regular site inspections must be carried out, and any accidents or hazards must be reported to DOSH.
Building occupation	Operation and maintenance stage		PD or PC to ensure that SHF is regularly updated throughout construction stage and present it to the client during completion. Keeping accurate records of inspections, training, and incidents, while ensuring emergency preparedness is in place.

CONCLUSION

The enforcement of the Occupational Safety and Health (Construction Work) (Design and Management) Regulations 2024 by DOSH, effective from 1st June 2024, has significantly accelerated the adoption of the PtD approach within Malaysia's construction industry. The conceptual framework developed in this study contributes

to this evolving landscape by providing a structured, practical guide that supports smoother PtD implementation, particularly as industry professionals strive to comply with both the CDM Regulations 2024 and the Occupational Safety and Health (Amendment) Act 2022, alongside existing guidelines like the Guidelines on Occupational Safety and Health in the Construction Industry (Management) 2017. Additionally, the adaptability of the framework not only addresses the immediate needs of the Malaysian context but also offers valuable insights for other developing countries aiming to adopt PtD principles. Furthermore, this study lays the groundwork for future research that could refine and expand the framework, particularly by developing a strategic process protocol that clearly delineates the duties of construction stakeholders across all phases in PtD-based project. This would promote more effective PtD adoption, ensuring higher compliance with safety regulations and ultimately contributing to safer, more sustainable construction practices.

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