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Article

Roles and Autonomous Motivation of Safety Officers: The Context of Construction Sites

Kritsada Khun-anod [1,*], Tsunemi Watanabe [2] and Satoshi Tsuchiya [3]

[1] Graduate School of Engineering, Kochi University of Technology, Tosayamada, Kami City 782-8502, Japan
[2] Faculty of Society and Design, Bond University, Gold Coast, QLD 4226, Australia; twatanab@bond.edu.au
[3] School of Economics and Management, Kochi University of Technology, 2-22 Eikokuji, Kochi City 780-8515, Japan; tsuchiya.satoshi@kochi-tech.ac.jp
* Correspondence: 256006k@gs.kochi-tech.ac.jp

Abstract: Safety officers have been underlined as key individuals in the implementation of safety programmes at construction sites. However, previous research mentioned that some project managers predominantly focus on other aspects, such as the productivity of construction and the management of time and cost. Such emphases may potentially demotivate safety officers from fully engaging in safety initiatives for construction projects. Moreover, scholars have devoted piecemeal discussions to the motivation of such practitioners. These problems were addressed in the current work through the development of a conceptual paradigm that captures the actual situation between project managers and safety officers. To this end, four constructs were extensively examined: (1) autonomy-oriented support from project managers; (2) the motivation of safety officers; (3) the engagement of safety officers in safety programmes (covering four major categories of safety-related tasks); and (4) safety performance. From August to September 2022, valid data from 195 safety officers working in construction projects were considered, after which the proposed paradigm was analysed via structural equation modelling. The results showed that the autonomous motivation of safety officers was activated by autonomy-oriented support from project managers (β = 0.520, sig. = 0.000). Such motivation significantly affected their safety performance (β = 0.231, sig. = 0.007) and levels of engagement with safety initiatives (β = 0.529, sig. = 0.000). These findings indicate that in the implementation of safety programmes, the autonomous motivation of safety officers serves as the engine, while autonomy-oriented support from project managers functions as the ignition key. Policymakers in construction companies can use the results as a reference for decision-making on initiating safety policy that highlights methods of training project managers in supporting safety officers.

Keywords: autonomous motivation; self-determination theory; safety management; safety performance; structural equation modelling

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1. Introduction

The implementation of safety programmes in the construction industry has improved to some extent over the last few decades, but it continues to rank the lowest among all sectors in terms of safety performance. For example, the US construction industry revealed that accidents among construction practitioners have gradually increased since 2016. A report released by the Bureau of Labour Statistics indicated that the industry was plagued with a nearly 50% incidence of fatal occupational injuries from 2016 to 2018, earning it a place alongside agriculture, mining, and manufacturing as one of the riskiest workplaces in commerce [1]. These problems occur equally in Asia, with the Chinese construction industry accounting for 35% of work-related incidents in 2015 [2] and the Thai construction industry accounting for the highest number of accidents among 131 industries from 2001 to 2011 [3]. In Thailand as well, the construction industry accounted for the highest rate of injury and illness (26.40%) among the most dangerous sectors in the country in 2016, according to the Social Security Office's historical data on occupational injury and illness [4].

To resolve the abovementioned issues, researchers have proposed essential strategies for helping stakeholders enhance safety performance in construction projects [5–16], such as cultivating sufficient commitment among management, providing safety training, and setting clear safety goals. Many analyses have also been conducted on success and failure factors, that is, what should and should not be done. However, limited research has focused on the individuals responsible for supporting these success factors to ensure the effective management of construction safety. An important challenge in addressing the 'who' and 'how' of construction safety appears to be the disparity between espoused values and the assumptions that characterise the culture of construction organisations [17]. Another problem is that the stakeholders of construction projects sometimes operate without a uniform agreement on site safety responsibilities [18]. Furthermore, although the slogan 'safety first' is commonly heard on construction sites, its practical implementation is often denied the emphasis that it deserves, with many project managers predominantly concentrating on matters such as construction productivity. This predilection leads to the occasional oversight of safety programmes.

The difficulties described above are poised to be resolved by safety officers, who are one of the primary stakeholders in construction initiatives. Their integral role in the execution of safety programmes, which are crucial to project success, was emphasised in [5]. This research suggested that safety officers have the opportunity to influence the various dimensions constituting the quality of safety programmes, including, but not limited to, empowering workers to safely perform construction activities, clearly communicating safety concerns to involved parties, and continuously monitoring the performance metrics of safety initiatives [5]. Nevertheless, the aforementioned propensity to prioritise facets such as construction productivity gives rise to the potential to inadvertently demotivate safety officers from wholeheartedly pursuing safety.

In a study that underscored the essentiality of autonomous motivation among safety officers involved in construction projects [19], the researchers differentiated these professionals based on their motivational profiles. The authors found that highly motivated practitioners consistently manifest a substantially greater degree of organisational commitment than their counterparts [19]. However, research focusing on both the contributions of safety officers and their autonomous motivation has been fragmented. Thus, there is an exigent need for a comprehensive consideration of the contributions of safety officers to construction safety management. Specifically, the issues that remain inadequately examined are as follows:

(1) The contributions of safety officers to safety performance at construction sites;
(2) The motivation of safety officers to ensure safety in these workplaces and its influencing factors;
(3) The interrelationship between items 1 and 2.

With regard to item 1, because safety officers are responsible for carrying out various tasks related to safety, it is necessary to collectively and exhaustively describe such duties, but accurately representing safety performance at construction sites remains challenging. Moreover, enquiring into the strengths and limitations of previous analyses and proposing new methods by which to improve existing safety approaches necessitate the consideration of various related aspects. As for item 2, noteworthy issues include autonomous motivation and support for autonomy from project managers. Additionally, well-educated safety officers are required to work diligently in challenging situations. On these bases, two hypotheses can be put forward: safety officers are likely to have high autonomous motivation, and maintaining such motivation requires autonomy support from project managers. With respect to item 3, if the aforementioned hypotheses are valid and the features highlighted therein are contributory to excellent safety performance, then various stakeholders can enjoy the following benefits: increased confidence among safety officers, opportunities to change and refine contractors' perceptions of safety officers, and more effective development and implementation of safety laws and regulations.

In consideration of the matters discussed above, this research developed a novel paradigm that captures the actual situation between project managers and safety officers, as well as the essential roles of the latter and their autonomous motivation. To this end, four constructs were extensively examined: the autonomy-supportive behaviours of project managers, the motivation of safety officers, their levels of engagement in safety initiatives, and safety performance. The proposed paradigm was used to quantitatively explore the issues of interest to satisfy three objectives: (1) to assess the effects of autonomy-oriented support from project managers on the motivation of safety officers and safety performance in the construction industry; (2) to evaluate the impact of safety officers' motivation on engagement in safety-related tasks and safety performance; and (3) to assess the relationship between safety officers' levels of engagement in safety tasks and safety performance. The findings are expected to empirically improve the understanding of safety officers' autonomous motivation in the safety programmes currently implemented in the construction industry. They can also help company management and project managers formulate strategies for enhancing safety performance by superseding conventional views in favour of a new approach: developing an environment in which safety officers can work with a tremendous sense of value, responsibility, and enjoyment instead of having their activities constrained.

2. Hypothesis Development

2.1. Self-Determination Theory (SDT)

SDT is a broad meta-theory maintaining that humans possess three types of motivation: amotivation (lack of motivation), controlled motivation, and autonomous motivation [20]. Individuals with high amotivation lack the drive to perform or engage in activities. People with controlled motivation take part in an activity to receive an external reward, avoid punishment, and protect their egos. Autonomously motivated individuals engage in a particular activity because of their interest in it and their perception of its importance.

2.2. Basic Psychological Needs

The theory of basic psychological needs states that human beings have three fundamental psychological requirements [21] to live in society: autonomy, competence, and relatedness. Autonomy concerns perceived feelings of volition, congruence, and integration, which enhance a person's sense of independence. Competence pertains to the desire of individuals to recognise that they can capably engage in a given activity, and relatedness refers to a person's perception of social connection and belonging. Theoretically, fulfilling these needs enhances the autonomous motivation of individuals to participate in a particular activity.

Studies have examined the positive relationship between autonomy-supportive leadership and the autonomous motivation of followers in other contexts, such as child education (e.g., the autonomous motivation to do homework) [22], the sciences (e.g., the participation of students in mathematics homework and the intrinsic motivation of students majoring in agricultural science) [23,24], and the hospitality industry (e.g., the autonomous motivation of employees in international hotel chains in China) [25]. Some researchers have found that support for autonomy, competence, and relatedness is positively associated with introjected regulation (controlled motivation) among elementary school students in Japan [26], while others have reported that amotivation and autonomy-oriented support are negatively related [27]. Assuming that autonomy-oriented support from project managers affects the autonomous motivation of safety officers, we established Hypothesis 1.

Hypothesis 1a: *Autonomy-oriented support positively affects autonomous motivation*.

Hypothesis 1b: *Autonomy-oriented support positively affects controlled motivation.*

Hypothesis 1c: *Autonomy-oriented support negatively affects amotivation.*

Studies have also uncovered that managers with considerable autonomy exhibit excellent information system planning [28] and that support for autonomy from local authorities directly and positively affects the outcomes of a waste separation programme [29]. A similar situation can occur with respect to safety programmes for construction projects, with improved autonomy-oriented support from project managers potentially engendering superior safety performance. On this basis, Hypothesis 2 was formulated.

Hypothesis 2: *Autonomy-oriented support positively affects safety performance*.

Previous research in various domains has confirmed that autonomous motivation significantly affects engagement levels [30–35]. In [19], for example, the researchers probed into the positive impact of autonomous motivation on the engagement levels of safety personnel in construction projects, and in [34], the authors confirmed that construction workers' autonomous motivation significantly affects their levels of engagement in enhancing construction productivity. In the context of chemical factories, the safety motivation of company crews considerably influences their levels of engagement in safety programmes [35], and research on an international airline verified that perceptions of the importance of a safety programme affect levels of participation in and compliance with safety management [30]. In the industrial sector, the autonomous motivation of employees was found to be positively associated with their safety-related behaviours [32]. Finally, researchers have emphasised that the autonomous motivation to participate in health-related activities significantly affects the intentions and behaviours of individuals [31].

From a conventional view, the literature has reflected a positive association between controlled motivation and intention with regard to other issues, such as the intention of managers in medium-sized manufacturing companies to use computers [36] and the prediction of workaholic behaviours [37]. Conversely, amotivation negatively affects levels of engagement [27,37]. Correspondingly, under the assumption that the motivation of safety officers affects their levels of engagement in cultivating the conditions conducive to the implementation of safety programmes, Hypothesis 3 was established.

Hypothesis 3a: *The autonomous motivation of safety officers positively affects their levels of engagement in cultivating the conditions conducive to safety programme implementation.*

Hypothesis 3b: *The controlled motivation of safety officers positively affects their levels of engagement in cultivating the conditions conducive to safety programme implementation.*

Hypothesis 3c: *Amotivation among safety officers negatively affects their levels of engagement in cultivating the conditions conducive to safety programme implementation.*

Studies have identified a positive link between motivation and outcomes in different fields. An example is research on educational institutions, which has emphasised that enhancing the motivation of employees has become one of the top priorities in ensuring successful institutional performance [38]. Scholars have suggested that autonomous motivation among undergraduate students is essential to achieving a desirable grade point average [39]. Other researchers have discovered that identified regulation (a type of autonomous motivation) significantly affects construction labour productivity [40] and that the greater autonomous motivation of villagers to cooperate in a waste separation programme leads to enhanced waste separation weights [29]. Investigations have also reported that external and introjected types of regulation (types of controlled motivation) drive construction productivity but that considerable amotivation diminishes it [40]. The insights from the studies discussed here imply a positive relationship between safety officers' autonomous and controlled motivation and safety performance and a negative relationship between their amotivation and safety performance.

Meanwhile, limited discussions have been devoted to the direct effects of motivation on outcomes. Of the few studies conducted in this respect, that of Tam et al. [34] documented the effects of workers' autonomous motivation on construction productivity and worker engagement. As discussed in Section 2.3, the activities carried out by safety officers were identified on the basis of a literature review and represented in safety officers' engagement. However, safety officers may engage in tasks other than those identified in the succeeding section, which can uncover the direct impact of motivation on safety performance. This possibility was therefore investigated on the grounds of Hypothesis 4.

Hypothesis 4a: *Autonomous motivation positively affects safety performance.*

Hypothesis 4b: *Controlled motivation positively affects safety performance.*

Hypothesis 4c: *Amotivation negatively affects safety performance.*

2.3. Influencing Factors in Safety Management

A literature review was conducted to identify factors that can affect the implementation of safety programmes in construction projects. Such identification can facilitate safety performance improvement by reducing accidents and promoting a positive safety culture. Researchers have examined five insufficiently pursued measures that affect safety performance in the Chinese construction industry [15]. These measures are safety awareness among top management, sufficient training, safety awareness among project managers, the accumulation of adequate resources, and careful operation. Scholars have also pinpointed four categories of factors for safety programme management at construction sites [7]: worker involvement, safety prevention and control systems, safety arrangement, and management commitment. In the Saudi Arabian context, seven such crucial factors have been explored: management support, clear and reasonable goals, personal attitudes, teamwork, effective enforcement schemes, safety training, and suitable supervision. A study determined safety management commitment, subcontractor and personnel selection, safety supervisors, safety plans, employee involvement, and safety evaluation as significant safety-related factors [9], while another delved into management commitment, worksite analysis, hazard and prevention control, and health and safety training as four important constructs linked to safety programmes [10]. On the grounds of the literature review, we selected 19 potential influencing factors as the foundation for the development of the conceptual paradigm presented in Table 1. Given the scope of these factors, previous studies organised them into four categories [7,8]. Those relevant to and adopted in the current work are (1) worker involvement, (2) safety prevention and control systems, (3) safety arrangement, and (4) safety commitment [7] (Table 1).

The first category, worker involvement, focuses on the encouragement of workers to participate in safety programmes [7]. It comprises continuing participation among construction workers, worker motivation, positive group norms, and personal attitudes [7]. In this category, Al Haadir and Panuwatwanich added safety meetings [8]. The final composition in the present study thus encompassed five factors that represent how well workers are involved in safety endeavours. The next category, safety prevention and control systems, emphasises managing the quality of safety programmes and safety regulations. It covers eight factors: programme evaluation, personal competence, enforcement schemes, safety equipment acquisition and maintenance, effective supervision, safety education and training, safety promotion policy, and safety knowledge [7,41]. The third category, safety arrangement, pertains to the positioning and organisation of resources through effective communication. Three factors are grouped under this category: communication, delegation of authority and responsibility, and sufficient resource allocation [7,8]. The final category, safety commitment, highlights the ambition and determination to achieve safety goals, and it incorporates three factors: management support, teamwork, and clear and realistic goals [7,8].

2.4. Safety Officers' Contributions to Cultivating Conditions Conducive to Safety Programme Implementation

In a construction project, safety officers are responsible for promoting safety-related activities, which include, but are not limited to, establishing safety measures, enforcing safety policies to lessen the risk of accidents, and responding to workers' safety concerns [42,43]. Such professionals are therefore tasked with contributing to the cultivation of the conditions (i.e., the influencing factors) presented in Section 2.3. Assuming that these conditions collectively and exhaustively cover all the necessary tasks of safety officers, Table 1 presents how these practitioners can leverage such conditions to guarantee safety on construction sites.

While safety officers contribute to a variety of aspects of safety programmes, project managers are supposed to encourage safety officers as they manage safety programmes. This entails activities such as supporting safety officers in fostering a decent safety climate at a construction site, allocating sufficient budgets to safety programmes, and supporting safety officers in delivering essential messages to involved individuals.

Table 1. Engagement of safety officers in cultivating conditions conducive to safety programme implementation (influential factors).

Conditions (Factors)		References	Engagement Details
1. Worker involvement	Continuing participation of workers	[5,7,8,41,44,45]	Safety officers obtain feedback from workers to help improve safety programmes. Constructive criticism from construction workers should be taken into consideration to determine ways to enhance safety performance.
	Personal motivation	[7,8,35,45]	Safety officers increase the motivation of workers in different ways, such as by providing them with an opportunity to express their opinions, arranging celebrations after a successful safety programme, and encouraging construction workers to report unsafe behaviours.
	Group norms	[7]	Safety officers focus on the following aspects: positively encouraging open communication as a platform for everyone to criticise the implementation of safety programmes; and educating construction workers on safety. The modification of this statement is expected to fortify the establishment of an exemplary group norm.
	Personal attitudes	[5,7,8]	Safety officers highlight the importance of safety and health issues to increase awareness of safety, encourage workers to obey safety regulations, and motivate them to update their knowledge. This initiative is anticipated to positively influence the cultivation of favourable attitudes among workers concerning safety.
	Safety meetings	[8,15,45]	Safety officers are responsible for arranging regular safety meetings. They also attend these meetings and encourage construction workers to participate during these sessions.

Table 1. *Cont.*

Conditions (Factors)		References	Engagement Details
2. Safety prevention and control systems	Programme evaluation	[5,7,8,45,46]	During the construction phase, safety officers are responsible mainly for tracking the progress of safety programmes. They arrange regular safety evaluations to identify sensitive aspects, track improvement in relation to these aspects, and analyse safety progress against safety plans.
	Personal competence	[7,8]	Safety officers encourage either site engineers or foremen to support construction workers in several aspects, such as assigning suitable construction activities and ensuring that these activities suit workers.
	Enforcement schemes	[7,8,35,46]	Safety officers regularly establish safety measures for a construction site, such as punishment for violating safety rules and procedures for using safety equipment. The direction of safety programmes should be well established by safety officers as the threshold for implementing safety programmes.
	Safety equipment acquisition and maintenance	[7,8,44–47]	Safety officers provide safety equipment, such as protective helmets, eyewear, ear plugs, dust masks, protective boots, safety gloves, and high-visibility clothing. They ensure the quality of such equipment. This enables construction workers to implement their tasks with a certain level of safety.
	Appropriate supervision	[7,8]	At construction sites, safety officers encourage safety behaviours among either site engineers or foremen. These include encouraging them to obey the same safety regulations, providing site engineers/foremen with beneficial information to support construction workers, and encouraging site engineers/foremen to establish appropriate examples of safety-related practices.
	Appropriate safety education and training	[5,7,8,35,44–46]	Safety officers mainly provide safety training to construction workers. New construction workers should be prepared through adequate training classes to develop their fundamental knowledge of safely implementing construction-related activities.
	Safety promotion policy	[35,44]	Safety officers determine ways to promote safety programmes, such as arranging celebrations of successful safety initiatives or other safety promotional activities to establish awareness of safety and provide construction workers with appropriate rewards when safety programmes are well implemented.
	Safety knowledge	[35]	During site inspections, safety officers can educate workers about some cautionary processes to be noted. They can encourage workers to update regulations, standard work procedures, and emerging instructions on how to use equipment.
3. Safety arrangement	Communication	[5,7,8,44,47]	Safety officers encourage communication at construction sites in several ways, such as conveying major concerns regarding safety-related practices and regularly encouraging open exchange.
	Delegation of authority and responsibility	[7,8,44,45]	Sufficient authority contributes to increased safety performance at construction sites. Thus, safety officers can assist in allocating sufficient safety staff tasked with inspecting construction sites and emphasising sensitive work areas.
	Sufficient resource allocation	[7,8]	Safety officers can encourage site engineers/foremen to provide workers with adequate resources. They can encourage assigning an appropriate number of workers to a specific task, providing sufficient and well-conditioned machines, and allocating sufficient time to practice.

Table 1. *Cont.*

	Conditions (Factors)	References	Engagement Details
4. Management commitment	Clear and realistic goals	[7,8,44]	Safety officers can determine safety goals, which include, but are not limited to, minimising accidents and providing construction workers with a safe work environment.
	Management support	[7,8,44,45,47]	Safety officers can support construction workers in different ways, such as by regularly inspecting construction sites and enthusiastically following the same safety regulations.
	Teamwork	[7,8]	Safety officers are the key contributors to teamwork in safety programmes. They address coping with safety-related issues and communicate that safety programmes require intensive involvement from all parties.

2.5. Influence of Engagement on Safety Performance and Measurement of Performance

2.5.1. Influence of Engagement on Safety Performance

Previous studies demonstrated that greater efforts in implementing safety-related activities can engender better safety performance in construction projects [5,7,8,15,41,44]. Although researchers have identified the effects of such implementation, some have disregarded safety performance indices in their analyses [8,15], while others have used limited samples for data analysis [7,9]. Investigations of the link between safety performance and the effort to engage in safety activities are valuable when both sufficient samples and safety performance indices are covered. Accordingly, we crafted Hypothesis 5.

Hypothesis 5: *The levels of engagement of safety officers in cultivating the conditions conducive to safety programme implementation are positively associated with safety performance.*

2.5.2. Measurement of Safety Performance

Past studies employed diverse indicators to assess safety performance within construction sites, including safety climate, safety orientation, management commitment to safety, near-miss events, job site audits, and accident occurrences. Notably, a perspective revolving around safety climate offers comprehensive coverage of multiple aspects of safety management practices within an organisation [48,49]. Accident occurrence has been widely used worldwide since it is recognised as a fundamental measure of safety performance [7,50,51]. Consistent with these orientations, we used two dimensions of safety performance as indicators: safety climate [45,52–54] and the frequency of construction accidents [45,55,56].

Safety climate is defined as the perception of individuals towards safety policies, safety procedures, and safety practices in the workplace [57]. In other words, it reflects individuals' impressions regarding the safety management efforts exerted by an organisation [45,54]. The safety climate at a construction site has been measured by employing questions based on a Likert scale [49], with the issues addressed including how safety resources are provided in the workplace and the extent to which the company cares about the health and safety of people.

In the present study, the direct employment of safety climate presented a challenge. Safety climate is related to safety officers' engagement in cultivating the conditions conducive to safety programme implementation (Section 2.4): The former stems from the viewpoints of all safety-related parties, whereas the latter derives from the perspectives of safety officers. It is therefore possible to interpret the safety climate as encompassing engagement. Hence, a different performance measure should be identified to prevent an overlap in coverage and potentially inaccurate results.

Construction accidents are the unintentional circumstances that abruptly occur as negative consequences of endeavours to perform construction-related activities. In multiple studies, statistics on construction accidents are used as a safety performance measure. This approach is advantageous in that it lends itself easily to statistical analysis, but it suffers from certain drawbacks. As revealed in an evaluation of statistical records focusing on accidents in construction companies, many cases are undocumented for various reasons [58]. For instance, project managers are afraid that disclosing mishaps might ruin their companies' reputations and call attention to their irresponsibility towards safety. Consultants would enforce stricter on-site safety procedures, which would be excessively extravagant for construction companies. Reporting accidents also disrupts work progress. Construction companies refrain from issuing such reports because of an acceptance among practitioners that construction is a dangerous occupation. Given this reality, safety performance should be cautiously measured because practitioners may be engaged in malpractice, leading to fraudulent information. In some situations, performance indicators (e.g., accident rate, near-miss historical record, and fatality rate) grounded in historical records are difficult to obtain because of confidentiality issues.

In addition to safety climate and construction accidents, satisfaction has been increasingly used as a performance index in the construction industry [59]. The major conception of satisfaction is to measure the difference between how much of something there should be and how much there actually is [59]. The former represents people's expectations, whereas the latter denotes their actual experiences after associated activities have been performed. If an expectation is greater than an actual experience, satisfaction is at an inferior level. Conversely, an actual experience greater than or equal to expectations leads to superior satisfaction. In measuring the success of a construction project, the satisfaction of stakeholders refers to the gratification ensuing from their interactions with other parties [60] as a perceived holistic view of cost, quality, and schedule. Measuring satisfaction has been substantiated as an effective approach to gauging performance in a construction project [59] because it can be used to ascertain the quality of practice and represent inner reality [61].

To improve conventional measurements, we put forward a new method of measuring safety performance. This method has three characteristics: (1) it incorporates the views of three parties: clients, project managers, and safety officers; (2) it entails the evaluation of the parties' views by a safety officer; and (3) it involves the use of satisfaction as a representation of these parties' perspectives.

First, to represent safety performance, the views of clients, project managers, and safety officers were determined. Project success generally means different aspects to different people [60,62]. It is an intangible perceptive feeling that can vary from individual to individual [63]. Similarly, safety performance may be defined in different ways by each stakeholder in a construction project. Contractors may desire only a pleasant historical record, such as few reported accidents and low fatality rates, to maintain their companies' reputations, whereas project owners may aim to secure all possibilities, from minimal accidents and fatalities to a pleasant safety climate. The literature has indicated that clients can impose several requirements in the workplace and should therefore be highlighted as essential parties in a construction project [59]. Project managers affect improvements to a safety programme [16], while safety officers are the main contributors to safety [19,64]. Evaluating the views of each party separately and then synthesising them clears the way for acquiring a holistic picture of the safety situation in construction.

Second, safety officers were asked to evaluate the other two parties' views. It was infeasible to collect data on the satisfaction of clients and project managers, and resorting to the aforementioned evaluation rendered the collection of sufficient data and their statistical analysis feasible. Safety officers are the main actors who bridge the gap among associated parties during the implementation of safety programmes. They interact primarily with project managers and project owners and are therefore assumed to have sufficient information on these parties' perspectives regarding safety performance.

Third, to represent the views of each party, their satisfaction levels were considered. Satisfaction includes components of safety climate and accident occurrence. There are three reasons for incorporating these two components into this study. To begin with, previous research confirmed the significant relationship between these two aspects, indicating that if safety climate is well achieved, then accident occurrences will be low [41,48,49]. This implies that accident records are not necessarily unreliable measures. In addition, since many of the respondents seemed to perceive favourable assurances and expectations regarding this study, they appeared willing to provide accurate information on accidents. This reduced the respondents' anxiety and increased the guarantee that they would disclose accident information. Furthermore, this study represented the feelings of safety officers, which have been minimally illuminated. On this issue, we received encouragement and appreciation from many of the respondents, implying an increase in their positive expectations towards this study and an enhancement of their willingness to provide accurate accident information. Finally, incorporating components of safety climate and accident occurrence enabled the safety officers to more appropriately evaluate the satisfaction levels of all parties, including their own, because each party focused on different aspects of performance. Notwithstanding this justification, however, trade-offs arose. Although integrating the three parties' views and conducting statistical analyses were beneficial, the reliability of the safety officers' evaluation of satisfaction among clients and project managers may have been low. This matter is discussed in Section 5.

Figure 1 illustrates the connections between the developed hypotheses. The conceptual model was used as the basis for developing the survey instrument and data collection, as described in the next section.

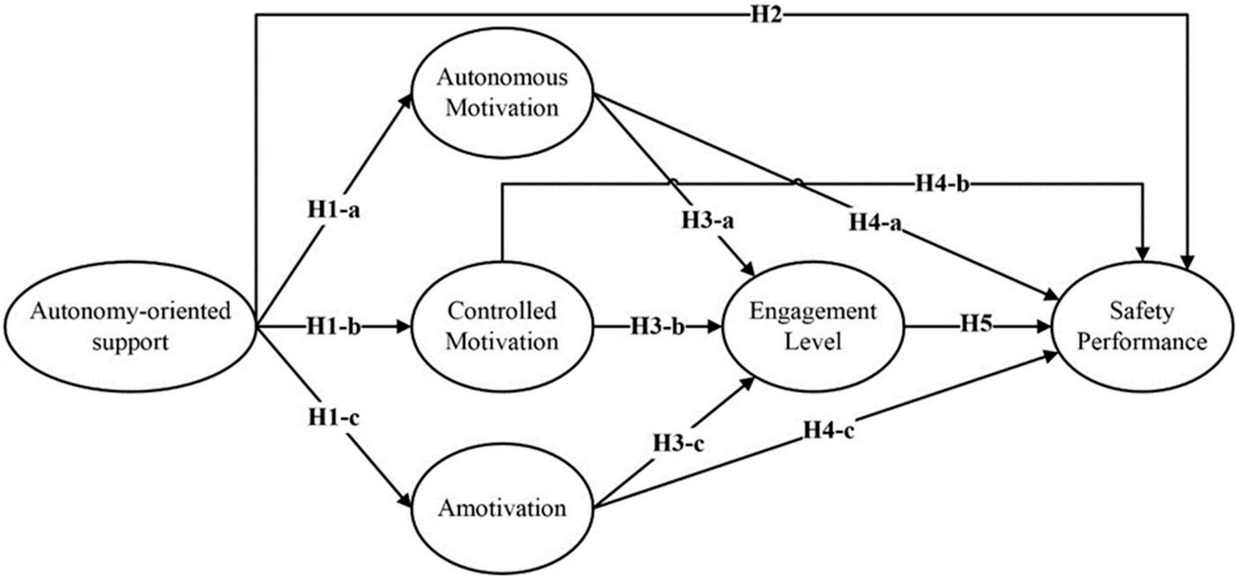

Figure 1. Hypothetical model of the enhancement of safety programmes in construction projects.

3. Survey Instrument

3.1. Questionnaire Design

The questionnaire was created by referencing the literature, and it was divided into five major sections: (1) general information; (2) autonomy-oriented support from project managers; (3) the motivation of safety officers; (4) safety officers' levels of engagement in safety programmes; and (5) safety performance. The first section is intended to obtain demographic information on construction projects, including the types of projects pursued, the educational levels of respondents, years of experience, and gender. The second section (nine items) is meant to determine perceptions regarding the support for autonomy received by safety officers from project managers, with the factors of interest being autonomy, competence, and relatedness. The third section (18 items) is concerned with the degree of motivation held by a safety officer at the time of involvement in a construction project [65,66]. The types of motivation covered are autonomous motivation, controlled motivation, and amotivation. The fourth section (45 items) pertains to potential success factors, which are used to determine the efforts exerted by safety officers in implementing the safety-related tasks categorised into four major groups [7,8]. The last section (three items) is designed to measure safety performance in a construction project on the basis of respondent, contractor, and owner satisfaction with actual safety practices (safety climate and accident occurrence). The questionnaire also includes a blank space for respondents to share additional perspectives on safety programmes.

3.2. Questionnaire Evaluation through Item–Objective Congruence (IOC)

IOC was ascertained to evaluate whether each question was pertinent to a particular objective. This concept was introduced to help researchers confirm the efficacy of a designed questionnaire before commencing with data collection [67]. At this stage, the important task is to evaluate whether questionnaire items and objectives are correspondent [67]. In this study, 75 items were evaluated during the IOC stage. Three experts were selected to assist in the evaluation, with each instructed to rate a question using three scales: +1 for appropriately measuring an objective, 0 for ambiguously measuring an objective, and −1 for not clearly measuring an objective. The IOC index of each objective was then calculated for each question, with the acceptable value being 0.60 [67,68]. Considering the expertise of the professionals involved, the experts selected were those who possessed extensive experience in both academia and the practical application of safety management. In these respects, each of the experts had more than a decade of experience. This careful selection was aimed at ensuring that the experts were qualified to evaluate the devised questionnaire. Two rounds of evaluation were conducted. In the first round, 80% (60 items) of the questionnaire items had IOC indices greater than 0.60, confirming their relevance to the objectives. The remaining 20% (15 items) were adjusted in accordance with the experts' suggestions. The insights provided by the experts covered four principal dimensions: (1) questions for accurately measuring factors of interest; (2) the identification of ambiguous questions that could hinder a comprehensively informed response; (3) lengthy questions that potentially impose a burden on respondents' time; and (4) recommendations for additional questions to enhance the effective measurement of targeted factors. The revised questions were subsequently resubmitted to the experts for further assessment to ensure their appropriate redesign. The evaluation outcome revealed a satisfactory IOC index exceeding 0.60.

3.3. Pilot Survey and Questionnaire Reliability

After the IOC assessment, 15 professional safety officers were invited to voluntarily participate in a pilot survey to ensure both the practicality and reliability of the instrument. They were also asked to provide us with minor recommendations for enhancing the questionnaire's practicality. The reliability of the questions revolving around soft data was tested on the basis of the responses of the volunteers; a Cronbach's alpha greater than 0.70 was regarded as indicative of reliability [67,69]. Accordingly, the four major categories of factors (autonomy-supportive encouragement from project managers, the motivation of safety officers, their degree of participation in implementing safety-related tasks, and safety performance) were subjected to a reliability test. The Cronbach's alpha values of these factors varied from 0.74 to 0.95, confirming that all the items were consistent and pertinent [67,69].

4. Data Collection and Data Profiles

The country selected for survey administration was Thailand, where ministerial regulations require professional safety officers to have a Bachelor of Science degree in occupational health and safety or an equivalent. This requirement guarantees that safety officers are properly trained by the educational system, through which they acquire relevant knowledge, such as that on laws and the ethics governing public health professions, engineering for occupational health and safety, and the management of occupational and environmental health issues. Upcoming safety officers also undergo on-the-job training through internships, ensuring their familiarity with both theory and practice. These qualifications reflect their instrumentality in improving safety in the industry.

The questionnaire was targeted towards professional safety officers who have experience working on construction projects in Thailand. The total population size was estimated using data from the 2013 to 2021 Yearbook of Labour Protection and Welfare Statistics, which documents a survey conducted by the Department of Labour Protection and Welfare [70]. In Thailand, the construction projects required to employ professional-level safety officers are those with a workforce of no fewer than 100 individuals. With the statistical records spanning the past nine years (2013–2021) as bases, the analysis encompassed four primary sizes of construction projects: (1) 684 projects with 100 to 299 employees; (2) 111 projects with 300 to 499 employees; (3) 57 projects with 500 to 999 employees; and (4) 18 projects with 1000 or more employees. Thus, the research sample comprised 870 construction projects. The essential sample size was computed using Equation (1), yielding an approximate requirement of 274 respondents for this research.

$$n = \frac{\mathrm{N}}{1 + \mathrm{N}(e^2)} \tag{1}$$

In the equation above, n denotes the sample size, N indicates the total population, and e refers to precision at a 95% confidence level ($e = 0.05$), following [71]. We secured permission to conduct the survey from the leaders of an official line group of safety professionals in Thailand. The questionnaire was created in an online form to facilitate the completion of the survey, which was administered to 290 randomly selected safety professionals. Within the questionnaire, three screening questions were embedded to ensure the selection of appropriate respondents: (1) Are you a safety officer at the professional level? (2) Have you served as a contractor for a construction project? (3) Do you hold a full-time safety officer position within a construction project?

In the primary research phase, 224 respondents (77%) actively completed the questionnaire, whereas the remaining 23% were unable to reveal project data because of confidentiality concerns. Among the 224 questionnaires received, 195 were considered valid, constituting the complete project data required for subsequent data analysis. The 195 respondents worked on three categories of construction projects: commercial building initiatives (88 respondents, 45.10%), infrastructural projects (56 respondents, 28.70%), and industrial facilities (51 respondents, 26.20%). Of these respondents, 99 (50.80%) were male and 96 (49.20%) were female. They were also grouped into three categories of experience: less than or equal to five years of experience (112 respondents, 57.44%), more than five but not over 10 years of experience (48 respondents, 24.61%), and more than 10 years of experience (35 respondents, 17.95%). As regards literacy/education, only three levels of education were considered: bachelor's (178 people, 91.3%), master's (16 people, 8.20%), and doctoral (1 individual, 0.50%) degrees.

5. Data Analysis and Results

5.1. Data Screening

This study integrated the responses of the participants as a single view to represent a perspective encompassing the entire construction industry. First, the collected data were screened via a one-way analysis of variance (ANOVA) to ensure the compatibility of the data from all the project types examined [72,73]. In relation to the three groups of construction projects, we tested six major constructs, namely, autonomy-oriented support, autonomous motivation, controlled motivation, amotivation, engagement level, and safety performance. The mean values of these constructs were regarded as representative of the situation in each type of construction project. The one-way ANOVA was conducted to compare the average values of the constructs across the three groups of respondents and determine statistical significance at a 95% confidence interval [72–74]. Table 2 presents the results of the comparison of the mean values of the constructs under the three project types (the extent to which each of the constructs is experienced by the respondents at construction sites).

Table 2. Mean values of the six constructs from the three project types.

Variables	(1) Commercial Buildings		(2) Infrastructure Projects		(3) Industrial Facilities		Sig.
	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	
Autonomy-oriented support	3.845	0.901	4.026	0.793	4.144	0.720	0.107
Autonomous motivation	4.372	0.524	4.462	0.484	4.326	0.547	0.379
Controlled motivation	3.252	0.872	2.908	0.953	2.944	1.065	0.059
Amotivation	1.913	1.108	1.304	0.529	1.693	1.105	0.002
Engagement level	4.353	0.646	4.520	0.431	4.525	0.496	0.107
Safety performance	3.898	0.777	4.006	0.662	4.078	0.662	0.336

The groups significantly differed only in terms of one construct—amotivation ($p = 0.002$). The p-values generated in the other comparisons were greater than 0.05, indicating no significant difference between the average values of the different types of construction projects [72,73]. This analysis confirms that the collected data on project types can be integrated into a holistic representation of views regarding construction projects in the Thai industry. We therefore integrated the responses revolving around these project types into the analysis of the hypothesised model [74].

5.2. Data Characteristics

To identify the characteristics of the data, the mean values and standard deviations of seven major factorial groups were computed for each type of construction project (Table 3). These groups were demographic information, autonomy-oriented support from project managers (autonomy, competence, and relatedness), autonomous motivation, controlled motivation, amotivation, safety officers' levels of engagement in safety activities (worker involvement, safety prevention system, safety arrangement, and commitment to safety), and safety performance (respondent, contractor, and owner satisfaction). Correlation coefficients were also calculated (Table 4).

Three noteworthy results were obtained. First, the mean value of the respondents' autonomous motivation was significantly higher than that of their controlled motivation. These values were compared using an independent sample t-test ($p = 0.000$). Second, amotivation and controlled motivation were significantly positively correlated (Table 4). Third, the mean values of satisfaction among the three stakeholders mostly followed a descending order—project owner > safety officer > project manager—for each type of project and the overall initiative. The project owners always showed the highest satisfaction levels. The results of the one-way ANOVA indicated that the mean satisfaction of the project owners (clients) and project managers (contractors) with the overall project significantly differed ($p = 0.004$). The implications of the first and second characteristics are discussed in the succeeding chapter. Those of the third are presented here.

The third characteristic may be attributed to the fact that before a client (an owner's representative or consultant) commences site inspection, a general contractor regularly receives an oral or written notification, which helps the contractor prepare a flawless construction site. Thus, clients are possibly exposed only to the best parts of safety management on each site. Few contractors, represented as project managers, focus on construction productivity, particularly when they work under tight schedules and budget constraints. This inclination becomes even stronger when they face considerable uncertainty from developments such as natural disasters or continual rain. In these cases, implementing proactive and reactive safety measures is perceived by project managers to be nothing more than a time-consuming and costly endeavour. This tendency implies that project managers having the lowest satisfaction is caused by the circumstances in which they find themselves. This issue should be analysed and discussed in detail in future research.

Table 3. Analysis of the mean values of associated variables.

Variables	(1) Commercial Buildings n = 88		(2) Infrastructure Projects n = 56		(3) Industrial Facilities n = 51		(4) Overall Project n = 195	
	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Demographic information								
Gender	1.534	0.502	1.482	0.504	1.431	0.500	1.492	0.501
Education	1.102	0.340	1.036	0.187	1.137	0.348	1.092	0.307
Experience	1.568	0.828	1.446	0.658	1.843	0.758	1.605	0.775
Autonomy-oriented support	3.845	0.901	4.026	0.793	4.144	0.720	3.975	0.832
Autonomy	3.856	0.881	4.030	0.842	4.176	0.668	3.990	0.826
Competence	3.795	0.953	3.988	0.814	4.105	0.776	3.932	0.876
Relatedness	3.883	0.963	4.060	0.858	4.150	0.847	4.003	0.907
Autonomous motivation	4.372	0.524	4.462	0.484	4.326	0.547	4.386	0.519
Intrinsic regulation	4.159	0.734	4.250	0.766	4.013	0.830	4.147	0.770
Integrated regulation	4.405	0.514	4.482	0.561	4.458	0.508	4.441	0.525
Identified regulation	4.642	0.519	4.750	0.357	4.598	0.640	4.662	0.516
Controlled motivation	3.252	0.872	2.908	0.953	2.944	1.065	3.073	0.958
Introjected regulation	3.322	0.934	3.024	1.029	2.935	1.414	3.135	1.112
External regulation	3.182	1.013	2.792	1.046	2.954	1.037	3.010	1.037
Amotivation	1.913	1.108	1.304	0.529	1.693	1.105	1.680	1.005
Lack of motivation 1	1.909	1.274	1.286	0.706	1.627	1.232	1.656	1.153
Lack of motivation 2	1.716	1.203	1.214	0.706	1.588	1.186	1.538	1.095
Lack of motivation 3	2.114	1.236	1.411	0.733	1.863	1.312	1.846	1.170
Engagement level	4.353	0.646	4.520	0.431	4.525	0.496	4.446	0.557
Worker involvement	4.400	0.626	4.579	0.434	4.545	0.532	4.489	0.556
Safety prevention	4.395	0.651	4.523	0.443	4.516	0.529	4.464	0.567
Safety arrangement	4.201	0.758	4.405	0.595	4.429	0.564	4.319	0.672
Safety commitment	4.417	0.643	4.574	0.434	4.611	0.489	4.513	0.555
Safety performance	3.898	0.777	4.006	0.662	4.078	0.662	3.976	0.717
Safety officer satisfaction	3.898	0.885	4.000	0.688	4.137	0.693	3.990	0.786
Contractor satisfaction	3.761	0.884	3.893	0.779	3.961	0.799	3.851	0.833
Owner satisfaction	4.034	0.837	4.125	0.740	4.137	0.693	4.087	0.772

Notes: Gender served as a dummy variable that was assigned a value of 1 when a subject was male and 2 when female. Education was a dummy variable that took a value of 1 for a bachelor's degree, 2 for a master's degree, and 3 for a doctoral degree. Experience was a dummy variable that was given a value of 1 for respondents with experience less than or equal to five years, 2 for those with experience spanning more than five years but not over 10 years, and 3 for respondents with more than 10 years' experience.

As described in Section 2.5.2, a trade-off exists in the evaluation of satisfaction among clients, project managers, and safety officers. We initially attempted to acquire reliable responses by employing three practitioners in the safety profession from both academic and practical fields to ensure that the respondents understood the intended meaning of the questions and that the designed questions were pertinent to the measurement of safety performance. During the survey, we received positive feedback on the benefits of this research, implying that the respondents were willing to provide pertinent project data, thereby presenting reliable responses. In addition, the results (Table 3) indicated that the satisfaction of the owners and project managers with each project was evaluated consistently, albeit this was assessed by the same safety officer. Therefore, the advantages of integrating the three parties' views and conducting statistical analysis outweigh the disadvantage of the potentially low reliability of the evaluation. Furthermore, the application of confirmatory factor analysis (CFA), statistically confirmed the reliability of the assessment of safety performance by the safety officers. The factor loadings corresponding to the satisfaction of the safety officers, contractors, and owners were 0.871, 0.840, and 0.822, respectively. These findings contribute to the validation of the measurement model and underscore the robustness of the safety performance evaluation by the specified entities.

Table 4. Mean scores, standard deviations, and correlation coefficients of associated variables.

Variables	$\bar{X}$	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Gender	1.492	0.501	1.000									
(2) Education	1.092	0.307	−0.163 *	1.000								
(3) Experience	1.605	0.775	−0.452 **	0.283 **	1.000							
(4) Project type	1.810	0.825	−0.085	0.029	0.124	1.000						
(5) Autonomy-oriented support	3.975	0.832	−0.010	−0.083	−0.034	0.151 *	1.000					
(6) Autonomous motivation	4.386	0.519	−0.048	−0.031	0.000	−0.022	0.424 **	1.000				
(7) Controlled motivation	3.073	0.958	−0.127	0.003	−0.006	−0.146 *	−0.012	0.108	1.000			
(8) Amotivation	1.680	1.005	−0.129	−0.010	−0.026	−0.123	0.007	−0.075	0.522 **	1.000		
(9) Engagement level	4.446	0.557	−0.006	−0.020	−0.033	0.137	0.525 **	0.431 **	0.017	−0.021	1.000	
(10) Safety performance	3.976	0.717	−0.091	0.018	0.005	0.106	0.630 **	0.481 **	0.195 **	0.098	0.540 **	1.000

Notes: Gender served as a dummy variable that was assigned a value of 1 when a subject was male and 2 when female. Education was a dummy variable that took a value of 1 for a bachelor's degree, 2 for a master's degree, and 3 for a doctoral degree. Experience was a dummy variable that was given a value of 1 for respondents with experience less than or equal to five years, 2 for those with experience spanning more than five years but not over 10 years, and 3 for respondents with more than 10 years' experience. Project type is a dummy variable that takes the values of 1 for commercial buildings, 2 for infrastructure construction, and 3 for the construction of industrial facilities; * $p < 0.05$; ** $p < 0.01$.

5.3. Causal Relationships among the Factors in the Proposed Model

The proposed model was analysed mainly through a measurement model and structural equation modelling (SEM) [75,76].

5.3.1. Measurement Model for Six Constructs

The measurement model consists of six latent variables, namely, autonomy-oriented support from project managers (detailed questions presented in Appendix A, Table A1), the autonomous motivation of safety officers, their controlled motivation, their amotivation, their levels of engagement in implementing safety programmes, and safety performance. The *p*-value derived using Bartlett's test of sphericity was 0.000, indicating that the correlation matrix was not an identity matrix and that it was ideal for conducting factor analysis [77]. The Kaiser–Meyer–Olkin (KMO) measure of sampling was used to ensure the plausibility of the collected data. The KMO value was 0.903, reflecting the suitability of the data for factor analysis [77]. As shown in Table 5, CFA was performed to ensure that the observed variables were ideal for each construct, with a factor loading of 0.50 regarded as acceptable [75,76].

The observed variables with standardised factor loadings greater than 0.5 were retained in the measurement model [78,79]. The model was verified with appropriate fit indices (p = 0.397, X^2/DF = 1.017, goodness-of-fit index [GFI] = 0.89, normed fit index [NFI] = 0.923, Tucker–Lewis index = 0.998, comparative fit index [CFI] = 0.999, and root mean square error of approximation [RMSEA] = 0.009). The analysis confirmed that the observed variables were ideal representations of each construct in the conceptual model.

Table 5. CFA results on the six constructs.

Constructs and Observed Variables		Factor Loadings	CR	AVE
Autonomy-oriented support	Autonomous support from project manager 1	0.798	0.961	0.734
	Autonomous support from project manager 2	0.875		
	Autonomous support from project manager 3	0.876		
	Competence support from project manager 1	0.860		
	Competence support from project manager 2	0.820		
	Competence support from project manager 3	0.844		
	Relatedness support from project manager 1	0.864		
	Relatedness support from project manager 2	0.877		
	Relatedness support from project manager 3	0.892		
Autonomous motivation	Intrinsic regulation of safety officers 1	0.591	0.830	0.384
	Intrinsic regulation of safety officers 2	0.600		
	Intrinsic regulation of safety officers 3	0.705		
	Integrated regulation of safety officers 1	0.717		
	Integrated regulation of safety officers 2	0.710		
	Integrated regulation of safety officers 3	0.555		
	Identified regulation of safety officers 1	0.530		
	Identified regulation of safety officers 3	0.505		
Controlled motivation	Introjected regulation of safety officers 1	0.552	0.809	0.416
	Introjected regulation of safety officers 2	0.690		
	Introjected regulation of safety officers 3	0.728		
	External regulation of safety officers 1	0.686		
	External regulation of safety officers 2	0.594		
	External regulation of safety officers 3	0.599		
Amotivation	Lack of motivation of safety officers 1	0.808	0.860	0.673
	Lack of motivation of safety officers 2	0.886		
	Lack of motivation of safety officers 3	0.762		
Engagement level	Worker involvement	0.950	0.963	0.867
	Safety prevention and control systems	0.980		
	Safety arrangement	0.903		
	Safety commitment	0.889		
Safety performance	Safety officer satisfaction	0.871	0.882	0.713
	Contractor satisfaction	0.840		
	Owner satisfaction	0.822		

The composite reliability (CR) values of the constructs (autonomy-oriented support, autonomous motivation, controlled motivation, amotivation, engagement level in safety programmes, and safety performance) were 0.961, 0.830, 0.809, 0.860, 0.963, and 0.882, respectively, which exceeded the acceptable value of 0.60 [80,81]. Their average variance extracted (AVE) values were 0.734, 0.384, 0.416, 0.673, 0.867, and 0.713, respectively. Although most researchers have argued that the AVE should be more than 0.50, other scholars have suggested that a value of approximately 0.40 is still acceptable [82]. Furthermore, if an AVE less than 0.50 is derived but the CR is well above the recommended level, then the internal reliability of measurement items can be considered adequate [80,81]. In the present research, autonomous motivation had an AVE of 0.384.

5.3.2. Structural Model

In the SEM, the final model was constructed by considering the model that was justified using the superior fit indices. The hypotheses regarding the structural model were tested to measure the degree to which each exogenous variable affected the endogenous variable. Figure 2 depicts the hypothetical model with the effect size underlying the relationships of the variables [73,75,76,83].

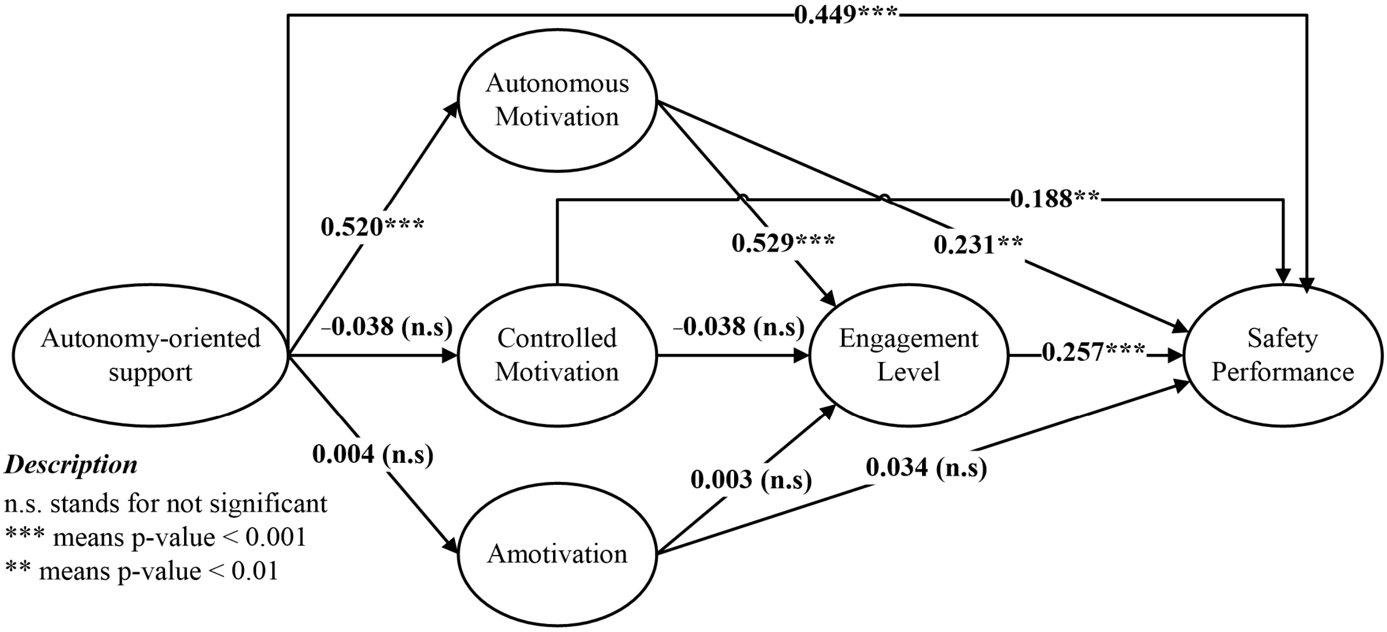

Figure 2. Results of the analysis of the structural model of assumptions.

To begin with, autonomy-oriented support from project managers positively affected both the safety officers' autonomous motivation and safety performance, with the standardised coefficients of these variables being 0.520 and 0.449, respectively. In addition, the safety officers' autonomous motivation positively influenced safety performance ($\beta_{H4\text{-}A} = 0.231$) and their efforts to engage in safety programmes ($\beta_{H3\text{-}A} = 0.529$). The same favourable effect on safety performance was observed with regard to controlled motivation ($\beta_{H4\text{-}B} = 0.188$). Furthermore, the degree of engagement among the safety officers in crucial activities was positively linked to safety performance, with the standardised coefficient being 0.257.

The fit indices were explored to ensure the effectiveness of the proposed model in capturing actual safety situations at construction sites. The fit indices included the p-value, X^2/DF, CFI, GFI, NFI, RMSEA, and the Akaike information criterion (AIC) [73,75,76,83], whose values should satisfy the statistical criteria indicated in Table 6 [84]. The fit indices were at acceptable levels, demonstrating the compatibility of the hypothesised model with the empirical data.

This compatibility implies that the constructed hypotheses are pertinent to real-world practice. This compatibility, together with the advantages presented by the research findings, is discussed in the succeeding section.

In SEM, a consensus regarding appropriate sample sizes is notably absent. Although the literature has proposed a minimum of 200 as a sample size for such analysis, the 195 respondents in the current research closely approach this threshold. A study suggested that an appropriate sample size for SEM should include a minimum of five cases per variable [85]. Considering the parameters dealt with in the present study, which involved 33 observed variables within the proposed model, adhering to this guideline requires that the minimal number of samples be 165. Consequently, our sample was deemed suitable for the execution of SEM.

Table 6. Results on the fit indices of the conceptual model (adapted from [84]).

Fit Indices	Criteria	Initial Model	Final Model
p-value	Greater than 0.05	0.000	0.087
X^2/DF	1 to 2	1.905	1.102
CFI	0 (no fit)–1 (perfect fit)	0.907	0.992
GFI	0 (no fit)–1 (perfect fit)	0.778	0.895
NFI	0 (no fit)–1 (perfect fit)	0.824	0.923
RMSEA	Less than 0.05	0.068	0.023
AIC	Small value	1076.001	791.356

6. Discussion

Table 7 presents each hypothesis, along with its standardised coefficient (β) and p-value. As previously stated, this research delved into four major aspects linked to safety implementation at construction sites: (1) the key role of autonomy-oriented support from project managers (H1a and H2); (2) the essential role of safety officers' autonomous motivation (H3a and H4a); (3) the impact of controlled motivation (H4b, H1b, and H3b); and (4) the engagement of safety officers in safety performance (H5).

Table 7. Details on each hypothesis, with estimated standardised coefficients.

Hypotheses		Descriptions	β	Sig.
H1	**H1a**	autonomy-oriented support → (+) autonomous motivation	0.520	***
	H1 b	autonomy-oriented support → (+) controlled motivation	−0.038	0.635
	H1c	autonomy-oriented support → (−) amotivation	0.004	0.956
H2		autonomy-oriented support → (+) safety performance	0.449	***
H3	**H3a**	autonomous motivation → (+) engagement level	0.529	***
	H3b	controlled motivation → (+) engagement level	−0.038	0.582
	H3c	amotivation → (−) engagement level	0.003	0.961
H4	**H4a**	autonomous motivation → (+) safety performance	0.231	0.007
	H4b	controlled motivation → (+) safety performance	0.188	0.003
	H4c	amotivation → (−) safety performance	0.034	0.561
H5		engagement level → (+) safety performance	0.257	***

Note: *** = $p < 0.001$.

6.1. Essential Role of Autonomy-Oriented Support from Project Managers (H1a and H2)

The results showed that autonomy-oriented support from project managers significantly affected the safety officers' autonomous motivation ($\beta_{\text{H1-A}} = 0.520$). Specifically, it was reinforced and maintained through autonomy-supportive behaviours, as indicated in the comments of multiple respondents. Some of the respondents stated that receiving such support would help them achieve certainty in their roles. Another participant shared an experience with a reputable company where the project manager paid extensive attention to supporting the safety programme, which in turn contributed to the success of such an initiative in the project. This situation may have enhanced the autonomous motivation of the safety officer to engage in safety practices. Note, however, that the high $\beta_{H1\text{-}A}$ means that undesirable situations also existed. One respondent asserted that safety management in Thailand has thus far been ineffective and that this problem stems from project managers' lack of intention to enhance safety programmes. This deficiency can drive safety officers to view safety programmes in the workplace as unimportant. Regardless of the presence of desirable or undesirable situations, autonomy-oriented support from project managers enhanced the autonomous motivation of the safety officers. These findings are similar to those of previous studies [23–25].

Autonomy-oriented project management significantly affected safety performance (β_{H2} = 0.449), which can be attributed to the following reasons: First, every action from project managers as leaders of construction projects can directly influence performance. Second, apart from affecting the autonomous motivation of safety officers, project manager support can be mediated by other relevant parties, such as site engineers and construction labour.

6.2. Essential Role of Safety Officers' Autonomous Motivation (H3a and H4a)

This research acknowledged the key role of autonomous motivation in successful safety programmes. The $\beta_{H3\text{-}A}$ of the effects of the safety officers' autonomous motivation on their degrees of participation in safety initiatives was 0.529; that is, the higher the autonomous motivation, the more intensive the effort exerted towards safety-related activities [19]. Some of the respondents from whom positive survey results were derived declared that they attempt to extensively manage safety programmes, given that they view these as their most important task. A number of the participants added that, as safety professionals, they are obligated to cautiously discuss safety issues with construction practitioners before construction is commenced to ensure their understanding of safety. This empirical evidence confirms that higher autonomous motivation among safety officers translates to greater engagement in safety-related activities. These findings are consistent with the literature on other matters, such as health-related behaviours [31], safety management in a Taiwanese international airline [30], safety management in a coal carbonisation company in China [32], the management of construction worker productivity [34], and the safety practices of a manufacturing factory in Turkey [33].

The results of the analysis pointed to a direct impact of autonomous motivation on safety performance ($\beta_{H4\text{–}A}$ = 0.231). Put differently, the autonomous motivation of the safety officers also significantly influenced safety performance. This result is ascribed to two factors: negotiations with project managers and/or the proposal of recommendations to regulators, and the conduct of health-related activities. With regard to the first factor, the scope of safety officers' engagement in this work is a set of activities involving workers, foremen, and site engineers. Suppose that the safety conditions on a construction site are undesirable and that highly autonomous safety officers propose a new method to project managers or clients or express their honest opinions to government regulators. The considerable contribution of these efforts to improvements in safety programmes counts as a direct influence of autonomous motivation on safety performance. As for the second factor, a respondent shared an experience at the early stage of the COVID-19 pandemic. Given undeveloped regulations at a site, the officer autonomously established additional health regulations, provided test kits and alcohol sprays to workers, and acquired temperature measurement equipment to protect the workers from illness. These two factors may be beyond the job descriptions of safety officers. It is possible that these 'invisible' efforts also support site safety in Thailand. Comprehensive discussions should be devoted to the mechanisms by which the autonomous motivation of safety officers directly elevates safety performance.

The mean autonomous motivation of the safety officers was significantly higher than their mean controlled motivation. Thai safety officers acknowledge the importance of safety programmes over external rewards and egos. As mentioned in the introduction section, they undergo thorough training and are familiar with both theory and practice. They seem to recognise the importance of safety programmes during these training sessions and enter the industry with a strong sense of responsibility. One of the respondents declared that every step of safety programme management should be cautiously performed. Furthermore, they provided support-related information that they had to intensively discuss with construction practitioners regarding safety practices before the initiation of construction-related activities. Thus, such practitioners are likely to value safety management as aligned with their major goals.

6.3. Roles of Controlled Motivation (H1b, H3b, and H4b)

As mentioned previously, the mean value of the controlled motivation of the safety officers was significantly lower than that of their autonomous motivation. The influence of autonomy-oriented support on controlled motivation (H1b) and the influence of controlled motivation on engagement level (H3b) were not validated. However, controlled motivation had a β_{H4-B} of 0.188 with a $p = 0.003$, showing that the controlled motivation of the safety officers also played a role in enhancing safety performance.

Controlled motivation comprises external and introjected regulation, and the extent to which each regulation was exercised in this work was represented by the mean value of three variables. The three variables pertinent to external regulation are the following reasons for engaging in safety programmes: (1) receiving a sizeable salary; (2) receiving external rewards; and (3) avoiding punishment. Introjected regulation covers (1) protecting the ego; (2) avoiding judgement from others; and (3) feeling like a failure under a disregard for safety programme management yet simultaneously dismissing the value of a safety initiative. The coefficient of correlation between safety performance and external regulation was 0.228 ($p < 0.01$). The coefficients of correlation between safety performance and salary and rewards from project managers were 0.250 ($p < 0.01$) and 0.215 ($p < 0.01$), respectively.

Section 6.2 presents a hypothesis that we developed for future study, which states that the direct impact of autonomous motivation on safety performance originates from negotiations with project managers and/or recommendations provided to regulators and the performance of extra health-related activities. These are beyond the job descriptions of safety officers. If this is true, the direct impact of controlled motivation on safety performance can be interpreted as a desire for an appreciation of the additional challenging tasks that safety officers undertake. As previously suggested, then, the mechanisms by which the motivation of safety officers directly affects safety performance should be identified and thoroughly explored in the future.

Another noteworthy result was that the coefficient of correlation between controlled motivation and amotivation was 0.522 and was statistically significant (Table 4). This result, as well as the significant value of $\beta_{H4\text{-}B}$, implies that enhancing controlled motivation is a double-edged sword. If controlled motivation is inappropriately promoted, safety officers may feel demotivated, consistent with Ryan and Deci's (2000) argument that excessively elevating such motivation may be harmful because it possibly hinders the enhancement of autonomous motivation. Thus, promoting controlled motivation through external rewards should be cautiously strategised to ensure that it does not affect autonomous motivation. In sum, project managers should not neglect the promotion of controlled motivation, but neither should it be a top priority.

6.4. Engagement of Safety Officers and Safety Performance (H5)

As demonstrated by the analytical results, the degree of engagement of the safety officers in safety-related activities positively affected safety performance ($\beta_{H5} = 0.257$). This confirms that increased efforts to conduct safety-related tasks contribute to successful safety performance [20,86]. The results on this aspect also validated the idea that safety officers' levels of engagement are positively associated with safety performance [5]. The findings are similar to those of other research on, for example, the implementation of waste management programmes [29] and health-related behaviours [31].

It is worth noting that the present study did not delineate the motivational levels of safety officers across distinct characteristics. This limitation can be addressed by alternative statistical models, including cluster analysis and latent profile analysis (LPA), which represent person-centred approaches designed to aid researchers in the exploration of potential subpopulations within a sample. As a conventional person-centred technique, cluster analysis exhibits certain limitations: First, it lacks formal criteria for evaluating optimal solution fit, and second, an individual is forcedly classified into only one cluster, which contradicts the reality that individuals can be allocated to various clusters [19,87]. These deficiencies can be addressed in LPA, which provides fit indices that facilitate the evaluation of model adequacy [19] and relies on diverse criteria, including likelihood (i.e., probability). Notably, LPA accommodates the allocation of individuals to multiple clusters. A comprehensive discussion of the potential and limitations of both models was presented by Gabriel et al. [87]. The findings derived from the application of these statistical models can offer a construction company with insightful perspectives, facilitating an exhaustive understanding of the diverse motivational profiles exhibited by safety officers. This understanding, in turn, may inform the formulation of a well-defined strategic framework aimed at supporting the motivational needs of safety officers operating within the construction industry.

7. Conclusions

Securing construction safety remains a considerable challenge, which stems fundamentally from, among other factors, the gap between espoused values and the assumptions that typify the culture of construction organisations [17]. 'Safety first' is a slogan heard on every site, but in reality, project managers focus primarily on other issues, such as construction productivity, and consequently neglect safety programmes at times.

One of the key parties who can bridge the abovementioned gap is safety officers. However, the following issues were not necessarily clarified in previous research: how the motivation of safety officers can be enhanced, whether motivation leads to augmented engagement, and whether engagement among safety officers improves safety performance. To shed light on these matters, we first hypothesised that autonomous motivation, with emphasis on value, responsibility, or interest in work, plays a vital role in safety. Without these characteristics, safety professionals cannot continue working diligently to address the aforementioned gap. In a worst-case scenario, these practitioners might end up resigning and leaving the construction industry, which would lead to a loss of valuable human resources. We then constructed a hypothetical model consisting of four major components: autonomy-oriented support from project managers, the motivation of safety officers, their levels of engagement in safety programmes, and safety performance. A survey was administered to 195 safety officers who had worked on construction projects in Thailand, and the hypothetical model was analysed via SEM.

First, a noteworthy result was that the mean autonomous motivation of the safety officers was significantly higher than their controlled motivation. Thai safety officers acknowledge the importance of safety programmes over external rewards and egos. Second, autonomous support from project managers positively affected the autonomous motivation of the safety officers, indicating that the former was instrumental in enhancing the latter's autonomous motivation. In reality, many project managers follow their companies' policies. Thus, the real key party in providing support to safety officers is company management. Third, the autonomous motivation of the safety officers significantly affected their engagement and safety performance. Fourth, the engagement of the safety officers significantly influenced safety performance. Fifth, controlled motivation significantly affected safety performance. Note, however, that controlled motivation was significantly correlated with amotivation, implying that the former has two sides: it is not a negligible issue but can be harmful if addressed inappropriately. These results mean that in the implementation of safety programmes, the autonomous motivation of safety officers serves as the engine, and autonomy-oriented support from project managers and company management functions as the ignition key.

The findings elucidated the salient interrelationship among the four constructs related to the activities of safety officers in Thailand on the basis of self-determination theory. To the best of our knowledge, this research represents the first systematic definition and investigation of the specific interrelationships concerning safety officers. It has the potential to augment the extant literature on safety management in construction projects.

From a pragmatic perspective, the outcomes provide indispensable insights for both project managers and organisational leadership. Notably, a considerable proportion of project managers adhere to their firms' established policies, positioning organisational management as the pivotal entity in proffering support to safety officers. The defined model can serve as a foundational framework, enabling project managers to devise strategies that augment the efficacy of safety programmes, especially for critical frontline stakeholders such as safety officers. As a result, the responsibility of embracing an autonomy-supportive approach, which encapsulates the incorporation of diverse perspectives, the provision of constructive feedback to safety officers, and the cultivation of an inclusive milieu, lies in the hands of project managers. Additionally, the research outcomes present a strategic blueprint for construction enterprises. Such firms can leverage these insights to either establish training programmes that underscore autonomy-supportive methodologies for project managers or formulate explicit guidelines ensuring the systematic integration of autonomy-centric strategies in construction endeavours.

A notable limitation of this study is its exclusive focus on safety officers operating within Thailand. The observed heightened autonomous motivation among these officers suggests an intrinsic attraction to the sector. This stems from a genuine interest, a commitment to implementing safety protocols, and an acknowledgement of the importance of safety measures. Moreover, even after entering the industry, they continue to maintain a strong sense of autonomous motivation. However, whether these attributes are ubiquitous among safety officers globally or are specific to those in Thailand remains inconclusive. Pursuing comparative analyses across nations would be a worthwhile endeavour. Combining the findings from such cross-national studies could further enrich our understanding of the support, motivation, and contributions inherent to the activities of safety officers. Furthermore, understanding the different characteristics of safety officers may provide a construction company with valuable guidelines on decision-making regarding appropriate strategies for supporting safety officers.

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Appendix A

The Appendix presents the measurement of autonomy-oriented support from project managers as perceived by the safety officers (Table 6). It covered support for autonomy, competence, and relatedness. Each respondent denoted their perception of the autonomy-oriented support from project managers using a five-point Likert scale (1 = no support at all, 2 = slight support, 3 = moderate support, 4 = high support, and 5 = extensive support).

Table A1. Questions on autonomy-oriented support and examples of evaluation.

Variables	Questions	1	2	3	4	5
Autonomy support 1	To what extent does a project manager encourage safety officers to have alternative choices when managing safety programmes?					
Autonomy support 2	To what extent does a project manager attempt to understand the conditions and responsibilities of safety officers?					
Autonomy support 3	To what extent does a project manager attempt to understand safety officers' perspectives before suggesting an alternative choice?					
Competence support 1	To what extent does a project manager convey their confidence in a safety officer's ability to manage safety?					
Competence support 2	To what extent does a project manager encourage safety officers to ask questions and provide suggestions relating to safety issues?					
Competence support 3	To what extent does a project manager provide safety officers with positive feedback when safety is well performed?					
Relatedness support 1	To what extent does a project manager make safety officers feel accepted by the company?					
Relatedness support 2	To what extent does a project manager encourage safety officers to be an important part of the organisation?					
Relatedness support 3	To what extent does a project manager help safety officers develop trust in project managers?					

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