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Quality Management System and Construction Performance

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Abstract – This paper discusses the level of effectiveness of quality principles and quality management system implementation and the relationship with performance of ISO9000 certified Indonesian contractors. It also discusses the statistical relationship between quality management systems (QMSs) and key performance indicators (KPIs) amongst a large sample of Indonesian construction companies. Data collected is from questionnaire surveys involving Quality Managers, Managers, and Project and Site Engineers representing 77 different companies. Results indicate that even though some contractors have not yet effectively implemented an effective QMS, most of the KPIs of respondent companies are still at the level of *high performance*. The statistical results show that the relationship between variables of ISO9000 QMS principles and contractors' KPIs is significant. These results suggest that an increment in the implementation level of QMS principles can increase KPIs, however that much effort is still required for Indonesian contractors to fully effectively implement QMS principles and thus substantially improve performance against KPIs.

Keywords – **Indonesian contractors, KPIs, QMS principles**

I. INTRODUCTION

The quality management systems (QMSs) currently being implemented by Indonesian constructors and builders, are based on the ISO9000 series of standards, and are becoming increasingly important to customers who have developed a growing aspiration to procure qualified and professional construction companies to undertake their projects. The performance of construction companies to achieve their set KPIs, is generally measured or assessed based on them operating within financial constraints, successfully gaining market position and obtaining profitability. Effective QMSs can have an impact on meeting the increasing demands of customers in the global market [1] due to the excellent evolution of processes and business performance promoted by ISO9000 certified companies [2].

The current quality issues prevalent in the Indonesian construction industry have caused construction companies to put much effort into improving (or in some cases starting) the implementation of ISO9000 certified QMSs.

These quality issues have been seriously considered by both government and the construction industry, since the output of construction services at the national level has not to date been optimal, and the influx of foreign construction companies undertaking construction of both government and private projects is gradually increasing [3] and [4]. As one of the new initiatives introduced to strengthen the provision of proven quality services and products, all grade-7 (G-7) construction companies (the highest grade of Indonesian contractor qualification) since 2004 are required to obtain ISO9000 certification prior to bidding for either national or local government infrastructure projects. From this perspective, it is important and timely to identify the current level of ISO9000 systems and principles implementation and examine the G7 companies' achievements in several key performance areas after almost a decade of implementation. Several key performance indicators (KPIs), namely (a) profitability for the preceding two years, (b) sales growth for the preceding two years, (c) market shares in company region for the most recent years, (d) global market contracts acquired, (e) quality of services and products, (f) sustainable construction products, (g) new product innovation and development, (h) generating employee satisfaction, have all been identified from an extensive literature review. Confirmation was also found from the results of opinion interviews with the Indonesian construction practitioners regarding the improvements that they expect to gain from QMS implementation for the duration of their companies' foreseeable business lives.

The objectives of this paper, therefore, are as follows:

1. To identify the way that ISO9000 principles are currently being operated in Indonesian construction companies;
2. To examine the performance of companies particularly during the implementation of their QMSs;
3. To examine the relationship between ISO9000 principles and the KPIs identified previously and seek to evaluate how well the independent variable (ISO9000 principles) is able to predict likely values of the dependent variable (KPIs).

Descriptive statistical and regression analyses are utilized to achieve the objectives of this study.

II. METHODOLOGY

The sample population for the questionnaire was drawn from G-7 as well as other small, medium and large ISO9000 certified construction companies in the three capital provinces of Indonesia, namely, Manado, Makassar, and Jakarta. The companies chosen are mainly engaged in the construction of building and, or, civil engineering works including roads and bridges, construction of highways, and irrigation schemes. The main reason for drawing respondents from these ISO9000 certified construction companies and developers in the three cities is that they represent the environment of the construction industry of typical small, medium, and large cities in Indonesia. In total there were 118 companies: 13 companies located in Manado (100% of the population of G-7 contractors), 25 companies in Makassar (100%), and 80 companies in Jakarta (89%) and all were recipients of the questionnaires, involving 900 proposed respondents.

The questionnaire survey was conducted from early September until the end of November 2010. Returned and useable questionnaires were obtained from 77 companies: 13 Manado companies (100%), 23 Makassar (92%) and 41 Jakarta (46%), consisting of 67 Quality Manager Representatives, 215 Managers (e.g., Project Manager, Purchasing Manager, Logistic Manager, Maintenance Manager, Finance Manager), and 121 Project and Site Engineers, which in total amounted to 403 (44.8%) respondents.

Data collected was computed using SPSS version 19 in conducting (1) a descriptive statistical analysis to reveal the implementation level of ISO9000 principles and the performance level of KPIs, and (2) a regression analysis to develop a model that can describe the relationship between the independent variable (ISO9000 principles) and the dependent variable (KPIs).

III. RESULTS

Results show that all the local contractors (Manado and Makassar) originally obtained QMS-ISO9000 certification between 2001-2008. The most significant number of local companies that achieved certification was concentrated during the period of 2005-2008: 10 companies in Manado and 12 in Makassar (Figure 1).

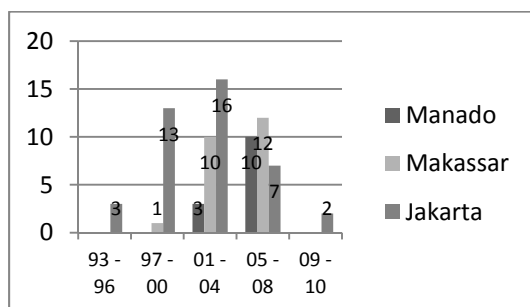


Fig. 1. Years of certification under ISO 9000

A. Mean

Results showing the level of ISO9000 principles implementation and KPIs achieved by the construction companies are in Tables I and II.

TABLE I
COMPANIES PRACTICE OF ISO 9000 PRINCIPLES

Variables	Mean	S.D.
Customer focus	3.41	0.619
Leadership	3.21	0.726
Involvement of people	3.09	0.741
Process approach	3.15	0.751
Systems approach to management	3.19	0.739
Continual improvement	3.19	0.813
Factual approach to decision making	3.06	0.802
Mutually beneficial supplier relationships	3.31	0.665

Notes: Less than 3.00 = minimally implemented, 3.00-3.50 = not so fully implemented, 3.51-4.00 = fully implemented.

The results in Table 1 show that the eight variables representing the KPIs of interest possess means ranging from 3.06 to 3.41. These values suggest that the construction companies generally do not fully implement the eight ISO9000 principles. Factual approach to decision making (3.06) and involvement of people (3.09) are considered as the two least implemented principles whilst the companies do see as being important, customer focus (3.41), followed by mutually beneficial supplier relationship (3.31) and leadership (3.21) respectively.

TABLE II
COMPANIES PERFORMANCE DURING IMPLEMENTING QMS

Variables	Mean	S.D.
Profitability for the preceding two years	2.83	0.619
Sales growth for the preceding two years	2.87	0.639
Market shares in your region for the most recent year	2.72	0.637
Global market contracts acquired	1.40	0.511
Quality of services and products	2.95	0.511
Sustainable construction products	2.75	0.625
New product innovation and development	2.43	0.717
Generating employee satisfaction	2.69	0.679

Notes: Less than 2.00 = very low performance, 2.00-2.50 = low performance, 2.51-3.50 = high performance, 3.51-4.00 = very high performance.

Table II shows that the eight KPIs have means of less than 3.00, spreading from 1.40 to 2.95. Results show that according to ISO9000 certified contractors, the current worst performance is for global market contracts acquired (1.40). For new product innovation and development, the contractors also have low performance (2.43), however they achieve relatively high performance in terms of quality of services and products (2.95), sales growth (2.87), profitability (2.83), sustainable construction products (2.75), market share (2.72), and generating employee satisfaction (2.69).

B. Simple Regression

The following propositions were set up to facilitate a regression analysis:

Hypotheses:

H1: *There is a significant relationship between QMS-ISO9000 principles and contractor's key performance indicators (KPIs).*

H0: *There is no a significant relationship between QMS-ISO9000 principles and contractor's key performance indicators (KPIs).*

Research Question:

How well does the ISO9000 principles variable predict the set of contractor's key performance indicators (KPIs) variable? How much variance in KPIs scores can be explained by scores of the QMS ISO9000 principles?

Results from a regression analysis undertaken to investigate the hypotheses and research question are shown in Tables III and IV.

TABLE III
MODEL SUMMARY OF REGRESSION ANALYSIS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.610	0.372	0.364	2.54645

a. Predictors: (constant) QMS elements.

The positive R-value (0.610) in Table III shows that a relationship between the KPIs (dependent variable) and QMS-ISO9000 principles (independent variable) does exist. The result also indicates that these two variables tend to increase together [5]. The value of R-Square (0.372) shows that 37.2% of the variance in KPIs is explained by QMS-ISO9000 principles. However, this also means that 62.8% of the variation in contractor's KPIs cannot be explained by QMS-ISO9000 alone; there might be many other factors that can explain this variation.

TABLE IV
COEFFICIENTS OF REGRESSION ANALYSIS

Model		Non-standardized Coefficients		Stand. Coeff.	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9.097	2.401		3.789	0.000
	KPI	0.781	0.117	0.610	6.670	0.000

a. Dependent variable: KPI.

The simple regression equation (model) can be found in the Coefficients of Regression Analysis and results in the following output (Table IV).

$$\text{KPIs} = 9.097 + 0.781\text{QMS-ISO9000 principles} \quad (1)$$

This model implies that for every increment of QMS-ISO9000 principles, KPIs increases by 78.1%. Table IV also shows that the *p*-values (0.000) suggest that the coefficients and the equation achieve a high level of statistical significance ($0.000 < 0.001$) [5]. Thus, the alternate hypothesis (H1) “*there is a significant relationship between QMS-ISO9000 principles and contractor's key performance indicators (KPIs)*” is verified, and the null hypothesis (H0) is rejected.

IV. DISCUSSION

Several empirical studies had been undertaken to investigate whether QMS or TQM improves construction organizational performance [2], [6], [7]. However, there has been limited research that studies the relationship between the major QMS-ISO9000 principles and several key performance indicators (KPIs) either in the Indonesian construction industry or in a global construction context. The statistical analysis approach applied in this paper has verified results that the variable of QMS-ISO9000 principles has a positive correlation with the variable of KPIs. Thus it can be posited that any increase in implementation levels of the eight QMS-ISO9000 principles will improve the key performance of companies. These statistical results, although achieved only in the Indonesian scenario, may be utilized within other countries to examine their own construction companies' performance related to their achievement in effective practice of ISO9000 principles and implementation of quality management systems (QMS).

In 2004, the Indonesian government enacted that all G-7 level contractors must obtain ISO9000 certification, which has meant that during the ‘boom’ period (2004-2008) for local contractors (in Manado and Makassar), there has been a significant impact on their operations and practices as they have been required to obtain ISO9000 certification of their QMSs. It is assumed that other provincial contractors have experienced similar effects to these two locations. Nevertheless, the implementation of the quality requirements by means of obtaining quality system certification has so far proven ineffective, as results from the data collection revealed that the implementation level of the ISO9000 principles was ‘not so fully implemented’. In fact, for the specified quality requirements and prescribed quality objectives to be effectively implemented and hence conform to the quality principles, it must be ensured that a full implementation of the quality principles is made. In other words, all organizational members and operational stakeholders must fully understand the essence of the principles and apply them without deviation into the all business processes of the company.

The implication of research into reasons for acquiring the required QMS certification for the contractors and builders is that many of these construction companies

have obtained their certification only to demonstrate that they actually have a formal management system, and that they can be deemed capable of producing at least a reasonable quality of project delivery. In other words, certification is often used in order for a company to be eligible to undertake bidding and procurement activities, particularly on highly lucrative or prestigious government sponsored projects. Related to this, apparently the misdirected reason for holding a QMS has been one of the major barriers to effective QMS implementation, particularly for those that are in the earliest stage of the QMS-ISO9000 implementation [8]. Therefore, it is certain that management commitment and focus on client's needs must drive the reframing of the purpose of holding a QMS so that a construction company has a rigorous and real opportunity for quality improvement in its management style and the work environment.

According to reference [9], ISO 9000:2000 provides examples of the benefits that can be derived from the use of these eight principles, and some of them are:

- improved customer loyalty;
- better communication throughout the organization;
- stimulation of people to always aim for continual improvement;
- lower costs and shorter cycle times;
- integration and alignment of business process;
- coordination of all improvement possibilities and activities;
- ability to review, challenge and change opinions and decisions;
- possibilities for creating value for a company and its supplier.

These findings when translated into the context of Indonesian construction companies will mean that the successful implementation of their QMSs may bring the company to the leading edge of its performance, such as gaining revenue and market share [10], higher quality performance [6], improved new tools and product innovation [7], and improved employee job satisfaction [10].

The positive statistical relationship between QMS principles and KPIs can encourage Indonesian construction companies to put much more effort into implementing their QMSs and in making continuous improvement, as these factors alone may lead to very high performance of companies when measured against established KPIs, particularly those relating to financial performance (e.g. profitability, sales growth, and market share), employees satisfaction, and proven quality services and products. This holistic performance improvement within the Indonesian construction sector may eventually have significant impact on the dominance of the G-7 contractors in procuring national infrastructure projects, and indeed global projects.

V. CONCLUSIONS

This paper highlights the results of a survey designed to examine the systems and success outcomes of ISO9000 certified contractors in the three cities of Indonesia and investigates the way that all eight QMS-ISO9000 principles are being operated in their companies, and the impact on the performance of companies due to implementing their QMSs. From this study it is found that currently, all eight of the ISO9000 principles are not yet fully implemented and that certain important KPIs, namely, new product innovation and development remain for now at a level of low performance. Global market contract capability is also at a very low performance level.

However, the research shows that high performance KPIs are related to providing quality services and products, gaining profitability, sales growth, and market share, creating sustainable construction products, and generating employee satisfaction.

The compulsory requirement to hold a valid ISO9000 certification in order to be registered as a G-7 contractor and thus becoming eligible to bid for tenders of government mega projects may encourage the contractors to pursue and possess an effective and continuous improved QMS. They can thus eventually gain higher KPI performance, and as a result develop a higher level of competitiveness against foreign competitors in the arena of Indonesian government projects.

Lastly, it is worth mentioning that this research was able to statistically test the relationship between QMS-ISO9000 principles and KPIs variables. After being analyzed, the results show that the two variables have a positive relationship and thus the increased value of QMS principles appears to increase the value of KPIs. It is proposed that these variables may also be tested in construction research in other countries outside Indonesia in order to have comparative studies and obtain more validity and reliability of the variables. Although much study has already been undertaken into quality management systems and construction performance research, none has empirically tested the relationships between the value of ISO9000 principles and the up-to-date contractors performance indicators as has been done here. Therefore, this study contributes to the introduction of QMS assessment performance at an early stage within ISO9000 certified companies to measure their achievement while implementing their quality management systems (QMSs).

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REFERENCES

- [1] R. U. Farooqui and S. M. Ahmed, "A stepping stone to total quality management for construction companies (Presented Conference Paper style)," presented at the *7th Latin American and Caribbean for Engineering and Technology*, San Cristobal, Venezuela, 2009.
- [2] A. J. Lordsleem, C. Duarte, and B. J. Barkokebas, "Performance indicators of the companies quality management systems with ISO 9001 certification (Presented Conference Paper style)," presented at the *CIB 2010 World Congress*, Salford Quays, United Kingdom, 2010.
- [3] Sudarto, "Identification of internal factors problems affecting the construction services' performance in Indonesia" (in Bahasa), *Jurnal Teknologi*, vol. XXI, no. 2, pp. 102-110. Jun. 2007
- [4] Construction Management and Engineering of Bandung Institute of Technology, *National Workshop on Community Action Forum for Indonesian Construction*. Online: http://www.ftsl.itb.ac.id/kk/manajemen_dan_rekayasa_konsultasi/?p=298 (accessed April 28, 2010).
- [5] H. Motulsky, *Analyzing data with GraphPad Prism* (Book style), 2004. Available online: <http://www.graphpad.com> (accessed April 6, 2011).
- [6] V. Arumugam, K. B. Ooi, and T. Ch. Fong, "TQM practice and quality management performance: An investigating of their relationship using data from ISO 9001:2000 firms in Malaysia (Periodical style)," *The TQM Magazine*, vol. 20, no. 6, pp. 636-650, 2008.
- [7] N. M. Cachadinha, "Implementing quality management systems in small and medium construction companies: A contribution to a road map for success (Periodical style)," *Leadership and Management Eng.*, vol. 9, no. 1, pp. 32-39, Jan. 2009.
- [8] A. Shibani, "Barriers of TQM implementation in Libyan Industries (Presented Conference Paper style)," presented at the *CIB 2010 World Congress*, Salford Quays, United Kingdom, 2010.
- [9] R. Tricker, *ISO 9001:2000 for Small Business* (Book style). Oxford, Butterworth-Heinemann, 2008, pp. 26-29.
- [10] P. Hoonakker, P. Carayon, and T. Loushine, "Barriers and benefits of quality management in the construction industry: An empirical study (Periodical style)," *Total Quality Management & Business Excellent*, vol. 21, no. 9, pp. 953-969, 2010.