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EVALUATING THE OCCUPATIONAL SAFETY AND HEALTH INSTRUMENTS FOR PREVENTION THROUGH DESIGN IMPLEMENTATION IN MALAYSIAN CONSTRUCTION

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Abstract

Prevention through Design (PtD) is a proactive approach widely practiced in developed countries to reduce construction-related accidents. In Malaysia, however, its implementation remains limited due to low awareness and understanding among practitioners. This study aims to explore and classify existing Occupational Safety and Health (OSH) instruments published by the Department of Occupational Safety and Health (DOSH) and the Construction Industry Development Board (CIDB), and to determine their alignment with PtD principles. A qualitative content analysis was conducted on official documents, and the instruments were grouped into three categories: technical documents, assessment tools, and digital tools. The findings shows that PtD elements are present in instruments such as the HIRARC framework and Building Information Modelling (BIM), though the level of integration remains inconsistent. By mapping this alignment, the study highlights the current readiness of these instruments to support PtD practices and provides a foundation for enhancing safety planning in the design phase, in line with the OSHCIM 2017 guideline.

Keywords: OSHCIM, Prevention through Design (PtD), OSH Instrument, construction, safety

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INTRODUCTION

Occupational safety and health (OSH) in the Malaysian construction industry continues to face significant challenges, particularly in managing risks during the early stages of project development. The persistently high accident rates on construction sites pose serious threats to worker safety, human resource sustainability, and overall project value due to the inherent hazards of site conditions (Jaafar et al., 2018). Despite the existence of safety procedures, policies, and regulations, the effectiveness of these measures remains questionable, as accident rates continue to rise prompting increasing concern from the Malaysian government (Nawi et al., 2016). In response, regulatory bodies such as the Department of Occupational Safety and Health (DOSH) and the Construction Industry Development Board (CIDB) have introduced several OSH instruments aimed at enhancing safety performance within the construction sector (Musarat et al., 2023). However, many of these instruments are still implemented reactively during the construction phase, rather than proactively integrated at the design stage where risks can be more effectively anticipated and mitigated.

To address this gap, DOSH has introduced the Occupational Safety and Health in Construction Industry (Management) Guidelines 2017, known as OSHCIM which represent a significant advancement by formally introducing the concept of Prevention through Design (PtD). PtD promotes the integration of hazard identification and elimination during the design phase, well before construction begins, offering a more proactive and effective approach to safety management. However, the adoption and operationalization of PtD within current Malaysian practice remain limited, with implementation still skewed toward the later stages of construction.

The present study aims to explore the common OSH instruments in Malaysia, specifically those published by the Department of Occupational Safety and Health (DOSH) and the Construction Industry Development Board (CIDB). It focuses on determining the alignment of each identified instrument with the PtD principles as outlined in the OSHCIM 2017 guideline. Based on this alignment, the instruments are then categorised to provide a clearer understanding of their role in supporting design-stage safety planning. This study contributes to the body of knowledge by mapping the presence of PtD elements across existing OSH instruments and offering insights into their current position within Malaysia's construction safety framework.

LITERATURE REVIEW

The Prevention through Design (PtD) principles as emphasized in the OSHCIM 2017, promotes the integration of hazard analysis and risk assessment at the early

design stages of construction projects to reduce risks to an acceptable level (Sinha et al., 2021). The implementation of PtD has been widely adopted in several countries where it is mandated by law. For example, Singapore enforced the Workplace Safety and Health (Design for Safety) Regulations in 2016, while the European Union, Australia, the United Kingdom, and South Africa have also institutionalized similar requirements. In contrast, the adoption of PtD in the United States remains voluntary and varies depending on project or client requirements (Aires et al., 2016). In Malaysia, the implementation of OSHCIM began on a voluntary basis but DOSH has announced plans to mandate the integration of PtD principles, reinforcing its commitment to strengthening OSH standards across the construction industry.

By addressing hazards during the design phase, PtD helps to reduce accidents and injuries on construction sites (Gambatese et al., 2005). Study in Hong Kong also confirmed PtD's positive impact on safety performance, productivity, and project outcomes (Lam et al., 2006), while others have linked it to cost savings and improved quality (Howe, 2008). Early hazard identification not only improves safety outcomes but also lowers costs related to injuries and claims (Anderson & Galecka, 2013). In addition, PtD contributes to better constructability, worker morale, cost-efficiency, quality, and adherence to schedules (Karakhan, 2016). These research findings consistently highlight the vital role of PtD in raising safety standards and construction performance. Over time, PtD has proven to be a practical strategy for reducing work-related injuries and illnesses in the construction industry (Che Ibrahim et al., 2022).

It is notable that achieving a safe construction environment is complex and evolving goal that demands the concerted efforts of all project stakeholders. Active stakeholder participation has been widely recognized as a key factor in this process (Ismail et al., 2022). Additionally, effective hazard identification and risk assessment during the design stage are essential to support the successful implementation of OSH practices (Elkaseh et al., 2024). However, previous studies have shown that the use of formal risk assessment techniques in the Malaysian construction industry remains limited (Zaini et al., 2011). Furthermore, lack of regulatory enforcement and poor implementation practices continue to contribute to the risk of workplace accidents (Ayob et al., 2018). Addressing these challenges require a shift towards structured and proactive risk management approaches that begin at the earliest stages of design. In this context, the application of PtD during the planning stage of construction not only involves design-based strategies but also the integration of PtD into legislation, including relevant laws, regulations and guidelines (Samsudin et al., 2023).

RESEARCH METHODOLOGY

This study adopted a qualitative research approach, which allowed for an in-depth exploration of OSH instruments adopted in the Malaysian construction sector particularly in relation to their alignment with PtD principles. The research process was guided by well-defined objectives and research questions aimed at understanding the extent to which current OSH instruments promote proactive design-stage safety planning.

To facilitate a comprehensive content analysis, data were sourced from both academic databases and official institutional websites. Specifically, Scopus, Web of Science and Google Scholar were utilized to retrieve peer-reviewed journal articles relevant to PtD frameworks, safety by design strategies, and international OSH practices. These databases were selected due to their broad coverage of reputable, indexed literature, and their advanced filtering capabilities. In parallel, a document search was conducted through the official institutional websites of the Department of Occupational Safety and Health (DOSH) (www.dosh.gov.my) and the Construction Industry Development Board (CIDB) (www.cidb.gov.my). These agencies were selected due to their credibility, regulatory authority, and established roles in OSH enforcement and promoting safety standards in Malaysia's construction sector. The search was conducted between January and April 2024, covering all publicly accessible guidelines, technical standards, management tools, and regulations relevant to construction safety.

A keyword-based search strategy was applied to identify relevant instruments. Keywords included: "OSH tools," "risk assessment tools," "safety guidelines," "construction safety," "OSH management," "design safety," and "Prevention through Design". Other search keywords were focused on the "Guidelines", "Publications," "OSH Management Systems," "Legislation,". The inclusion criteria required that materials be directly related to OSH practices in the construction sector and provide actionable insights for hazard prevention, risk minimization, or regulatory compliance. All identified documents were compiled into a structured database. For each item, metadata were recorded, including the document title, issuing agency, publication year, purpose and scope, target users, and relevance to PtD or other design-stage interventions. The instruments were then categorized and analyzed to evaluate their applicability to safety management in construction projects.

The next phase involved a focused content analysis to determine the presence, relevance, and level of integration of PtD concepts across the documents. This included evaluating whether the instruments explicitly or implicitly aligned with the PtD framework introduced in OSHCIM 2017. To aid interpretation, findings were tabulated into a PtD-OSH integration heatmap.

To ensure the credibility of the findings, a validation phase was carried out through expert consultation. This involved a semi-structured review session with one senior officer from DOSH who possessed extensive experience in policy enforcement and two construction safety professionals with over 10 years of field experience in implementing OSH tools in safety design and site management. The experts reviewed the PtD–OSH integration heatmap and thematic summaries and were asked to assess the accuracy of categorization, the relevance of PtD elements, and to identify any missing or unclear items. Their feedback helped improve to refine the classification of instruments and confirm the overall interpretation of PtD integration in the reviewed documents.

ANALYSIS AND DISCUSSION

Prevention through Design Principles and Elements

To evaluate the extent to which Malaysian OSH instruments align with Prevention through Design (PtD) principles, seven (7) core PtD elements were identified from recent scholarly literature as shown in Table 1. These elements serve as the conceptual basis for integrating safety considerations during the design stage of construction project.

Table 1: Element of PtD

ID	PtD Element	Description	Author
PtD1	Hazard Identification at Design Stage	Early detection of potential hazards during conceptual and detailed design to allow proactive risk planning.	Hossain et al. (2023)
PtD2	Risk Elimination or Reduction	Eliminating or reducing risks through safer design choices, materials, and construction methods.	Zhou et al. (2023)
PtD3	Design for Safe Maintenance and Use	Ensuring long-term safety in access, maintenance, and eventual demolition of the structure.	Samsudin et al.(2022)
PtD4	Stakeholder Collaboration	Integrating input from clients, designers, engineers, and contractors to ensure coordinated safety decisions.	Che Ibrahim et al.,(2021)
PtD5	Lifecycle Safety Consideration	Addressing OSH risks across all stages from construction to use and eventual decommissioning.	Jin et al. (2023)
PtD6	Compliance with Legal and Industry Standards	Aligning designs with applicable OSH legislation such as OSHCIM, OSHA 1994, or CDM regulations.	(Him et al., 2023)
PtD7	Documentation and Communication of Safety Risks	Recording safety measures and residual risks in project documentation for contractor awareness.	(DOSH, 2017)

OSH Instruments regulated by the DOSH

Table 2 shows the eleven (11) OSH instruments in the form of documents which has been published and regulated by DOSH. Those documents categorized under Building Construction and Engineering Work, include eight (8) guidelines (D1, D2, D3, D4, D6, D7, D8, D10) and three (3) supplementary resources (D5, D9, D11) such as best practice manuals and spreadsheet-based calculation tools. All documents were in English, except for D10, which was published in Malay. These instruments were developed in alignment with the Occupational Safety and Health Act (OSHA) 1994 which aim to enhance safety compliance, reduce accident rates, and instil a culture of proactive risk management in the Malaysian construction industry. For example, the Guidelines for the Prevention of Falls at Workplaces (2007)-D3, were published in response to alarming fatality rates involving falls from height, which accounted for 51.97% of 229 fatal cases between 1996 and 2005 (Murty et al., 2006). This document guides employers, particularly contractors, on designing and implementing fall prevention strategies at the design stage. Nevertheless, despite the availability of such resources, fatal injuries particularly among foreign workers remain frequent, with primary causes linked to falls, being struck by objects, and unsafe worker actions (Rafindadi et al., 2022). These findings suggest a gap between guideline availability and effective on-site implementation, often influenced by factors such as cost constraints, job complexity, lack of protective measures, and pressure to meet deadlines (Hamid et al., 2019).

Table 2: Documents published by DOSH

ID	Name of Documents	Year	Summary of Content
D1	Guidelines on Occupational Safety and Health in Tunnel Construction	1998	Outlines safety procedures in tunnel construction, focusing on ventilation, emergency preparedness, and confined space safety.
D2	Guidelines on Trenching for Construction Safety	2000	Details trenching hazards and control measures such as shoring and soil stability assessment to prevent collapses.
D3	Guidelines for the Prevention of Falls at Workplaces	2007	Presents fall prevention strategies, including PPE use, safe access routes, and risk management for work at height.
D4	Guidelines for Public Safety and Health at Construction Sites	2007	Covers site control measures for public protection, including barriers, signage, and hazard communication.
D5	Calculation Loading of Scaffolding	2016	Provides methods for calculating scaffold loading to ensure structural safety during construction.
D6	Guidelines for Approval of Design Scaffolding	2016	Specifies submission and approval procedures for safe scaffold design in line with regulatory requirements.

Herda Balqis Ismail, Noor Nabilah Sarbini, Hamizah Liyana Tajul Ariffin, Mohd Fairuz Ab Rahman, Mohd Syamir Senin
Evaluating The Occupational Safety and Health Instruments for Prevention Through Design Implementation in Malaysian Construction

ID	Name of Documents	Year	Summary of Content
D7	Guidelines of Occupational Safety and Health in Construction Industry (Management)	2017	Introduces PtD principles and stakeholder responsibilities for safety planning and OSH management.
D8	Guidelines of Occupational Safety and Health in Construction Industry (Excavation Work)	2017	Focuses on excavation safety, including hazard identification, control strategies, and protective systems.
D9	Best Practices on Occupational Safety and Health in Construction Industry	2019	Compiles effective OSH practices in construction, emphasizing continuous improvement and leadership commitment.
D10	<i>Garis Panduan Keselamatan dan Kesihatan Pekerjaan Industri Pembinaan (Pengurusan)</i>	2020	Malay-language OSH management guideline mirroring OSHCIM principles for local implementation.
D11	Guidance on Safe Use of Mobile Access Tower	2023	Details safe use procedures for mobile access towers, focusing on stability, assembly, and fall protection.

Source: (DOSH, 2024)

Additionally, the Hazard Identification, Risk Assessment and Risk Control (HIRARC) model is one of key framework published by DOSH. HIRARC enables the systematic identification and evaluation of workplace hazards based on their likelihood and severity. It supports risk mitigation strategies consistent with PtD principles and fulfils the legal obligation under OSHA 1994, which mandates employers to provide a safe working environment. The application of HIRARC encourages structured planning, early hazard recognition, and the prioritization of controlling key components of effective design-stage safety integration. The HIRARC model is a general guideline that been referred and adopted by all sectors including construction.

OSH Instruments based on CIDB

Out of thirty (30) Construction Industry Standards (CIS) published by the Construction Industry Development Board (CIDB) which covering diverse construction aspects and processes, a total of fifteen (15) CIS covered on the design, safety and health aspects as shown in Table 3. Mainly, these standards were published in English languages to ensure uniformity in construction practices and establish measurable benchmarks across the industry.

Table 3: CIS in relation to improve OSH practices

CIS	Title	Year	Summary of Content
CIS 8	Design Guide on Precast Concrete Hollow Core Slab	2007	Guidelines for the design and application of hollow core precast concrete slabs in building construction.
CIS 9	Guidelines On Handling, Transportation, Stacking and Installation of Precast Concrete Components	2023	Standards for safe handling, stacking, and installation of precast elements to avoid structural damage and ensure safety.
CIS 10	Safety And Health Assessment System in Construction (SHASSIC)	2020	A tool to assess contractors' safety and health performance through documentation, site inspection, and interviews.
CIS 11	Design Guide on Precast Concrete Frame with Moment Connection	2008	Design procedures for structural precast concrete frames with moment-resisting connections.
CIS 13	Guidelines On Handling, Transportation, Stacking and Installation of Structural Steel	2023	Procedures for handling and installing structural steel to ensure safe assembly and site practices.
CIS 14	Guidelines On Construction Works at Night	2019	Safety measures for night construction, including lighting, noise management, and worker visibility.
CIS 15	Guidelines On Prevention of Fall at Construction Site	2019	Prescribes fall protection systems, work-at-height protocols, and hazard control strategies.
CIS 16	Guidelines For Works at Confined Space in Construction Site	2019	Instructions for confined space entry, including air monitoring, permits, and emergency procedures.
CIS 17	Guidelines For Working at Noisy and Dusty Areas in Construction Site	2010	Health protection measures against excessive noise and dust, with emphasis on PPE and control systems.
CIS 22	Product Conformity for Used Scaffolding in Construction	2023	Criteria for evaluating and certifying the safety compliance of reused scaffolding equipment.
CIS 23	Product Conformity for Falsework in Construction	2023	Standards for the design, material, and reuse of falsework systems in construction.
CIS 24	Industrialised Building System (IBS) Assessment & Certification	2023	Provides assessment metrics for IBS adoption, supporting industrialised construction practices.
CIS 25	Construction Activities Risk Assessment (CARA) Hazard Identification, Risk Analysis and Risk Control (HIRARC)	2018	Framework for hazard identification, risk assessment, and risk control in construction activities.
CIS 27	Occupational Safety and Health – Specification & Bill of Quantities (BQ) for Construction Works	2019	Guidance on including OSH specifications in tender documents and bills of quantities.
CIS 28	Public & Road User Safety – Construction Works Adjacent to and Above Roadways	2021	Guidelines for protecting public and road users during nearby or overhead construction works.

Source: (CIDB, 2023)

Additionally, CIDB advocates the adoption of Building Information Modelling (BIM), an innovative digital tool that enhances collaboration and hazard identification during the design phase. BIM supports key safety functionalities such as visualization, simulation, and clash detection, enabling designers to integrate safety solutions into the project lifecycle. BIM's role in improving safety planning, inspections, and communication is well documented (Yap et al., 2023), with evidence suggesting it can significantly reduce workplace incidents and fatalities.

Integrating PtD Elements in the OSH Instruments

An extended content analysis was conducted to evaluate the existent of Prevention through Design (PtD) principles which are embedded and aligned with the OSH instruments identified in this study. The analysis focused on four (4) main instruments: DOSH-published guidelines, CIDB-published Construction Industry Standards (CIS), the HIRARC framework, and Building Information Modelling (BIM).

The DOSH-published guidelines targeted safety measures and procedures that align with PtD principles. These documents guide practitioners in conducting risk assessments, planning safe work environments, and documenting safety procedures. Although CIDB-published CIS do not explicitly mention the PtD principles, the detailed work methods and preventive measures encourage practitioners to incorporate safety considerations into the planning and execution phases. Overall, the DOSH-published guidelines emphasize continuous improvement in safety practices, reflecting the foundational principles of PtD. Similar to the CIDB-published CIS documents which complement the OSHCIM guideline by offering technical specifications for safe construction practices, thus reinforcing the importance of early-stage safety planning. Together, the DOSH-published guideline or CIDB-published CIS and OSHCIM may form a comprehensive structure that promotes PtD-aligned practices across various project stages.

Meanwhile, the HIRARC framework shows its strong alignment with PtD principles by emphasizing hazard identification and risk control during the early stages of project planning. The framework recommends hazard reviews during three key stages: concept design, detailed design and maintenance, and pre-construction planning. These stages mirror the PtD model that required in the OSHCIM guidelines which promotes hazard elimination through thoughtful design solutions.

Among the reviewed OSH instruments, BIM demonstrates the highest potential for operationalizing PtD in the construction industry. BIM facilitates hazard identification and communication, safety planning, and design simulation

through 3D modelling and digital collaboration tools. These features enable stakeholders to embed safety information throughout the design and construction lifecycle and site inspections (Yap et al., 2023). In addition, Zulkifli et al. (2021) and Rodrigues et al. (2018) confirm BIM's usefulness as a Design for Safety (DfS) tool aligned with PtD principles. Despite its potential, the widespread use of BIM in Malaysia faces several challenges, including high implementation costs, limited awareness, lack of standardized training, and weak regulatory support (Taata et al., 2022). The adoption of BIM technology for site safety management in the construction industry also remains relatively low (Li Ting & Yahaya, 2024).

Overall, the combination of technical guidelines, assessment tools, and digital innovations provides a strong foundation for integrating PtD into Malaysian construction practices. In addition, management commitment plays a crucial role in shaping a positive safety culture among industry stakeholders (Him et al., 2023). To enhance pattern recognition, a heatmap was generated to visualize the extent of alignment between PtD elements and each OSH instrument as shown in Figure 1. This allowed for the identification of instruments with the strongest coverage of PtD principles, particularly within DOSH-published guidelines and CIDB-published Construction Industry Standards (CIS).

Instrument		Prevention through Design Elements						
		PtD 1	PtD 2	PtD 3	PtD 4	PtD 5	PtD 6	PtD 7
DOSH	D1	1	0	0	1	0	0	1
	D2	1	1	0	1	1	0	0
	D3	1	0	1	1	0	0	1
	D4	1	0	1	1	1	0	1
	D5	1	1	0	1	0	0	1
	D6	0	1	0	1	1	1	1
	D7	1	1	1	0	1	1	1
	D8	1	0	1	1	1	1	0
	D9	0	1	0	0	1	1	0
	D10	1	1	1	1	0	0	0
	D11	1	1	0	1	0	0	1
	HIRARC	1	0	0	0	1	0	1
CIDB	CIS 8	1	0	1	1	0	1	0
	CIS 9	1	0	1	1	1	1	0
	CIS 10	0	1	1	0	0	0	1
	CIS 11	1	1	0	1	1	0	1
	CIS 13	0	0	1	0	0	0	1
	CIS 14	0	1	0	1	0	1	0
	CIS 15	1	0	1	1	0	1	0
	CIS 16	1	0	1	0	0	0	1

Instrument	Prevention through Design Elements						
	PtD 1	PtD 2	PtD 3	PtD 4	PtD 5	PtD 6	PtD 7
CIS 17	0	1	1	0	1	1	1
CIS 22	1	1	0	1	1	0	1
CIS 23	1	0	0	0	1	1	1
CIS 24	1	0	1	0	0	1	0
CIS 25	0	1	1	1	1	0	0
CIS 27	1	1	1	0	1	0	1
CIS 28	1	0	0	1	0	1	1
BIM	1	1	1	1	1	0	1

Figure 1: Integration of PtD elements and OSH instruments
 Color intensity reflects the degree of alignment with PtD elements
 (0 = none, 1 = partial - strong)

Additionally, based on the analysis, four (4) CISs have been identified as tools for monitoring safety aspects and performance assessment namely CIS10, CIS22, CIS23 and CIS24. For example, CIS10, known as the Safety and Health Assessment System in Construction (SHASSIC), primarily evaluates contractor performance during the construction phase. While it does not fully align with the design-focused principles of PtD, SHASSIC contributes to an overarching safety framework by promoting continuous safety monitoring and performance evaluation throughout project implementation. Furthermore, Abas et al. (2020) emphasize that although SHASSIC offers limited integration at the design stage, it remains a valuable tool for reinforcing organizational safety practices. In contrast, CIS22 and C23 focuses on the safety compliance and conformity of reused scaffolding equipment and falsework, ensuring its integrity and safe application on-site. Meanwhile, CIS24 provides a structured assessment framework for evaluating the adoption and implementation of the Industrialised Building System (IBS) in construction projects, which indirectly supports risk minimization through prefabrication and off-site construction practices.

Category of OSH Instruments

The OSH instruments identified from DOSH and CIDB are grouped into three main categories based on their purpose and format: technical documents, assessment tools, and digital tools. Technical documents such as guidelines, regulations, and procedures which serve as key references to ensure compliance and manage risks during both the planning and execution stages of construction. This category includes most of DOSH-published guidelines and CIDB-published Construction Industry Standards. Assessment tools, like the HIRARC framework, help identify and control risks in a structured way to improve safety performance. CIDB has also developed tools such as SHASSIC to enhance site safety practices. Digital tools, particularly Building Information Modelling

(BIM), support safety planning, hazard visualization, and collaboration during the design stage, aligning well with PtD principles. Overall, DOSH focuses mainly on technical and assessment tools, while CIDB contributes through both conventional standards and digital innovations. This categorization provides a clear view of how these instruments can be integrated to support effective safety management from design to construction.

CONCLUSIONS

This study has explored and categorized the Occupational Safety and Health (OSH) instruments developed by the Department of Occupational Safety and Health (DOSH) and the Construction Industry Development Board (CIDB), with a particular focus on their alignment with Prevention through Design (PtD) principles as outlined in the OSHCIM 2017 guideline. Malaysia's construction sector is supported by a range of instruments, including technical guidelines, risk assessment frameworks, and digital tools such as Building Information Modelling (BIM). While the explicit integration of PtD within these instruments remains limited and inconsistent, core PtD elements were identified in several key tools namely the Construction Industry Standards (CIS), the HIRARC framework, and BIM. These instruments demonstrate a foundational alignment with PtD principles, particularly in relation to early hazard identification and proactive risk planning.

The study's findings indicate that although current instruments are not formally structured around PtD, they exhibit the potential to support its adoption. For example, BIM is increasingly recognised as a digital tool that facilitates early hazard detection through 3D visualization, enabling design teams to foresee and mitigate safety risks during the planning stage. Similarly, HIRARC provides a structured and systematic approach to hazard recognition and risk control which aligns well with the proactive ethos of PtD by promoting risk elimination before construction activities begin. By mapping this alignment, the study contributes to a clearer understanding of how existing OSH instruments may serve as a basis for strengthening design-stage safety practices. Further efforts such as formal guidance, regulatory reinforcement, and enhanced collaboration between DOSH and CIDB can help advance the integration of PtD and support the development of a more preventive safety culture in Malaysia's construction industry.

ADDITIONAL INFORMATION

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