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INTEGRATION OF STRUCTURE, CONDUCT, PERFORMANCE INTERRELATION OF INSTITUTIONAL POLICY AND SAFETY CULTURE IN CONSTRUCTION INDUSTRY

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Abstract

Construction has been one of the major industries contributes significantly to the economy. However, its poor accident record of 32% has raised a noticeable problem in comparison to other industries in the construction sector in Indonesia, the main problems are a very bad safety culture, policies that are not implemented and institutions that are not yet integrated which impact in companies not being mature in achieving safety performance. This study aims to improve the policies and institutions in term of maturity level, safety performance, and project performance in Indonesia's construction industry. Primary and secondary data in this study are surveys to 293 respondents and construction accident data for the validation process. The variables measured in this study are policy, institutional, safety culture, safety maturity level and safety performance. Gathered from the literature with expert's validation and actual questionnaire survey analysed using the Structural Equation Model-Partial Least Square Method. The conclusion in this study explains that institutional renewal to become the National Construction Safety Committee, innovation of reward and punishment policies, implementation of construction safety management systems significantly increases the maturity of safety culture in the construction sector in Indonesia.

Keywords: Institutions, Policies, Safety culture, Safety maturity level, Safety performance.

1. Introduction

The uniqueness in the construction industry is a special characteristic compared to other industries. With the existence of problems in each construction project which is unique in its implementation.[1]. The planning and project implementation stage is a critical stage due to time pressures and limited budget; this is a characteristic that means that construction projects are different from projects in other industries. Therefore, the construction project has an impact, namely unsafe conditions and it can be harmful to the workers [2].

The construction industry has a huge impact on the economy in Indonesia. Job creation, according to data from the Ministry of Manpower and Transmigration, shows that around 4.5 million workers in Indonesia work in the construction sector, and this accounts for 7-8% of the total number of jobs in all industrial sectors. In 2015, data shows that the number of workers in the construction sector even reached 7.72 million people [3].

In the 2014 - 2019 government period, the development of the construction service industry is a priority agenda that has direct implications for domestic problems in the form of the dynamics of construction safety culture which is still a problem in every construction project [3]. These challenges require structuring and strengthening safety regulations and institutions in the field of construction services to ensure that the construction service sector can grow, develop and have added value that increases in a sustainable, professional and competitive manner [4]. One of the efforts made by the Government is by making Construction Services Law No. 2 of 2017 [5] as a new paradigm in developing the construction service sector, especially work safety issues

Safety level (safety improvement) has been evolving since 1960 by improving its design and technology. It wasn't long after, in the 1970s aspects of human resource management and safety played a major role. In the early 2000s until today, the focuses are on system management and developing a culture in managing work safety as seen in Fig. 1.

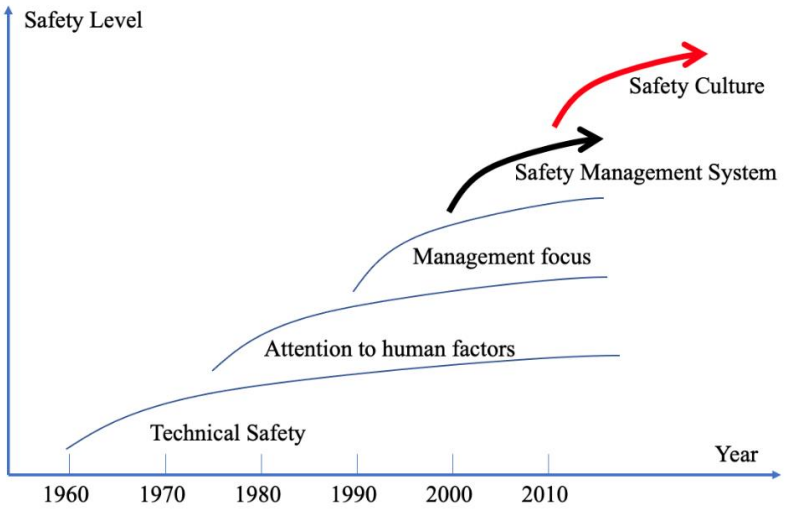

Fig. 1. Contributed factors to safety level [6].

In the oil and gas industry in Malaysia, there are four basic stages in a behaviour-based approach to reduce the level of work accidents which are identification, observation, intervention, review and monitoring, this research shows the *Behaviour Based Safety* (BBS) approach implemented in the Malaysian oil and gas industry can minimize accidents, change unsafe behaviour, and improve the quality and safety environment [7]. In Norway, the safety culture in the oil and gas industry is developed effectively because drilling operations take aspects such as worker training, competence, communication, management, documentation and activity schedules into account [8].

Identification of the problem in this research is that work safety is not only the responsibility of the contractor but the responsibility of all stakeholders including owners, developers, designers, quantity surveyors and all elements both the community and institutions involved in every stage of the construction industry [9]. Work safety in the construction industry has a broader dimension, which is safe for workers, safety for the public, safety for property and safety for the environment those require a systemic, integrative, and comprehensive approach from all socio-engineering aspects of the construction organization both upstream and downstream.

Efforts to improve workplace safety culture have been carried out with various approaches and one of them is through the implementation of policies related to work safety. Meanwhile, Law No. 2 of 2017 in Chapter VI Article 59 states that in every construction service implementation, users and providers are required to meet the standards of security, safety, health and construction sustainability [10]. This is the background for improving policies and institutions as a strategy in developing a safety culture that will be carried out in this study. The purpose of this study is to integrate policies and institutions in building a safety culture to increase the maturity level and construction safety performance.

2. Study Literature

In this study, a conceptual model of safety culture theories was built based on the relevant previous research literature. Developing the theory in this study states that safety culture has four dimensions in shaping character on construction project, 1) safety behaviour culture, 2) safety management and norm culture, 3) physical safety culture and 4) safety ideological culture [11]. This theory, it is developed with policy and institutional variables as forming a safety culture in the construction industry in Indonesia. Integration between structure conduct and performance in policies and institutions is essential in building a safety culture and increasing the level of maturity in construction service companies. Various kinds of literature explain that policies and institutions in a separate dimension can form the characteristics of safety culture effectively and efficiently. Meanwhile, the policy itself is the main variable in shaping the safety institution and determining stakeholders according to the character of a construction project [12].

One of the efforts to prevent workplace accidents effectively is by improving the policy or regulation of the work safety management system in the construction sector. The empirical implementation to minimize the risk of work accidents is that the government needs to develop, enforce and supervise safety regulations and procedures regularly and strictly [10]. The conceptual model in this study is explained by the relationship between safety culture variables, institutional variables, policy variables, maturity level variables and safety performance variables. The relationship

between these variables will explain the conditions in developing a construction safety culture. So that the identification of the hypothesis in this study is how policies and institutions can build a safety culture and increase the level of maturity in construction service companies to improve safety performance.

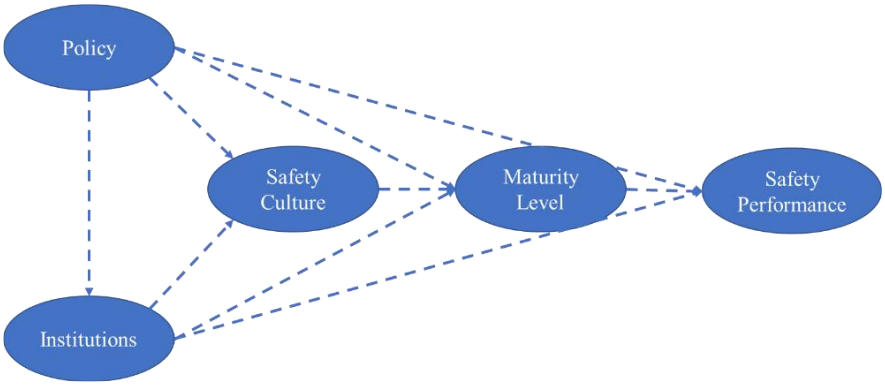

Fig. 2. Research conceptual framework.

The conceptual framework in this study as seen in Fig. 2. The research will include institutions policy as the main variable at the macro level in shaping safety culture. The meso level this research uses the maturity level variable as a basis to improve the performance of construction service companies. The micro-level the project performance variables will be used to know the significant impact of building a construction safety culture that is formed in this study.

Meanwhile the institutional variables are built based on the roles and functions of safety stakeholders in increasing the capacity of the institutions involved in developing a construction safety culture in Indonesia. The institutional is a process of emphasizing safety regulations so that they can be implemented on every element consequently macro, meso and micro [13].

Safety culture is a combination of attitudes, values, beliefs, norms and perceptions of workers in an organization that has a joint relationship to safety, safe behaviour and its practical application [11]. The novelty in this research is integrating the influence of policies and institutions in intervening safety culture in the construction industry.

3. Methodology

This section will explain the research methods to be carried out which include the selection of research strategies, the research process, identification of research variables, research instruments, data collection and analysis methods used.

3.1. Identification research variables

The variables of this study were obtained from the results of a literature study that had been synthesized on the research framework which was then validated by safety experts in order to obtain the variables to be measured in this research.

The explanation of the variables and their definitions that will be used in this study is shown in Table 1.

Table 1. Research variables.

Research variable	Definition	Reference
Policy	Rules and targets (goals) of an organization related to safety is formally declared by the leader.	[9, 14]
Institutional	Rules that facilitate institutions or organizations in coordinating and working together to achieve the desired common goals.	[15, 16]
Safety culture	Safety culture is a combination of the attitudes, values, beliefs, norms and perceptions of prospective employee (trainee) in an organization, which have a mutual relationship to safety, safety behaviour, and their practical application in the production process.	[1, 11, 17-20]
Safety maturity level	The process of reaching maturity in an organization is accompanied by changes in behaviour.	[21, 22]
Safety performance	How the organization / company can be aware of high-risk and error-prone work can lead to a reduction in accidents.	[23-25]

Variables identification in this study is used to assist in determining the data collection and also the technical tools of content and construct validation processing in order to achieve validated variables so that it can be used in the structural equation model analysis process.

3.2. Research methodology

The methodology used in this study uses an input-process-output approach in answering the research objectives

Input

The first thing to do in this research is a literature study to determine the research variables as shown in Table 1 obtained from various references from previous studies and regulations on construction safety management systems.

Process

After the variables are formed from the literature study, then validation is carried out by the expert to validate the variables that have been formed from the results of the literature study. There were 5 experts selected in this study with a minimum criterion of master's education in construction safety and a minimum of 15 years of experience in the construction field. The next step is to conduct a pilot survey with 30 respondents which aims to validate the research questionnaire that has been prepared in this study to prove whether the questionnaire acceptable to the respondents. Then after the pilot survey was carried out, the next step was to conduct a survey to 293 respondents with minimum bachelor's degree criteria and

at least 5 years of experience in the construction industry. After the questionnaires were collected, a Structural Equation Model Analysis was carried out with SmartPLS software to determine the relationship between the variables of policy, institutional, safety culture and maturity level which had implications for project performance. Then the last step of this research is to carry out final validation of the results of the study which aims to integrate the structure, behaviour and performance of the Government and Construction Stated-Owned Enterprise

Output

The results obtained from this study are to prove that the intervention carried out according to the recommended strategy can reduce the accident rate in the construction industry

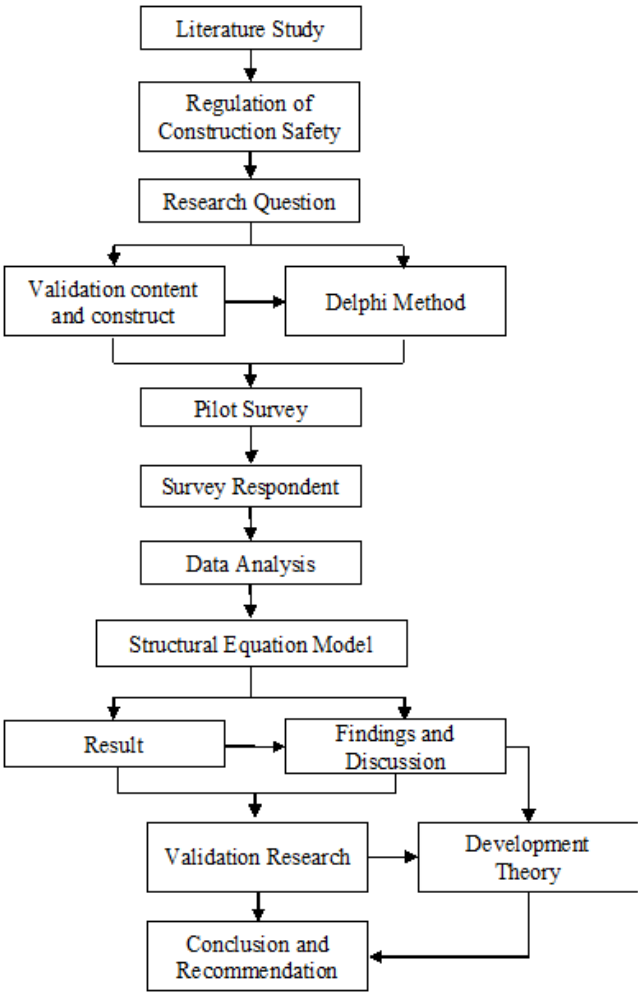

Fig. 3. Research methodology.

In Fig. 3, it explains the implementation mechanism of each stage is discussed based on the *input-process-output* diagram. The discussion of *input* includes an explanation of the types of data used as well as the data collection instruments at each

stage. Discussion of the *process* is a discussion related to data processing methods or data analysis used in each stage. The discussion of the *output* is an explanation related to the description of the results or findings obtained from each stage.

4. Results and Discussion

4.1. Research data analysis

The data collection process was carried out using validation by 5 construction safety experts. as in Table 2

Table 2. List of safety expert for content and construct validation.

Expert	Position	Education	Experience
Expert 1	Instructor and Lecturer	Master's degree	38 Year
Expert 2	Practitioner in Construction Field	Master's degree	27 Year
Expert 3	Senior Manager HSE in Construction Company	Master's degree	24 Year
Expert 4	HSE Manager in Foreign Company	Master's degree	25 Year
Expert 5	Senior Safety Expert in Construction Company	Master's degree	35 Year

From the results of the content and construct validation process by 5 construction safety experts, 5 variables were obtained, namely safety policy, safety institutions, safety culture, maturity level and safety performance with 24 indicators as shown in Table 3.

Table 3. Validated variables and indicator of the research.

Code	Variables	Code	Indicators
X1	Safety Policy	X1.1	Construction Safety Policy
		X1.2	Construction Cost Policy
		X1.3	Reward Policy
		X1.4	Punishment Policy
X2	Safety Institutional	X2.1	Program Objective
		X2.2	Benchmarking
		X2.3	Main Obstacle
		X2.4	Institution Involved
		X2.5	Pattern of Role and Relationship
X3	Safety Culture	X3.1	Physical Culture
		X3.2	Behaviour Culture
		X3.3	Norm and Management Culture
		X3.4	Ideology Culture
X4	Safety Maturity	X4.1	Basic Level
		X4.2	Reactive Level
		X4.3	Compliant Level
		X4.4	Proactive Level
		X4.5	Resilient Level
X5	Safety Performance	X5.1	Accident Rate
		X5.2	Awareness
		X5.3	Productivity
		X5.4	Self-Discipline Management
		X5.5	Cost of Safety
		X5.6	Performance Assessment

In this process, the Delphi method is used with structured interviews by experts to determine research variables and indicators. And according to experts, these indicators are in accordance with the variables formed from the results of the literature study. These results explain that to measure safety policy in building a safety culture, it is necessary to review the construction safety policy, safety cost policy, reward and punishment policy.

Then in building safety institutions it can be measured by ensuring that program objectives are achieved, and the main obstacles can be overcome, so that the Maturity Level of Safety Culture represented by Physical Culture, Behavioural Culture, Ideological Culture, Norms and Management Culture and construction safety performance can increase.

Variables and indicators that have been validated by experts in the field of safety at this stage of content and construct validation will be used to conduct pilot surveys and survey respondents to determine the relationship between these variables and indicators. The next step is a survey method to 293 respondents and analysed using SEM to find out the relationship between variables described in the next sub-chapter

4.2. Relationship analysis with SEM-PLS with Software SmartPLS 3.0

SEM-PLS aims to test the predictive relationship between the constructs by seeing whether there is a relationship or influence between the constructs by seeing whether there is a relationship or influence between the constructs. The consequence of using SEM-PLS is that the test can be carried out without a strong theoretical basis, ignoring some assumptions (non-parametric) and the accuracy parameters of the prediction model seen from the coefficient of determination (R-Square). Therefore, SEM-PLS is very appropriate to be used in research that aims to develop theory.

The purpose of using SmartPLS 3.0 is to estimate the causal-predictive relationship between institutional variables and the level of safety maturity on safety performance in construction companies.

Table 4. Loading factors average variance extracted (AVE).

Research Variables	AVE
Safety Policy	0.521
Safety Institutional	0.571
Safety Culture	0.670
Safety Maturity	0.697
Safety Performance	0.681

Standardized loading factors as shown in Table 4 are useful for assessing whether a construct has sufficient discriminant validity, which is obtained by comparing the correlation of indicator of a construct with the correlation of these indicators with other constructs. If the correlation of indicator of the construct has a higher value than the correlation of these indicators with other constructs, then the construct is said to have high discriminant validity. Standardized loading factor describes the magnitude of the correlation of each measurement item (indicator), meaning that the indicator with the loading factor at a level >0.7 is valid as an indicator that measures the construct. Item reliability is seen from the loading factor

according to kind of literatures which mention the loading factor above 0.7 is ideal. However, a standardized loading factor value above 0.5 is acceptable, while a standardized loading factor below 0.5 can be excluded. Modelling research results using smartPLS as shown in Fig. 4.

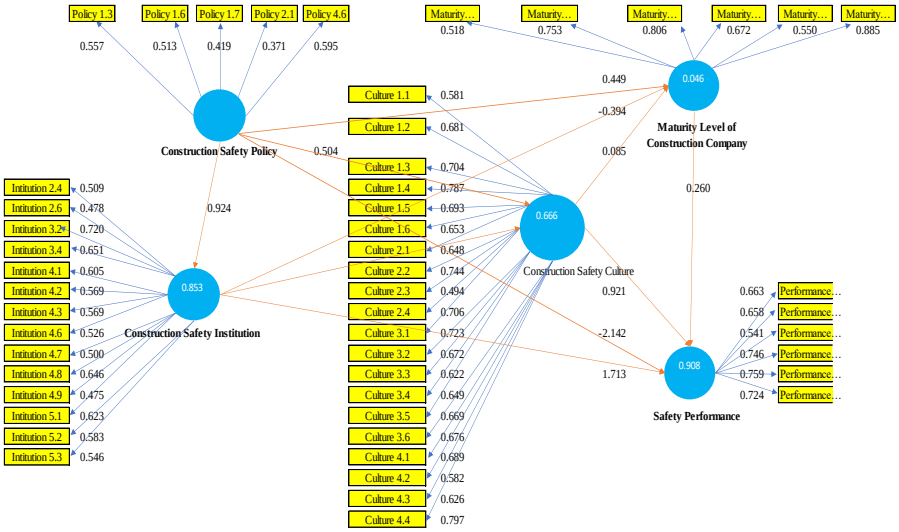

Fig. 4. Calculation of PLS algorithm (Outer loadings).

By running the calculate main menu in the SmartPLS 3.0 program, there is a PLS Algorithm option which step is often referred to as the *first-order confirmatory factor analysis* with results can be seen as shown Table 5

Table 5. Interrelation variable for improvement Safety Culture (R2).

Research Variable	R Square (R^2)
Safety Policy	0.667
Safety Institutional	0.853
Safety Culture	0.666
Safety Maturity	0.046
Safety Performance	0.908

Based on the R^2 table above, the R-Square value of Safety Performance is 0.906, meaning that the variability of the Safety Performance construct can be explained by Safety Policy, Safety Institutions, Safety Culture, and Safety Maturity Level of 90.6%.

In the safety policy there needs to be rewards and punishments so that what has been planned can be carried out according to Heni [26]. The leading sector in construction safety institutions is at the level of the ministry of manpower and the ministry of public works and housing as the regulator of the government to implement the safety policies that have been set [27]. In developing a safety culture, it is necessary to look at the maturity level of the construction company, so that the integration of structure, behaviour and performance that is intervened by policies and institutions can improve safety performance in the construction industry.

4.3. Result validity test

The newly developed theory is validated by the Ministry of Public Works and Housing as the regulator and by the construction companies as the practitioner. The methodology used is research instruments and interviews with experts. Work accident data are compared before and after the Construction Safety Committee was formed by the Ministry of Public Works and Housing.

The data used in the validation process is secondary data in the form of construction accident data for 2015 – 2019 validated by interviews with 3 safety experts, as shown in Fig. 5, it is explained that in 2015-2017 there was an increase in construction accidents and reached its peak in 2018. The results of the validation process to experts explained that the intervention of safety policies and institutions in the form of the establishment of a Construction Safety Committee and the application of rewards and punishments were very effective in reducing accidents in the next period in early 2019.

The results of the Validation Analysis are presented in Fig. 5.

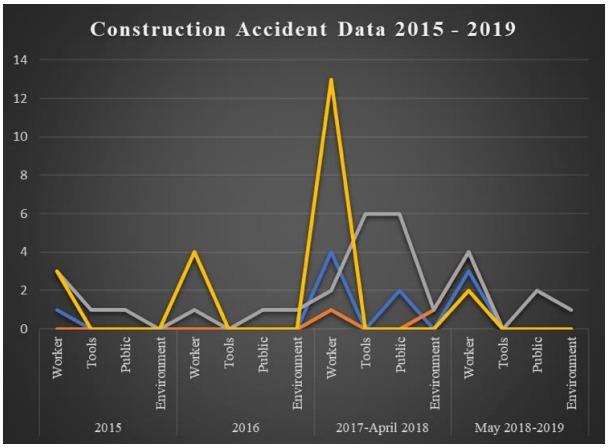

Fig. 5. Construction accident data.

From the theory developed, policy intervention in this case, is the formation of the Construction Safety Committee which has successfully reduced the number of construction work accidents from 20 death cases to 2 death cases or decreased by 90%.

Then validation is also carried out at construction companies to determine the safety maturity level before and after the Quality Health Safety Environment (QSHE) Unit is formed as a policy recommendation from the Ministry of State-owned Enterprise.

The results of the validation analysis as shown Fig. 6.

These results explain that the maturity level after the formation of the QSHE Unit has increased significantly in State-owned and Foreign companies.

The hypothesis of this research according to the validation results is that effective policies can create a strong institution which able to form a safety system so that a safety culture can be developed, and the maturity level of construction companies may increase which results in a decrease in the level of construction accidents.

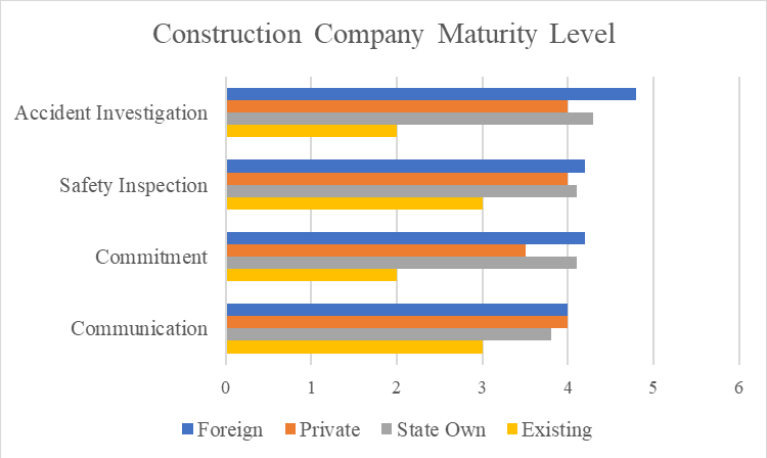

Fig. 6. Maturity level in construction company.

The contribution in this research is the development of the Theory of Integration Construction Safety Culture Improvement, namely how innovation in safety policies can increase the maturity of construction companies so that safety performance can be achieved. Boateng et al. [28] also explained that in evaluating safety culture, the safety culture index model can be used as a tool to formulate the level of safety culture. The reform of the governance of construction safety institutions must be able to have major implications for improving the safety culture in the construction sector. Nissan et al. [29] stated that policy reforms and incorporating institutional aspects can facilitate the impact of the economy against any disaster. The impact generated in every construction accident disaster has a very significant effect on the competitiveness of a country and the economic sector [30].

This theory explains that the company's maturity level can increase with commitment, two-way communication, evaluating and monitoring in the implementation of an integrated investigative audit in managing the implementation of an effective and efficient construction safety management system [31] as shown in Fig. 7 .

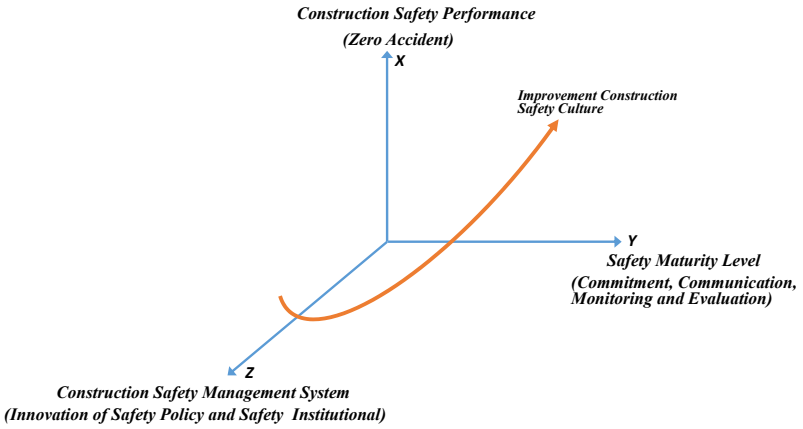

Fig. 7. Theory of integration construction safety culture improvement.

5. Conclusions

Some recommendations for the integrated safety culture improvement from the dominant significant variables are as follows:

- Innovation of Safety Policy in the Construction Industry significantly increase the maturity of Construction Safety Culture,
- It is necessary to establish the *Komite Nasional Keselamatan Konstruksi (KNKK - Indonesia version)* or the National Construction Safety Committee,
- The practice of rewards and punishment against companies should be outlined firmly in laws and regulations so that construction services companies can focus and commit to construction work safety,
- Evaluation and monitoring costs included in the components of safety costs should be more detailed and as well adding non-safety cost components to the Circular of the Minister of Public Works and Public Housing Number: 10 / 2021 concerning Costs for Implementing Occupational Safety and Health Management Systems, Construction of the Work Sector General so that it can be a reference in making a safety plan.

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