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The Relationship of Knowledge Codification towards Organizational Performance in Indonesian Construction Industry

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ABSTRACT

The construction industry, as one of the project-based industries, is still considered as a one-off. Knowledge is often not codified and gone in the next project. Project complexity also brings a more significant challenge to the successful performance of the construction industry. This study examined how codification might affect organizational performance in the construction industry and how project complexity affects their relationship. Findings from 54 construction firms in Indonesia indicated that, as separate independent variables, codification and project complexity brought a positive influence on organizational performance. However, as a moderator variable, project complexity may bring a negative impact on the relationship between codification and organizational performance. There were two clusters formed from cluster analysis, which indicated respondents' different levels of codification implementation.

Keywords: Codification, construction industry, cluster analysis, moderated linear regression, organizational performance, project complexity

INTRODUCTION

The construction industry has become an important sector for economic growth in Indonesia. In 2018, the construction industry topped in the third position with economic growth of 0.61% (Miftahudin, 2019). With a construction service market potential of US$ 267 trillion, Indonesia became the most significant construction service market in ASEAN (Septiadi, 2017).

However, as one of the project-based industries, the construction industry has unique and temporary characteristics (Project Management Institute, 2013). Construction projects often made up of individuals who employed temporarily, whose knowledge was often not codified (Dubois & Gadde, 2002). Project complexity also brought a huge challenge. The more complex the project, the higher the need for the project team to coordinate knowledge sharing (Bakri et al., 2010).

Based on the abovementioned background, this study aims to provide empirical evidence related to the codification strategy towards organizational performance in Indonesia's construction industry, with project complexity as a moderating variable. This study also aims to assess and map the implementation of the codification strategy in the construction industry in Indonesia.

According to Chai and Nebus (2011), codification defined as capturing and storing knowledge in explicit form in a centralized-knowledge repository. Hansen et al. (1999) stated that codified knowledge could be reutilized for various purposes. In principle, codification could reduce the loss of knowledge since knowledge could be stored and retrieved indefinitely (Cowan & Foray, 1997). Codification could also be a core process for economic activity because it could directly speed up knowledge creation and innovation (Cohendet & Steinmuller, 2000). Codification tools might describe what to do ("know-what"), how to do it ("know-how"), and why it made sense to do it that way ("know-why") (Singh & Zollo, 1998). Codification could reduce complexity by making organizations less vulnerable to knowledge loss stored in individuals (Prencipe & Tell, 2001). Blayse and Manley (2004) stated the importance of construction firms to codify knowledge acquired in projects because knowledge could be more easily flow between projects. Addis (2016) further stated that in construction, codification enables control and application to raise organizational performance.

Turner and Cochrance (1993) showed that project complexity had uncertain nature, which affected the project's goals and methods. Williams (1997) also stated that project complexity involved in the differentiation and interdependency of projects. Baccarini (1996) stated that, in the construction industry, project complexity influenced planning, coordination, and control requirements, which might affect organization performance.

Table 1 illustrates this research position against other researches.

Table 1: Research Position

	Codification	Project Complexity
Consultant	Hansen et al., (1999)	Baccarini (1996)
Engineering	Cowan and Foray (1997)	
Non-specific firms	Cohendet and Steinmuller (2000)	Williams (1997), Turner and Cochrance (1993)
	Singh and Zollo (1998)	
Construction	Prencipe and Tell (2001) Blayse and Manley (2005) Addis (2016)	
	This study	

RESEARCH METHOD

This study used secondary data from Nirwana (2016) because this study focused on the same target population and sample. Data was gathered from construction firms in Indonesia, represented by the owner, director, manager, or other employees in strategic positions. This study used 54 sample sizes. The sample size fulfilled the criteria from Harris (1985), who suggested that the sample size should exceed the total predictor variable by at least 50.

There were three variables examined in this study: codification, organizational performance, and project complexity. This study developed three theoretical models, which are explained respectively in Figure 1, Figure 2, and Figure 3. These models were elaborated further into five hypotheses.

Theoretical model 1

H_1: There is a significant relationship between codification and organizational performance

Theoretical model 2

H_2: There is a significant relationship between codification and organizational performance

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H_3: There is a significant relationship between project complexity and organizational performance

Theoretical model 3

H_4: There is a significant relationship between codification and organizational performance

H_5: There is significant interaction between codification and project complexity towards organizational performance

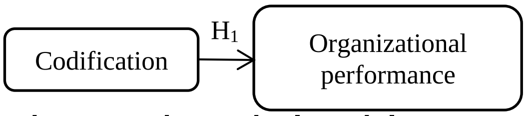

Figure 1: Theoretical model 1

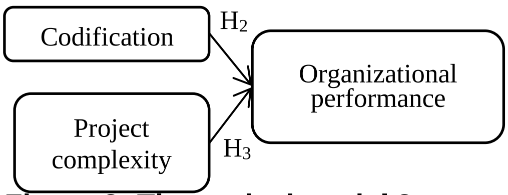

Figure 2: Theoretical model 2

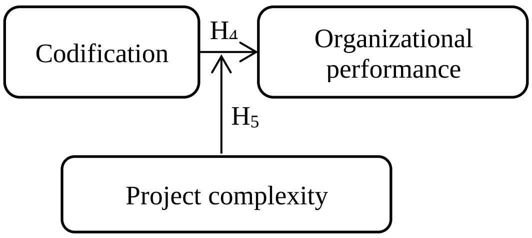

Figure 3: Theoretical model 3

This study started by problem formulation based on literature studies related to the codification strategy and current condition of the construction industry in Indonesia, which then followed up to objective formulation. After that, instrument adaptation was carried out from the instrument in Nirwana (2016). Then, data analysis was carried out, which consisted of error measurement reduction, exploratory factor analysis, the test of the classical assumption of regression analysis, data transformation, and cluster analysis. Flowchart of study stages is depicted in Figure 4.

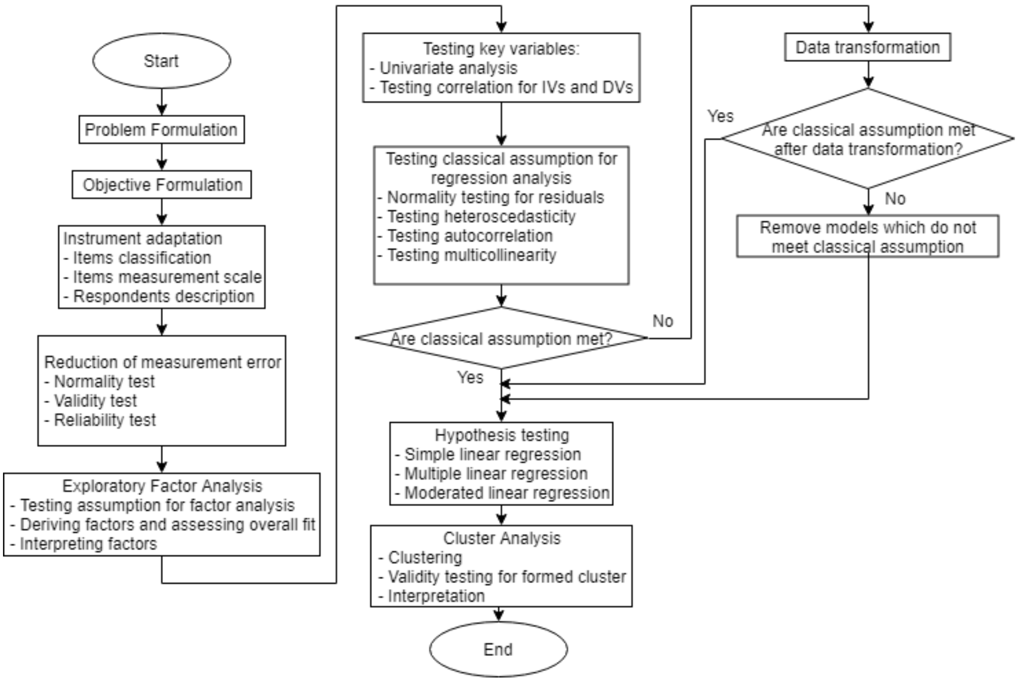

Figure 4: Research framework

RESULTS AND DISCUSSION

Two dimensions applied for codification, i.e., process and technology. According to Pee and Kankanhalli (2009), people, process, and technology were crucial key process areas in knowledge management. It was because KM needed to consider human, task or process, and technology to deliver thorough and successful business support. Opposite to personalization, codification tended to rely more on IT to carry on the KM process (Hansen et al., 1999). Thus, process and technology were suitable dimensions for codification.

This study also considered project complexity as moderator variables, of which dimensions were uncertainty in goals and uncertainty in methods (Turner & Cochrane, 1993), as well as differentiation and interdependency (Baccarini, 1996). The items for each dimension are further explained in Table 2 for codification and Table 3 for project complexity.

Table 2: Items for codification

Dimensions	Item no.	Items	Reference
Process	KM1.1	There is documentation of knowledge necessary for performing projects	Kochikar (2000)
	KM1.2	My company put much emphasis on documenting past project experience and lessons	Newell and Edelman (2008)
	KM1.3	Past project standards, work instructions, and other documented sources become major references for new projects	Prencipe and Tell (2001)

	KM1.4	We tend to refer to project reports rather than talking to project engineers who did the work.	Janicot and Mignon (2012)
Technology	KM2.1	A system is used in my company for the management of patents, copyright, trademarks	Ragab and Arisha (2013)
	KM2.2	My company utilizes an integrated, company-wide project documentation database	
	KM2.3	Tools for project data mining and analytics	
	KM2.4	A knowledge management system is used for a complete and extensive repository of project reports, standard operating procedures, etc.	

Table 3: Items for project complexity

Dimensions	Item no.	Items	Reference
Uncertainty in Goals	KM3.1	In my company, the projects' objectives are clearly specified in the beginning phase of project implementation.	Crawford and Pollack (2004)
	KM3.2	In this company, projects' deliverables can be observed	
	KM3.3	In my company, project deliverables are easily measurable	Hartono et al. (2019)
	KM3.4	In my company, projects' requirements need to be continuously reviewed and redefined	
	KM3.5	There are significant changes in the original contract during project implementation	

Table 3: Items for project complexity (continued)

Dimensions	Item no.	Items	Reference
Uncertainty in Methods	KM3.6	In general, hazard rates of projects in my company are very low	Hartono et al. (2019)
	KM3.7	In my company, projects involve high technological difficulty	
	KM3.8	In my company, the possibility of project reworks is very low	
	KM3.9	In my company, external risks are considered very crucial for projects (e.g., bad weather during construction projects)	
	KM3.10	In my company, there are limited possible methods to deliver project goals	
Structure Complexity (Differentiation)	KM3.11	The average total projects' man-hours of in my company are very high	
	KM3.12	The average projects' budgets are very high	
	KM3.13	In my company, project outputs comprise very few subsystems or components	
	KM3.14	In my company, projects are divided into a few simpler tasks	
Structure Complexity (Inter-dependence)	KM3.15	In my company, there are many internal departments or subdivisions involved in the implementation of projects	
	KM3.16	In my company, there are many external stakeholders involved in projects (e.g., sub-contractors, vendors, and suppliers).	
	KM3.17	In my company, the projects are handled by project team members with high levels of expertise diversity	

Most of the participating respondents worked for 3-6 years (38.89%) and 6-10 years (33.33%), compared to those who worked <3 years (9.26%) and worked >10 years (18.52%). Most of the respondents were the firm's owner (35.18%) and top-level managers (33.33%), while the others were director/CEO (16.67%), project managers (9.26%), and other positions (5.56%). They mostly worked at the current position for 3-6 years (53.70%), while the others worked for <3 years (22.22%), 6-10 years (14.82%), and >10 years (9.26%). The firms' number of projects in the last three years were 3-15 projects (83.33%), <3 projects (11.11%), and >15 projects (5.56%).

This step was first carried out by testing normality to decide the right statistical analysis for validity testing. Shapiro-Wilk test was used for correlation between data and the corresponding normal scores, where significance values $\alpha<0.05$ indicated that the distribution was significantly different from normal (Peat & Barton, 2005). Based on the

Shapiro-Wilk test, all codification and project complexity items had significance values $\alpha<0.05$, meaning that all data did not have normal distribution so that all data would be tested using non-parametric testing. Then, validity testing was conducted using the Spearman correlation test, since Spearman correlation test were the statistics most frequently adopted to test non-parametric correlation (Artusi et al., 2002). All items had significance values $\alpha<0.05$, so that all data were valid. After that, reliability testing was carried out using Cronbach's alpha, which was a measure of reliability that stretches from 0 to 1, with values of 0.60 to 0.70 deemed the lower limit of acceptability (Hair et al., 2010). All items' alpha values were more than 0.60, meaning that all items were reliable.

Exploratory Factor Analysis was conducted to define the underlying structure among the variables (Hair et al., 2010). Using eigenvalues and Varimax rotation, the number of factors was then limited to two factors for codification and three factors for project complexity. Process and Technology remained as factors for codification. Meanwhile, factors for project complexity were categorized as (1) uncertainty in goals, (2) uncertainty in methods, and (3) structural complexity.

Before conducting a regression analysis, there were some assumptions that must be filled. First, residual data must be normally distributed using the Kolmogorov-Smirnov normality test for unstandardized residual data, with significance value must be higher than $\alpha=0.05$ (Hair et al., 2010). All models' α were more than 0.05. Second, a heteroskedasticity test was conducted using the Glejser test to examine if regression residuals in absolute value were correlated with some other variables, with at least $\alpha=0.05$ should be obtained (Im, 2000). No heteroskedasticity was present since all models' α values were more than 0.05. Then, the autocorrelation test was carried out to observe if the present variables' value was affected by past variables' value. Durbin-Watson test was used with test values varied from 0 to 4, with a value close to 2 reflected that error terms of a regression model had no serial correlation (Durbin & Watson, 1950; Chen, 2016). In this test, all models' values were close to 2. Finally, a multicollinearity test was observed to test if there was a high correlation between independent variables found in the regression model. There were two kinds of multicollinearity measurement: (1) tolerance, with acceptance value ≥ 0.10, and (2) Variance Inflation Factor (VIF), with acceptance value of ≤ 10 (Hair et al., 2010). All models had a tolerance of more than 0.10, and VIF values lower than 10. Hence, no multicollinearity was present. Because all classical assumptions were met, data transformation was not performed.

After the classical assumption for regression was conducted, the next step was to test the hypotheses stated in Methods. Hypotheses testing results were shown in Table 4.

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Table 4: Hypotheses testing result

Model	Independent var.	Moderator var.	Dependent var.	Model	*Unstandardized Coeff.* B	*Unstandardized Coeff.* *Std. Error*	*Unstandardized Coeff.* Sig.	Sig.	R^2	Equations	Remark
Model 1	Codification (X_1)	Organizational performance (Y)	-	*Constant*	.477	.040	.000	.023	.096	$Y_{2.2.3} = 0.477 + 0.180X_1$	H_1 supported
				X_1	.180	.077	.023				
Model 2	Codification (X_1) Project complexity (X_2)		-	*Constant*	.353	.082	.000	.018	.146	$Y_{2.2.3} = 0.353 + 0.271X_1 + 0.107X_2$	H_2 supported H_3 supported
				X_1	.271	.092	.005				
				X_2	.107	.062	.090				
Model 3	Codification (X_1)		Project complexity (X_2)	*Constant*	.270	.109	.017	.026	.167	$Y_{2.2.3} = 0.270 + 0.429X_1 + 0.231X_2 - 0.292 X_1{*}X_2$	H_4 supported H_5 supported
				X_1	.429	.166	.013				
				X_2	.231	.125	.071				
				$X_1{*}X_2$	-.292	.256	.260				

Hypotheses testing result displays the type of relationship from each variable, which shows that codification strategy and project complexity have a positive relationship as an independent variable. However, if project complexity is considered as a moderator variable, it has a negative relationship with the model.
Cluster analysis was further conducted to determine the level of Hair et al. (2010) stated that the multivariate technique with the objective of grouping respondents or cases with similar profiles on a defined set of characteristics. In this study, cluster analysis was conducted to observe distinctive profiles of the respondents based on their codification implementation.
Figure 5 shows the formed clusters for each dimension of codification and average profit in three years. From the figure, it is depicted that Cluster 2 has higher cluster mean values in both dimensions. Therefore, it can be concluded that organizations in Cluster 2 have more advanced codification strategy implementation, both in the Process dimension and Technology dimension.

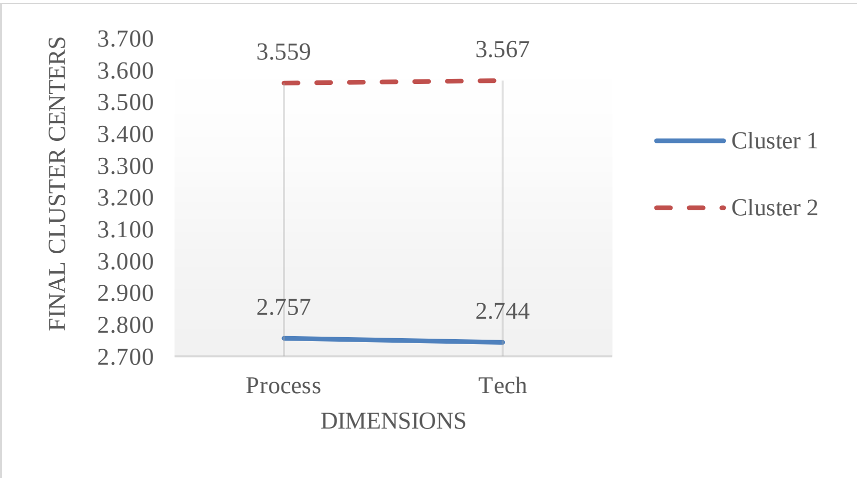

Figure 5: Formed clusters

The result of the codification strategy being a positive influence on organization performance was suggested by previous studies in previous fields (Hansen et al., 1999; Chai & Nebus, 2011). Meanwhile, the findings of project complexity to have different impacts on different models were quite interesting. The positive influence of project complexity in organizational performance in this study proved this result, like the findings by Baccarini (1996). It stated that project complexity is important to the construction industry, mainly because project complexity helps determine planning coordination and control requirements. However, this study found that project complexity, as a moderator variable, brought a negative impact on the relationship between codification and organization performance. This phenomenon might be contributed to the nature of project complexity, as it demanded the construction project team to work together to share ideas, information and knowledge to be executed successfully (Bakri et al., 2010). The mentality of the project as a one-off might also hinder full potential implementation (Carrillo et al., 2000). Thus, in Indonesia’s construction industry, project complexity still becomes a daunting element that negatively affects the implementation of the codification strategy to gain positive influence in the construction industry.
Cluster analysis also shows the positive impact of technology on better implementation of the codification strategy. This result was also linear to Hansen et al. (1999), which stated that codification relied on knowledge storage in databases, where it could be

accessed and used easily by anyone in the company. It was why the codification strategy centered on computers, and advanced technology might support the implementation of codification strategy.

CONCLUSIONS

This study discovered that codification and project complexity had significant relationships with organizational performance in various terms. Codification, as a single independent variable had a positive relationship with organizational performance, so as codification and project complexity as two independent variables had a positive relationship with organizational performance. However, if project complexity was considered as a moderator variable, it showed a negative relationship between codification strategy and organizational performance. Meanwhile, according to cluster analysis in this research, codification implementation in construction firms in Indonesia was grouped into 2 clusters. It also showed that a cluster with a higher level of codification strategy implementation had a better implementation in technology.
This study examined the relationship between codification and project complexity towards organizational performance. However, the relationship between the dimensions has not yet been explored. Thus, further research may focus on the dimensions of codification and project complexity in order to further determine the possible significant dimensions which may affect organizational performance.

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