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Safety Leadership and Performance in Indonesia's Construction Sector: The Role of Project Owners' Marurity

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ABSTRACT

The construction sector in Indonesia witnesses a significant number of work accidents, with construction sites being particularly prone to such incidents. It is imperative for stakeholders, especially project owners, to prioritize safety performance. The authorization of safety plans empowers project owners, granting them substantial influence over safety outcomes. This research employs Structural Equation Modeling (SEM) to investigate the relationship between project owners' safety leadership and safety performance, with valuable input obtained from contractors who directly interact with project owners. The identified variables encompass leader's maturity attributes, psychosocial factors, participatory approaches, communication practices, and competence levels. All interrelationships between the variables demonstrate high significance in shaping safety performance (with z-scores exceeding 1.96). Two distinct patterns are identified to characterize project owners' leadership styles. The first pattern relates to the personal maturity of the owner, while the second pattern focuses on the owner's ability to foster effective stakeholder relationships. To manifest maturity, project owners must make three key contributions: 1) ensuring safety costs are factored into the project value, 2) procuring contractors with well-defined safety policies, and 3) ensuring swift responses to accidents. These findings underscore the importance of project owners in enhancing construction safety practices, emphasizing their role beyond that of contractors.

1. INTRODUCTION

1.1 Background

The construction industry is prone to a high number of work accidents, often resulting in fatalities and severe injuries [1]. Consequently, it is crucial to implement effective strategies aiming to minimize casualties and achieve accident-free environments [2]. This concern has been particularly emphasized in Indonesia, where the construction sector experienced the highest number of accidents in 2019, accounting for approximately 32% of all incidents [3]. The complexity and inherent safety risks associated with construction activities contribute to this alarming statistic [3]. Notably, the involvement of multiple stakeholders, particularly those associated with infrastructure projects, further amplifies the intricacy [4]. These stakeholders comprise the project owner, main contractor, planner/designer, supervisory or management consultants, subcontractors, and affected communities.

While Indonesia has made significant efforts to ensure safety in construction projects, the regulations primarily focus on the technical aspects of safety management, with limited attention given to the involvement of stakeholders. Furthermore, leadership within the safety management system is often overlooked. Consequently, comprehensive measures considering the human aspect and stakeholder engagement are lacking.

Existing research on construction safety has predominantly centered around the main contractor [5-7]. However, it is the project owner who wields the most influence and possesses the authority to authorize safety plans, as mandated by presidential and ministerial regulations in Indonesia, thereby rendering them a key player in ensuring safety [8]. Moreover, their active engagement in safety activities and projects significantly impacts safety performance [8].

Enforcement and engagement are identified as the two key attributes for achieving high safety performance in the construction industry [9]. These attributes serve as the foundation for cultivating a safety culture, which is considered pivotal in driving changes within the management system strategy. Currently, Indonesia exhibits a reactive safety culture [10], which falls under the second level among the existing five levels [11], indicating the need for increased awareness. Safety culture plays a fundamental role in safety performance [12] and is strongly influenced by safety leadership [13]. Notably, leaders, particularly within the contextual setting of construction project structures, are deemed the most influential in shaping a safety culture [14]. Therefore, it is essential to consider project owner leadership as a significant variable, requiring an appropriate measurement tool. Such consideration forms the basis for developing a safety management strategy that yields positive impacts [9].

Maturity models have been successfully employed across various industries to evaluate intangible aspects such as safety leadership and safety culture [15]. While maturity models have predominantly focused on contractors, specifically project managers or leaders [6], the development of maturity models encompassing project owners can yield substantial benefits [8]. Adopting such models provides a unique perspective on organizational dynamics, highlighting the significance of the project owner's involvement throughout all project stages. Consequently, the development of a maturity model specific to safety leadership becomes imperative. Therefore, this research aims to investigate the relationship between project owners' safety leadership and safety performance through the development of a maturity model.

1.2 Project owner's leadership

There is a positive relationship between Owner Commitment (OC) and Traditional Delivery Performance (TDP) in terms of quality, schedule, and cost performance, as conceptualized within a maturity framework [16]. Owner Commitment encompasses several factors: 1) Education of the project team, 2) Facilitating the integration of other projects, 3) Introduction of project intentions, 4) Providing vision and rationale for development, 5) Promoting performance improvement, and 6) Supporting project management organization. Two studies conducted in the same year offer additional insights into the project owner's perspective on safety. The first study Huang and Hinze [8] employs regression analysis to develop a reference model for assessing the project owner's role in safety-related activities. Huang and Hinze [8] applied this model, demonstrating that project owners must prioritize safety by engaging in effective communication with all stakeholders, selecting appropriate project participants, and actively participating in safe project execution. The project owner's influence on safety performance manifests through contractor selection, incorporating safety requirements in contracts, and active involvement in project management, ultimately yielding positive effects.

In the modern era, leadership emphasizes member participation rather than strict supervision and absolute discipline. Notably, the project owner plays a vital role in this context. The most significant attribute of effective leadership is the provision of added value to team members, achieved through service and respect. Service entails care, knowledge, and direct support in executing assigned tasks. The servant leadership style aligns with these conditions and proves to be the most effective [17]. It fosters a supportive work environment and significantly enhances team engagement in maintaining safety [14]. These attributes are rooted in the intensive and two-way communication fostered by servant leadership between leaders and subordinates. In the realm of safety management, this communication is of paramount importance as it raises awareness and contributes to the formation of a safety culture.

1.3 Safety performance in construction projects

The construction industry, both in Indonesia and globally, holds significant importance and has become a prominent subject of research. Preliminary studies have extensively demonstrated the relationship between safety leadership and its impact on performance through the establishment of a safety culture [13, 14]. Furthermore, the substantial contribution of project owners in shaping safety performance has been widely acknowledged [8]. To assess construction project safety performance, specific indicators are required.

Construction safety indicators can be evaluated using measurable parameters, serving as a reflection of project success [18]. It is crucial to develop these indicators based on the actual on-site conditions, avoiding normative measurements. These indicators are categorized into two types: lead indicators and lag indicators [19]. Lead indicators are proactive and preventive measures. They are employed when continuous improvement is necessary to enhance safety performance, particularly in countries with a low level of safety culture. Conversely, lag indicators are reactive and corrective measures, often characterized by more tangible parameters, such as the number of work accidents and the accident response rate. Lag indicators are commonly used in construction projects with a well-established safety culture. Given that Indonesia still practices a reactive safety culture [10], the implementation of a greater number of lead indicators is required.

1.4 Maturity model concept

A maturity model serves as a valuable tool for assessing managerial capabilities and weaknesses, providing a comprehensive understanding of organizational maturity [20]. In the construction sector, various maturity models have been developed and utilized [15, 21]. The complexity of stakeholder involvement in construction projects makes maturity models particularly suitable, as they primarily focus on the non-technical aspects, especially the human element. Notably, Oswald and Lingard developed a maturity model that targets mid-level management, building upon previous studies [12]. This concept encourages stakeholders to establish new levels of safety and health maturity, with a particular emphasis on top-level management.

The application of a maturity model offers a robust means of measuring intangible aspects, such as safety leadership, especially in countries with weak safety culture conditions [14]. It can serve as an effective approach to evaluating safety culture within the framework of a maturity model. Additionally, the maturity model assesses safety, risk identification and management, and supports the enhancement of internal controls and processes [21]. It has been argued that the maturity model primarily focuses on the process aspects of safety culture and requires in-depth case studies and practical experience to fully comprehend its utilization [15]. Therefore, when considering the adoption of a maturity model to assess safety culture, a pragmatic perspective is essential while acknowledging its value when combined with other assessment methods [15].

1.5 Type of maturity model

Previous research has classified maturity models in the field into two main types: leveling models and factorized models [22]. Leveling models employ a multilevel maturity process that assigns levels to indicate the maturity of the object, with higher levels indicating greater maturity. In the context of construction safety, leveling maturity models are more commonly utilized by scholars and practitioners [14, 23-25]. These models typically consist of five levels, each representing a step towards achieving maturity [26, 27]. For example, Law et al. [27] developed a five-level maturity model for the healthcare sector: 1) pathological; 2) reactive; 3) bureaucratic; 4) proactive; 5) generative. As the maturity level increases, patients develop an inherent awareness of safety. Conversely, Albert et al. [23] proposed a simple three-level maturity model for construction: 1) least mature; 2) less mature; 3) mature. Higher maturity levels are associated with increased stakeholder capacity to recognize construction hazards.

While leveling maturity models are familiar to stakeholders, they possess inherent rigidity, meaning that changes in an organization's business processes also impact its maturity. Consequently, objects need to be reassessed to ensure alignment with evolving circumstances, thus presenting a weakness that becomes an advantage for factorized maturity models.

Factorized maturity models exhibit similarities to Critical Success Factors (CSFs) analysis and have been less frequently employed in prior research compared to leveling models. These models are constructed based on a collection of factors that reflect the maturity of the object [28-30]. Preliminary investigations have identified maturity models comprising 3 [8], 5 [31], 7 [5], 8 [32], and 9 [30] factors. For instance, Skipper and Bell developed a maturity model for measuring the leadership behavior of construction project managers. A project manager is considered mature if they exhibit all of the following factors: 1) modeling the way; 2) inspiring a shared vision; 3) challenging the process; 4) enabling others to act; 5) encouraging the heart.

Factorized maturity models offer greater flexibility compared to leveling models by remaining unaffected by changes in business processes. Adjustments in the number of factors may occur without compromising the identification results because the factorized model measures various aspects of maturity. For example, a project owner may demonstrate a high level of maturity in psychosocial and public communication aspects but possess a low level of safety competency. Conversely, another project owner may exhibit strong leadership and participatory attributes but have limited proficiency in public communication.

2. METHODOLOGY

A quantitative approach was used to develop a maturity model to measure the project owner's safety leadership. This methodology is based on a technical approach related to data collection and analysis techniques. However, identifying variables and indicators along with the validation procedure is an activity performed before data is collected.

2.1 Variables, indicators and validation

Variables are divided into two parts, namely, independent (exogenous) and dependent (endogenous). The independent variables consist of five aspects and the dependent consists of one. Indicators (observed variable) are attributes that reflect variables, and all depend on identifying factors related to safety leadership maturity. These are identified by conducting an in-depth literature analysis.

An expert validation was performed through Delphi round technique to ensure that the variables and indicators used in this research are applicable in the Indonesia's construction industry. A total of six experts contributed in this process from academics (two experts) and each representative of regulator, Indonesia's construction safety committee, construction project owner, and contractor.

Through the Delphi round technique, all the experts agreed that the independent variables, that consists of five aspects can shape two types of leadership. These are aspects that lead to two styles: 1) personality of the leaders (X1 and X5); 2) ability to have a required relationship between stakeholders (X2, X3 and X4). Experts also agreed that these two are the crucial styles for leading the construction industry, particularly in terms of safety. All validated variables and indicators are described in the Table 1 [33-46].

2.2 Data collection

Data were collected through questionnaires distribution to the party which has capacity to assess the project owner, i.e., contractors [47-50]. The contractors are considered to be the appropriate party since they have direct interaction to project owners. Questionnaires were spread to the contractors of middle to big size of Indonesia's construction project. According to the regulation, a middle size construction project has a minimum value of 100 billion Indonesian Rupiah and the big size of 250 billion. It is meant to avoid the project with low-risk safety and ensure the homogeneity of the respondents.

A total of 598 contractor personnels from 246 projects were contacted, both direct and indirect (online survey). There was no restriction on selecting the projects, as long as its budget is middle or big size. However, only 324 personnels that sent back the questionnaires. Thus, the responses rate was 54.18% and mostly came from the direct survey. The questionnaire consists of a number of questions based on the indicators. Therefore, a total of 37 questions is included. To perform the assessment, contractors should provide answer on each indicator using the Likert scale of 1-5. The number of 5 in Likert scale illustrates that the indicator perfectly describes the actual condition of project owners while the number of 1 is the opposite.

2.3 Data analysis

Structural Equation Modeling (SEM) is used to develop the maturity model and determine the relationships between variables [28, 50]. The SEM statistical method is highly cross-sectional, linear, general and uses Confirmatory Factor Analysis (CFA) and multiple regression analysis to check and justify relationships in a hypotheses model. It is explaining a particular phenomenon in the theoretical structure analysis [51]. Since this research focused on examining the relationship between safety leadership and safety performance, therefore the SEM method is used to analyze whether it is also applies in Indonesia's construction sector or not, especially project owner with the main object.

There are two major steps in performing SEM, i.e., pre-test and model development. SEM's pre-test comprises of three measurements, namely outliers screening, validity and reliability test, and common method bias. Furthermore, the SEM model development is consisting of structural and measurement model [52]. The structural model is used to describe the relationship between latent variables (independent and dependent variables). The relationships are hypotheses to be tested by the z score parameter which has a predetermined number to see the significances. Meanwhile, the measurement model is used to link latent variables with its indicators and described the significancy by the loading factor. It is a parameter to define the ability of an indicator to reflect its latent variable. The more indicators passed the loading factor's threshold, the stronger the latent variable to describe the relationship between safety leadership and safety performance.

Table 1. Variables and indicators on project owner safety leadership maturity model

Variables	Indicators/Observed Variables		References
X1: Leader property & character maturity	X1.1	Project owner's commitment to safety implementation	[21, 33]
	X1.2	Persistence, perseverance, and consistency of the project owner	[34]
	X1.3	Trustworthy/reliable and honest	[6]
	X1.4	Ability to set an example to project stakeholders	[35, 36]
	X1.5	Able to gain individual respect based on professional relationships	[37]
	X1.6	The project owner's ability to affect others	[35]
X2: Psychosocial maturity of the project owner	X2.1	Able to be recognized by contractors, consultants, and workers for providing safety motivation	[29, 37]
	X2.2	The project owner can provide coaching to solve construction problems in the field	
	X2.3	Able to carry out sufficient control and supervision to maintain the safety	[37]
	X2.4	Internal project stakeholders are concerned about the safety of the owner	
	X2.5	Able to ensure that every safety regulation is complied with by internal stakeholders through professional closeness	[22]
X3: Participatory maturity of the project owner	X3.1	Can make reward & punishment policies	[39]
	X3.2	Able to make SOP as the implementation of reward & punishment policy	
	X3.3	Able to consistently visit construction projects with stakeholders through management walkthroughs and safety patrol	[22]
	X3.4	Able to carry out performance evaluations by reviewing stakeholder safety records	
	X3.5	The project owner's persuasive ability to operate the safety system	[29, 37]
X4: Maturity of the project owner's public communication	X4.1	Able to provide adequate information regarding the project to the surrounding community	[39]
	X4.2	Able to be recognized by exposed and project-affected communities through the provision of a responsive contact representative	
	X4.3	Able to report the Environmental Management Plan-Environmental Monitoring Plan to stakeholders in the environmental sector	[13]
	X4.4	Able to mediate the settlement of external problems resulting from project impacts	[37, 40]
	X4.5	Persuasion ability to community leaders which focuses in humanity and environment	[29, 37]
X5: Maturity of the project owner's safety competence	X5.1	Able to formulate project safety goals	[40]
	X5.2	Able to conduct a review of safety methods	[37]
	X5.3	Have creativity and innovation in maintaining safety	[8, 37]
	X5.4	Able to become a reference party for stakeholders in solving safety problems	
	X5.5	Ability to evaluate safety audits and accident investigations	[41]
Y: Construction project safety performance	Y1	Able to determine the number of Occupational Safety and Health experts needed in the construction work package	[42]
	Y2	Able to identify, assess and determine the level of construction safety risk in tendered packages	[19, 20, 43]
	Y3	Able to determine the owner's estimate, which includes the safety management cost	[20, 22]
	Y4	Able to consult with construction Occupational Safety, Health experts, and safety officers in conducting auctions	[6, 19, 20]
	Y5	Able to discuss and approve documents on the implementation of safety management at the Pre-construction Meeting	[19, 20, 44, 45]
	Y6	Able to carry out random and routine monitoring & evaluation of the construction safety implementation based on the guidelines	[19, 20, 42, 44]
	Y7	Able to make construction safety aspects as an assessment factor in determining the winner of a contractor	[20, 46]
	Y8	Able to provide a certificate of zero work accidents to contractors with good safety performance	[19, 20, 33]
	Y9	Able to provide periodic warnings and temporarily stop work through inspection of the construction safety management implementation	[19, 20, 42]
	Y10	Have periodic reports on the achievement of construction safety	[19, 20]
	Y11	Able to compile a work Terms of Reference (TOR) based on documented information on previous similar work	[42]

3. RESULTS

3.1 Respondent demographics and pre-test

Data were collected from the contractors personnels in 185 projects. The respondents were initially classified into two main divisions, i.e., contractors from Stated Owned Enterprises (SOE) and the private sector. SOE dominance in the Indonesian construction market makes this classification important to review. Approximately 86.69% of respondents came from SOE, and the rest were from the private sector. The respondent's position also plays an important role in ensuring the confidence level toward the questionnaire input. Site managers have the largest respondents (52.63%), followed successively by project managers (24.15%), HSE supervisors (9.60%), HSE managers (6.81%), technical staff (6.19%), and the Board of Directors (BOD) of contractor companies (0.62%), as shown in Figure 1.

Before entering model development, all variables and indicators are pre-tested to prevent the use of biased data (see results in Table 2). The first step is removing outliers from a dataset of 324 respondents out of which 39 have the potential to cause data bias. The next step is to test the validity using six indicators, namely Kaiser-Meyer-Olkin (KMO) higher than 0.50, Measure of Sampling Adequacy (MSA) minimum of 0.50, Bartlett's Test of Sphericity Significance maximum of 0.05, Loading Factor minimum of 0.50, Component Matrix Column showing the component matrix in 1 column, and Communalities minimum of 0.40. Based on validity testing, indicators with only 1 parameter mismatch are declared invalid and are not included in model development. This is followed by the reliability test on each latent variable with a Cronbach's Alpha parameter of at least 0.70.

The final pre-test is the Common Method Bias (CMB). If the entire data is collected from one source, in this context from contractors, and during one time, the CMB method can pose a risk regarding consistency of analysis [53]. A Hermann's one factor test was performed to know the CMB threat. The test shows that all variables only produce 38.668% of the inconsistency that is lesser than 50%. Therefore, it is assured that the CMB was not a threatening problem for developing a SEM model.

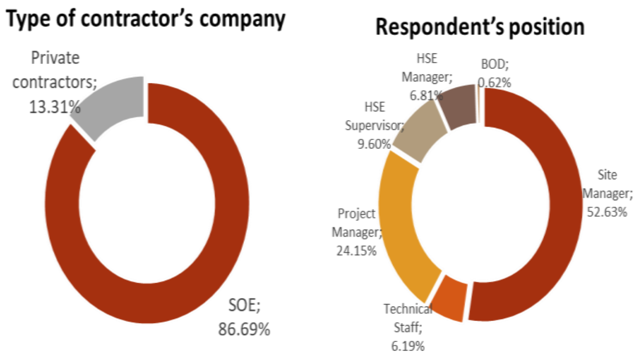

Figure 1. Respondent demographics

Table 2. Validity and reliability test

Variables	Reliability (Cronbach's Alpha)	Validity							
		Indicator	KMO	MSA	Barlett's Sig.	Loading Factor	Comp. Matrix Column	Communalities	Result
X1: Leader property & character maturity	0.876 (Good)	X1.1	0.853	0.827	0.000	0.812	1 component extracted	0.659	Valid
		X1.2		0.814		0.807		0.652	Valid
		X1.3		0.879		0.829		0.687	Valid
		X1.4		0.881		0.784		0.615	Valid
		X1.5		0.877		0.766		0.587	Valid
		X1.6		0.848		0.722		0.521	Valid
X2: Psychosocial maturity of the project owner	0.731 (Acceptable)	X2.1	0.754	0.759	0.000	0.625	1 component extracted	0.390	Invalid
		X2.2		0.759		0.776		0.602	Valid
		X2.3		0.791		0.716		0.512	Valid
		X2.4		0.776		0.631		0.424	Valid
		X2.5		0.710		0.797		0.635	Valid
X3: Participatory maturity of the project owner	0.803 (Acceptable)	X3.1	0.756	0.727	0.000	0.787	1 component extracted	0.619	Valid
		X3.2		0.718		0.826		0.682	Valid
		X3.3		0.826		0.463		0.214	Invalid
		X3.4		0.778		0.829		0.688	Valid
		X3.5		0.811		0.685		0.469	Valid
X4: Maturity of the project owner's public communication	0.864 (Good)	X4.1	0.840	0.829	0.000	0.841	1 component extracted	0.707	Valid
		X4.2		0.814		0.849		0.722	Valid
		X4.3		0.854		0.854		0.730	Valid
		X4.4		0.902		0.653		0.427	Valid
		X4.5		0.867		0.818		0.669	Valid
X5: Maturity of the project owner's safety competence	0.876 (Excellent)	X5.1	0.894	0.879	0.000	0.823	1 component extracted	0.678	Valid
		X5.2		0.880		0.822		0.676	Valid
		X5.3		0.890		0.804		0.647	Valid
		X5.4		0.866		0.846		0.715	Valid
		X5.5		0.895		0.796		0.634	Valid
Y: Construction project safety performance	0.972 (Excellent)	Y1	0.766	0.618	0.000	0.515	1 component extracted	0.336	Invalid
		Y2		0.409		0.148		0.689	Invalid
		Y3		0.850		0.741		0.549	Valid
		Y4		0.524		0.788		0.692	Valid
		Y5		0.468		0.124		0.658	Invalid
		Y6		0.550		0.836		0.724	Valid
		Y7		0.869		0.738		0.549	Valid
		Y8		0.849		0.753		0.575	Valid
		Y9		0.884		0.728		0.541	Valid
		Y10		0.863		0.758		0.596	Valid
		Y11		0.796		0.765		0.653	Valid

3.2 Maturity model development

The hypothetical model was built based on the assumption that the x variable (safety leadership) in the construction work system can affect the assessment of the project owner's maturity level as an endogenous variable. A hypothesis model is a form of relationship between latent variables as an interpretation of the in-depth research on the literature. There are two exogenous variables, including X1/ξ1 and X2/ξ2 and four endogenous variables, namely X3/η3, X4/η4, X5/η5, and Y/η6. The variables X3, X4, and X5, apart from acting as endogenous for X1 and X2, are also exogenous for Y. All the relationships of all the above mentioned variables described in the Table 3.

Table 3. Relations between variables in the hypothetical model

Notation	Relations Between Variables	Description	References
1/γ31	X1/ξ1→X3/η3	The maturity of the property aspect & the character of the project owner promotes the participative aspect.	[22, 38]
2/γ32	X2/ξ2→X3/η3	Psychosocial maturity supports the participative aspects of the leader's properties and character.	[34, 40]
3/γ42	X2/ξ2→X4/η4	The psychosocial maturity of the project owner shapes the public communication aspect.	[16]
4/β63	X3/η3→Y/η6	The participatory maturity of the project owner directly determines the safety performance of the construction.	[12, 54]
5/β65	X5/η5→Y/η6	The maturity of the project owner's safety competency directly determines the construction safety project performance.	[35, 55]
6/β64	X4/η4→Y/η6	The maturity of the project owner's public communication directly determines the safety performance of a construction project.	[12, 56]

Table 4. Goodness of fit

Goodness of Fit Parameter	Overview Parameter	Result	Conclusion
	Absolute Fit		
Chi Square (X^2)/Degree of Freedom	Expected to be small (<3.00)	617.086/521=1.18	Good Fit
P-value of Chi Square (X^2)	>0.05 Good Fit; ≤0.05 Poor Fit	0.000	Poor Fit
Root Mean Square Error of Approximation (RMSEA)	<0.08 Good Fit;<0.10 Marginal Fit	0.063	Good Fit
Goodness-of-Fit Index (GFI)	≥0.90 Good Fit; 0.80≤GFI<0.90	0.851	Marginal Fit
Standardized Root Mean Square Residue (SRMR)	≤0.05 Good Fit;<0.30 Marginal Fit	0.028	Good Fit
Expected Cross-Validation Index (ECVI)	Close to ECVI Saturated	ECVI Default=2.597 ECVI Saturated=2.481	Good Fit
	Incremental Fit		
Comparative Fit Index (CFI)	Values range from 0-1. the closer to 1 the better or Good Fit Yield≥0.90 Good Fit 0.80≤Yield<0.90 Marginal Fit	0.915	Good Fit
Normed Fit Index (NFI)		0.851	Marginal Fit
Tucker-Lewis Index (TLI)		0.905	Good Fit
Incremental Fit Index (IFI)		0.916	Good Fit
Relative Fit Index (RFI)		0.834	Marginal Fit
Adjusted Goodness of Fit Index (AGFI)		0.821	Marginal Fit
	Parsimonious Fit		
Parsimony Goodness of Fit Index (PGFI)	≥0.80 Good Fit;<0.80 Marginal Fit;<0.50 Poor Fit	0.708	Marginal Fit
Akaike Information Criterion (AIC)	The AIC value close to the Saturated AIC value indicates a Good Fit	AIC=735.086 Saturated AIC=702.000	Good Fit
Consistent Akaike Information Criterion (CAIC)	The CAIC value close to the Saturated CAIC compared to the Independence AIC indicates a Good Fit	CAIC=1009.375 Saturated CAIC=2333.7909 Independence AIC=4319.751	Good Fit

Based on the SEM pre-test result (see Table 2), 5 indicators were invalid and were not included in the model, namely X2.1, X3.3, Y1, Y2, and Y5. These excluded from the model since it doesn't meet the parameter of communalities (X2.1, X3.3 and Y1) and loading factor (Y2 and Y5). Further, through a series of trials and errors, 6 additional indicators, namely X3.5, X4.1, X5.3, X5.5, Y4, and Y6 need to be removed to produce a model which fulfills all applicable parameters. Even though these 6 indicators meet the pre-test parameter, it interferes the model's stability as described by Goodness of Fit (see Table 4). This indicates that the total number of indicators used is 26, as shown in Figure 2.

The goodness of fit test is the final step before carrying out structural tests on the SEM model. It is used to test whether the resulting model describes the actual conditions and consists of absolute, incremental, and partial fits. According to Wijanto [57] and Hair et al. [52], a SEM model can proceed to the next analysis if the number of good fit exceeds the marginal and poor fit. This safety leadership maturity model resulted in a good fit in 9 out of 15 reviews, with a marginal and poor fit of 5 and 1 parameters. The only poor fit parameter is the P-value of Chi Square. It describes the error value of Chi Square from the statistical calculations [52]. Meanwhile, the Chi Square explains the possibility of failure of indicators to reflect the whole model. However, since the Chi Square results the value of 1.18 (far above the threshold of 3.00), the poor fit result of P-value of Chi Square is tolerable.

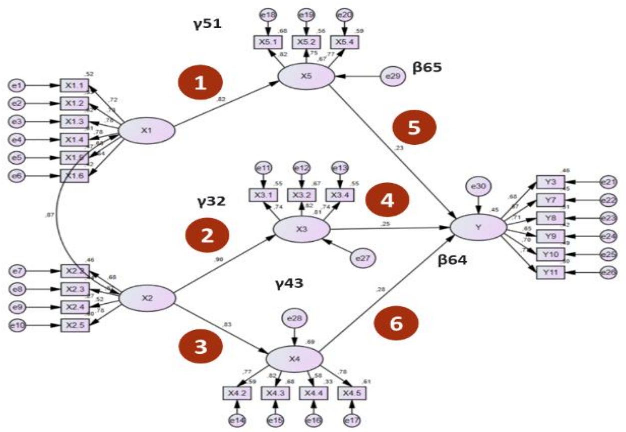

Figure 2. Project owner safety leadership maturity model

This model has six relationships between latent variables, which are further tested in the structural model. The value of the relationship between variables through the z score (gamma and beta) according to the minimum parameters is 1.96, therefore it is significant. The results of testing the structural model against the initial hypothesis show that all the relationships between variables are positive and significant (see Table 5). The smallest and largest z score (beta) is the relationship between X 4/Y and X 2/X 3, with a value of 1.967 and 11.869.

Structural model testing becomes elementary analysis for deep-diving in measurement model. The ability of indicators to reflect its latent variable is described by its loading factor. An indicator is reflecting its latent variable significantly according to the minimum parameters of 0.50 [52]. However, the primary target of an indicator is to obtain the loading factor with the minimum number of 0.70 where it is considered as highly-significant to reflect its latent variables. Through some adjustments on the number of indicators, all of them are highly-significant in reflecting its variable, except X 2.4 (0.516) and X 4.4 (0.578). Nevertheless, these two indicators still fulfill the minimum parameters of loading factor which considered as significant (see Table 6).

Table 5. Structural model testing results

No.	Relationship Between Latent Variables	Estimate [1]	S.E. [2]	|z| [1, 2]	Conclusion
1	X1→X5	1.093	0.113	9.704	Significant relationship
2	X2→X3	1.124	0.095	11.869	Significant relationship
3	X2→X4	0.886	0.077	11.449	Significant relationship
4	X3→Y	0.158	0.091	2.294	Significant relationship
5	X4→Y	0.209	0.080	1.967	Significant relationship
6	X5→Y	0.170	0.085	2.007	Significant relationship

Table 6. Measurement model testing results

Variables	Indicator	Loading Factor	Result
X1: Leader property & character maturity	X1.1	0.721	Highly-significant
	X1.2	0.730	Highly-significant
	X1.3	0.784	Highly-significant
	X1.4	0.780	Highly-significant
	X1.5	0.683	Highly-significant
	X1.6	0.644	Highly-significant
X2: Psychosocial maturity of the project owner	X2.2	0.680	Highly-significant
	X2.3	0.667	Highly-significant
	X2.4	0.516	Significant
	X2.5	0.778	Highly-significant
X3: Participatory maturity of the project owner	X3.1	0.744	Highly-significant
	X3.2	0.817	Highly-significant
	X3.4	0.742	Highly-significant
X4: Maturity of the project owner's public communication	X4.2	0.771	Highly-significant
	X4.3	0.823	Highly-significant
	X4.4	0.578	Significant
	X4.5	0.784	Highly-significant
X5: Maturity of the project owner's safety competence	X5.1	0.824	Highly-significant
	X5.2	0.750	Highly-significant
	X5.4	0.767	Highly-significant
Y: Construction project safety performance	Y3	0.678	Highly-significant
	Y7	0.673	Highly-significant
	Y8	0.713	Highly-significant
	Y9	0.645	Highly-significant
	Y10	0.699	Highly-significant
	Y11	0.709	Highly-significant

4. DISCUSSION

4.1 The leadership pattern of the project owner and its maturity aspects

The relationship model of the leadership maturity and safety performance is a factorized model. It is indicating that a leader with a strong character (X1), good psychosocial (X2), intensive participatory (X3), good public communication (X4), and high safety competence (X5) is mature. The factorized model allows the project owner to be able to have these factors according to needs and abilities randomly. Ownership of certain maturity factors in the factorized model can produce different leadership patterns.

Leaders need to be trustworthy, reliable, honest (X1.3), and able to set examples to their subordinates regarding safety (X1.4). These two indicators are the two most significant indicators in reflecting the maturity of the leader's properties and character (X1). Furthermore, through these two indicators, a project owner can have the ability to formulate project safety goals (X5.1) with the ability to become a reference party in solving safety problems (X5.4). The last two indicators reflect the safety competence of the project owners (X5). This first pattern shapes the leadership styles with strong intrapersonal maturity, both soft and hard skills.

In the next pattern of leadership, a leader needs to have the ability to provide coaching (X2.2) and be able to apply policies to internal stakeholders through professional closeness (X2.5). These two indicators are steps in forming psychosocial maturity (X2) and form the basis for the creation and application of rewards and punishments in projects (X3.1 and X3.2) which reflects the participatory maturity (X3). Furthermore, these last two indicators could enable communication maturity of project owners (X4) reflected by significant coordination with agencies in the environmental sector (X4.3) and the ability to persuade community leaders which focuses in humanity and environment (X4.5). This second leadership pattern illustrates the leadership style of project owner to have a good relationship with the relevant external stakeholders.

4.2 How the project owner leadership maturity shapes project safety performance

Participatory maturity, public communication maturity, and safety competency maturity are latent variables of the project owner leader used to produce a high safety performance construction project. The higher the maturity of the project owner, the more significant the contribution in all stages of construction. The project safety performance identified through the Y variable and its indicators illustrates the successful construction work safety management implementation formed by the owner's contribution. The safety management stages are mainly divided into two, namely before and during construction. Furthermore, an additional stage when an accident occurs is required to identify a more detail contribution. Therefore, the contribution is deep-dived three main stages of a construction project, namely: 1) before construction (assessment, planning, design, and selection), 2) during the construction, and 3) when an accident occurs.

4.2.1 Project owners' contribution before the construction

The project owner's contribution before the construction according to the model are as follows:

(1) Ensure that the cost component of the construction work safety management system is within the project value (Y3)-at the planning stage.
(2) Select a contractor with a clear company safety policy (Y7)-at the project procurement stage.

Specifications (Y7) and construction work safety management system components in the Owner Estimate (OE) (Y3) are important indicators in ensuring project safety performance. This is considered important due to its very close relationship with quality (specifications) and cost (OE) [58]. The linkage of safety with other project performance, such as time, communication, etc., is less significant than quality and cost. Specifications determine the construction implementation method, which is often the basis for work accidents. Meanwhile, insufficient costs in maintaining safety are also often a factor for contractors to reduce the required safety facilities and infrastructure. This includes the construction work safety management system cost component in the OE and ensuring payment in accordance with the progress of work on each item in the Work Breakdown Structure (WBS), which are crucial steps by the project owner in ensuring the availability of adequate safety facilities.

Lack of detail of cost component in the OE may results in serious problems. Shikdar and Sawaqed [59] explained that health and safety program, sourced from an adequate fund, directly affect various issues in workplace, i.e., job satisfaction, poor ergonomics, personnel's complaints, absence and decrease in the productivity. Further, a study in 455 Spanish companies reported that small allocations of fund for safety management system can lead to weak financial and economic competitiveness performance of construction industry [60].

All of the explanations above emphasize the importance of the procurement stage in a construction project. The project owner needs to ensure that the winning bidding contractor has good construction work safety management system with adequate source of funds. The mistake of selecting a contractor in the early stages is the beginning of project failure in achieving zero accidents. Therefore, the project owner must always be involved in ensuring that the implementation of procurement is in accordance with standards, both in terms of legal basis and best practice.

4.2.2 Project owners' contribution during the construction

The construction stage is a crucial phase in implementing construction work safety management system. Based on the model, the main contribution of the project owner during the construction period in ensuring zero accidents is as follows:

(1) Provide recognition, rewards, and incentives for positive construction safety performance (Y8).
(2) Routinely supervise contractor activities with safety risks (Y10).
(3) Routinely carry out field observations on unsafe worker behavior and habits (Y9).

A study of construction safety performance indicators in 14 countries and 41 papers proved that routine inspection is ninth most common of 48 identified indicators [20]. An intensive inspection is very important to ensure that all the component stated in the safety management plan, which usually includes in the contract, are implemented by the contractor. Project owners need to perform a variance analysis of the safety performance weekly. This could prevent accident effectively by preventing workers from unsafe behavior and habits. It is also called as a job site audits as the fifth most common indicators [20].

Another important thing at the construction stage is the project owner ensuring the implementation of all contributions made by each party. Hansen stated that a clear construction contract is one crucial step in ensuring that each party contributes [61]. The maturity model results have two main contributions from project owner, such as those related to the supervision of contractors (Y10) and specific to the workforce (Y9). When there is a discrepancy in the implementation of the work, there should be steps that are regulated to take corrective action. Therefore, a good construction contract must have a Standard Operating Procedure (SOP) that provides notification of inappropriate actions by one of the parties, including safety [62]. Given that the construction contract is one of the products of the project owner, leadership maturity is the key to enforcing construction work safety management system regulations based on the contract.

4.2.3 Project owners' contribution when the accident occurs

This research also discussed the project safety steps that must be mitigated properly when an accident occurs. The main contribution of the project owner is the speed of handling (Y11). The faster the handling process, the better the safety performance of construction projects. The significance of this indicator indicates that the lag process is still needed in determining safety performance. This stage is a differentiator since the lead indicators shape the safety performance before and during construction. All of the project owner's contributions that represent leadership maturity are efforts to achieve one main goal in construction projects, namely zero accidents.

5. CONCLUSIONS

Construction safety has become an important topic of discussion in line with the growth of its activities in Indonesia. Stakeholders need to increase awareness of safety issues by implementing strategies that can reduce accidents. One of the best ways to increase awareness is by fostering a safety culture by the project owner, who has responsibility to involve in all stages of the project. It is very crucial since the project owner is rarely discussed in Indonesia's construction industry. This model can improve the stakeholders' awareness, particularly in middle to big size construction projects in Indonesia, that safety performance of the contractors is highly dependent on the project owner safety leadership. This led to the development of a factorized maturity model to explore the relationship between safety leadership and safety performance, shaped by a leader's maturity property and characters, psychosocial, participatory, communication, and competence.

All relationships between variables have a high significance in shaping safety performance, with two leadership patterns used to form maturity. The first pattern describes the intrapersonal maturity of the owner, both soft and hard skills, which is illustrated by the reliable character (X1.3) and ability to be a role model (X1.4). The second maturity leadership pattern is related to the ability of a project owner to have a required relationship between relevant (external) stakeholders, which is related to the owner's ability to provide coaching (X2.2) and professional closeness (X2.5). These two patterns can be applied separately or simultaneously. Project owners can choose the most needed pattern according to construction project's characteristics. A project with complex construction work method may need a project owner leader with strong first pattern. Meanwhile, a project with high social safeguard issues may need the second pattern. Therefore, through these two leadership patterns, construction project owner's need to make three main contributions as a form of maturity. These include: 1) ensuring that the construction work safety management system cost component is included in the OE (Y3), 2) choosing a contractor with a clear company safety policy (Y7), and 3) ensuring the speed of accident handling (Y11). The first two safety performance indicators show the lead indicator, and the third indicates the lag indicator.

The use of factorized maturity model could lead to further research since the construction industry uses leveling model more. The factorized model in this research is limited to the Indonesia's context of project owner. The application of this model in other countries may benefit to some enticing findings that would enrich the safety construction knowledge.

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