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博士の専攻分野の名称 博士（工学） 氏名 LABADAN Rimmon Salvacion

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A Study on a Building Information Modeling-based Process Design to Facilitate Prevention Through Design for Improving Safety Management in Philippines

(設計段階での予防促進による安全管理の高度化を可能とするビルディング・インフォメーション・モデリングのフィリピンでの導入要件に関する研究)

Working within the construction site environment is synonymous with heightened exposure to occupational hazards, making it an inherently high-risk profession. Despite the Architecture, Engineering, and Construction (AEC) sector's aspirations to create accident-free work environments, the realization of this idea remains elusive. Extensive research has sought to dissect these accidents, pinpoint their root causes, and develop strategies to prevent their recurrence. Empirical research has substantiated a correlation between various design elements and the construction process, identifying them as significant factors contributing to the incidence of accidents in the industry. Improvements to the design may have reduced the accident risk level based on the cases evaluated. This recognition resulted in the development of an innovative safety management called Prevention Through Design (PTD).

PTD is an innovative concept that has been gaining momentum in the construction industry, primarily due to its promising potential in reducing construction-related accidents. However, the widespread adoption and implementation of PTD have encountered significant challenges within the industry. Research has pointed out that barriers to adopting PTD were a lack of construction safety knowledge, unavailability of analysis tools, cost incentives, the complexity of industry structure, and fear of liabilities. The absence of adequate tools for designers has pinpointed one of the critical obstacles to adopting PTD practices, and one of the potential avenues for intervention is to harness the capabilities of existing Building Information Modeling (BIM) technologies. Research stressed that equipping designers with computational and analytical tools can enable the successful implementation of PTD. Thus, a BIM-based approach to PTD adoption was explored to see how it may intervene in PTD adoption and provide empirical evidence to support such an argument.

The study was divided into three distinct phases, each aligned with a specific objective. First, the study comprehensively assessed the current level of awareness and comprehension of the PTD concept among structural designers in the Philippines. This preliminary investigation was a foundational step in gaining insights into the existing knowledge surrounding PTD, which is pivotal for informing subsequent intervention strategies. The results unveiled that, for most structural engineers in the Philippines, PTD was a relatively novel concept. Despite lacking familiarity with PTD, the respondents acknowledged its significance and deemed its implementation essential within the construction industry. In essence, they recognized the value of PTD even though the concept was still in its early period within the country. The first objective, conducted as a preliminary study, also explored the prominent obstacles to implementing PTD. The study revealed that the designer was concerned about

inadequate methods and tools for addressing PTD and promoting construction safety awareness. Thus, the second part of the study aimed to assess the applicability of BIM as a tool for PTD. The second objective was divided into two feasibility studies. In the first feasibility study, the applicability of BIM for PTD was demonstrated by developing a BIM-based PTD tool. Next, the applicability of BIM for PTD was assessed based on the expert's perception. Overall, the study's outcomes have conclusively substantiated the practical viability of employing BIM for PTD. The research outcomes provide concrete evidence of how BIM, through its advanced functionalities, can effectively contribute to integrating safety considerations throughout the various phases of construction projects, thereby affirming its applicability in promoting a proactive and safety-conscious construction environment.

Thirdly, the study aimed to examine the idea of BIM-based PTD from the perspective of its adoption by gathering insights from a broader range of participants. The third objective explored socio-technical factors that may impact the adoption of BIM for PTD. A theoretical model was developed by extending the Technology Acceptance Model (TAM). The Structural Equation Modelling (SEM) analysis substantiated the model's components. This research examined the causal impacts of each element based on data collected from 131 respondents who were structural designers in the Philippines. Results showed that the perceived usefulness and the relative advantage of BIM for PTD were determined to influence the behavioral intention of designers to adopt PTD directly. However, the perceived benefit and the perceived ease of use of BIM for PTD indirectly affect the designer's intent to adopt PTD. The study's findings supported most hypothesized causal pathways that led to behavioral intention to adopt PTD. As an exploratory effort to empirically model the adoption of BIM-based PTD through integrating the qualities of BIM for PTD, this study contributes to a deepened understanding of how designers may interact with BIM to implement such innovative technology for PTD.

In summary, this research has expounded on the instrumental attributes of BIM that facilitate the integration and adoption of PTD principles within the construction industry. The insights derived from this study hold the potential to serve as a valuable resource for the construction sector, offering innovative ideas on harnessing the capabilities of BIM to realize proactive construction safety analyses, particularly among design engineers during the crucial design phase. The research output explains the transformative potential of BIM in enhancing safety protocols. It provides practical suggestions for leveraging this technology to advance the industry's collective commitment to construction safety.