

Assessment Model of Contractor Quality Management Maturity

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Abstract—One of the most important parts of a project management is the quality management. While it is absolutely necessary to conduct a thorough research on the maturity of quality management in construction companies, especially contractors so that construction companies know at what level of their company quality, this has an effect on building customer perceptions of their companies and the business of the company itself to continue to grow to be able to reach the highest maturity level. This paper aims to propose an assessment model of contractor quality management maturity (QMM) that covers both the corporate and project levels of a construction project. Determination of research variables was conducted with the study of literature in depth and validated by experts. Weighting variables by pairwise comparison method were based on interviews with experts and was represented in the form of a spider web. For model validation, case studies of large state-owned contractors and a medium-sized private contractor in Surabaya were used. The weighting for QMM assessment on contractors is 43% on corporate level and 57% on project level. In corporate level there are 10 variables with each weighting: People and Customer Management (2.9%), Supplier Partnership (1.6%), Communication of Improvement Information (2.4%), Customer Satisfaction Orientation (5.3%), External Interface Management (1.4%), Strategic Quality Management (6.2%), Team Work Structures for Improvement (4.3%), Operational Quality Planning (4.4%), Quality Improvement Measurement System (8.2%), and Corporate Quality Culture (6.3%). Project level quality consists of 39% for product quality and 18% for service quality. In the project level there are 8 variables for product quality: Performance (9.0%), Features (4.1%), Reliability (8.0%), Conformance (5.6%), Durability (4.5%), Serviceability (3.0%), Aesthetics (1.7%), Perceived Quality (3.1%). While the service quality consists of 5 variables: Service Reliability (4.9%), Responsiveness (2.7%), Assurance (5.7%), Emphaty (1.8%), and Tangibles (2.8%).

Keywords—Quality Contractor, Quality Management, Project Management, Maturity, Maturity Model.

I. INTRODUCTION

Project management in contractor company is an essential activity because contractor is a type of project-based companies. One of the most important parts of a project management is the quality management. From the perspective of a construction company, quality management in a construction project means maintaining the quality of necessary and standardized construction work so as to obtain customer satisfaction that will bring long-term competitiveness and business viability to the company [1].

A strong quality culture has been recognized as an important prerequisite to the achievement of sustained competitive advantage through the continuous delivery of high quality products and services as well as clients'/end-users' satisfaction. Therefore, many contractors trying to win the competition by improving the quality of both the project level and the corporate level to provide customer satisfaction. Contractors who do not prepare to improve the quality of work will have difficulty to compete. So, we need to measure the quality maturity of contractor.

A maturity model is a phased approach to improve business processes over a considerable period of time.

Maturity is achieved at the advanced level when processes are not only being managed well, but staffs are involved in a continuous process of improvement on a daily basis [2],[3]. A maturity model is regarded as a framework that provides guidelines for a process or product development [4]. The purpose of any maturity model: "It shows where you are today, where you should go in the future, what is the value of doing so, and how to get there". The maturity model provides a "big picture" overview, composed of small elements, and thus comprehensively explains how to implement the development of a product or a process [5].

The purpose of the quality maturity model is four-fold. Firstly, it is intended to be a roadmap to determine where they are located on the journey towards achieving a ubiquitous culture of quality, and what the appropriate direction of travel is, because if you don't know where you are, a map won't help; and if you don't know where you are going, any road will do. Secondly, it is a framework to enable the management to prioritize actions. Thirdly, the quality maturity model is a tool for assessment. Fourthly, the quality maturity model is intended to provide a common language and a shared vision for a community of practice [6].

Much research has been done on project management maturity, but mostly on all parts of project management, there has not been much in-depth research on the quality management maturity. While it is absolutely necessary to thorough research on the maturity of quality management in construction companies, especially contractors so that construction companies know, at what level of their company quality, this has an effect on building customer perceptions of their companies and the business of the company itself to continue to grow to be able to reach the highest maturity level.

Contractors who do not prepare to improve the quality of work will have difficulty to compete. So, we need to measure the quality maturity of contractor. This study aims to develop assessment model of contractor quality management maturity based on two aspects : the corporate level and the project level that cover both the product quality and service quality.

This study has the following research limits:

1. The research was conducted on 3 large state-owned contractors and 1 medium private contractor in Surabaya, Indonesia. This measurement is for a sample case study only, limited to one or two projects in each contractor. This study does not compare (rank) the contractors by the QMM score, but only attempts to apply the assessment model. The model of assessment proposed in this study can be implemented for any type of project.

2. Small contractors are not included in this research because they are unlikely to have a quality management system.

3. For project level quality is limited to project output based on the assessment of the owner.

The benefits of this research are:

1. Benefit for scientific development, that is as a reference of similar research.

2. Practical benefits, which can be a reference by practitioners for QMM measurement (quality management maturity) in contractor company.

3. QMM assessment model (quality management maturity) proposed in this study is to be able as a self assessment to describe how high the maturity level of the contractor.

4. The QMM assessment model (quality management maturity) proposed in this study can be as benchmarking by the contractor and similar projects, so that the contractor could understand their strengths and weaknesses.

5. QMM assessment model (quality management maturity) can also as a corrective action to improve the quality performance in the contractor company.

The success of a project found in the literature depends on the project quality as a key concept [7],[8],[9]. The concept of quality is meeting the legal, aesthetic and functional requirements of a project [10]. Quality is both a philosophy and a set of guiding principles that represents a continuously improving organization [11]. Quality can be translated into the quality dimensions that include: levels of quality, reliability and safety, quality performance, durability, and serviceability [12],[13],[8]. That it is the role of management to ensure the achievement of established requirements in a project is when competition increases and change occurs in the business world [14].

Product quality is defined as the collection of features and characteristics of a product that contribute to its ability to meet given requirements. In the era of service economy, how to meet customers' expectations and to measure customers' satisfaction turns to be the locus of value creation [15],[16],[17],[18].

Service quality is the gap between what the customers want and what they actually get or perceive what they are getting [15],[18]. Consequently, many companies would attempt to offer a high service quality in order to retain their customers. It has been empirically proved that high service quality motivates positive customer behavioral intention to repurchase, and in turn, promotes customer retention [15],[19]. This implies that service quality is linked positively to customer loyalty. Actually, many studies have shown that quality is indirectly linked to repurchase intention and customer loyalty through customer perceived value [15],[20]. A related theory to customer satisfaction is the SERVQUAL model [21]. This model indicates that there are five dimensions used in measuring customer service quality. The dimensions included in this model are tangibles, reliability, responsiveness, empathy and assurance.

Project has been defined by different organizations in different way [22]. A few of definitions are explained below: Project is a unique, transient endeavor undertaken to achieve planned objectives, which could be defined in terms of outputs, outcomes or benefits [23]. Another definition of a project is a temporary endeavor undertaken to create a unique product, service or result. The temporary nature of projects indicates that project has a definite beginning and end [24]. A comparison of these definitions gives common features of projects as unique, temporary and task focused [25]. A clear definition of project management will enable to understand the difference between project management and project. Project management is the application of processes, methods, knowledge, skills and experience to achieve the project objectives [23]. Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements [24]. Program management is the application of knowledge, skills, tools, and techniques to a program in order to meet the program requirements and to obtain benefits and control not available by managing projects individually [24]. Program management is coordinated management of projects and change management activities to achieve beneficial change [23]. Portfolio management refers to the centralized management of one or more portfolios (projects, programs and sub-portfolios managed as group) to achieve strategic objectives [24]. Portfolio management is selection, prioritization and control of an organization's projects and programs in line with its strategic objectives and capacity to deliver [23]. The two definitions give common feature of Portfolio management as overall effort of an organization to deal with projects and programs in alignment with its strategic goals.

Contractor is defined as the person or company that receives the job and conducts the work at the cost specified in accordance with the drawing plan and the rules and the conditions stipulated [26].

It is important to present some concepts related to quality management in projects [27]. Quality management in projects includes the processes and activities of the performing organization that determine quality policies, objectives and responsibilities, so that the project meets the needs for which it is undertaken. It implements the quality management system through policies and procedures by continuous improvement activities of processes performed throughout the project as appropriate [24].

The trend of using maturity models for increasing organization's performance have been increased in recent years [22],[28]. Maturity models provide framework to organizations for improving their performance across different business areas [29]. Maturity in organizational context is a state that creates perfect condition for organization to achieve its desired objectives. Thus maturity, when applied to projects of organization, provides perfect condition to handle the projects [30]. The purpose of using any maturity model is always to find improvements by assessing existing practices of project management. The maturity model differs with each other in terms of their characteristics, factors and structures to achieve desired purpose [31], that concluded from their comparison that Organizational Project Management Maturity Model (OPM3) stands best because OPM3 refers to PMBOK that is a worldwide acceptable standard, OPM3 publisher PMI has status of being most popular around the world for project management, covers strategic management, covers project, program and portfolio management aspects, follows continuous approach compared to other maturity models which follow staged approach, date of issue shows that it is not old, provides tools for self-assessment and external assessment of project management maturity, identifies strength and weakness and suggest alternatives to improve, provides path to prioritize improvements, simple and easily understandable, the assessment has low cost, industry independence and can be applied to any industrial sector. OPM3 self-assessment questionnaire contains 151 questions [32] and 42 questions are related with quality management maturity. Organization can be used to assess its current level of project management for comparison with best practice standard of OPM3. It provides high level assessment about organization's project management maturity [33]. Description of maturity levels for OPM3 is explained as follows [33] :

Level 1: None – no such practice exist.

Level 2: Standardize – a standardized process of doing projects have been documented and communicated within organization. This practice is not used by all the projects but only few.

Level 3: Measure – standardized process is used by all the projects within organization and processes are measured to evaluate effectiveness for organization.

Level 4: Control – measured process is corrected for poor application of the standardized practice. Upper and lower limits are established and process is analyzed.

Level 5: Improve – continuous improvement of process becomes a practice for outcome of Best Practice standard.

II. METHOD

A. Research Methodology

This paper uses a case study design with contractors in Surabaya as the object of research. Determination of research variables was conducted with the study of literature in depth and validated by experts. In order to assess the QMM on existing contractor, there are 13 variables at project level namely : performance, features, reliability, conformance, durability, serviceability, aesthetics, perceived quality, service reliability, responsiveness, assurance, empathy and tangibles. And 10 variables at corporate level are : people and customer management, supplier partnership, communication of improvement information, customer satisfaction orientation, external interface management, strategic quality management, team work structures for improvement, operational quality planning, quality improvement measurement system, and corporate quality culture.

Weighting variables by pairwise comparison method were based on interviews with experts. There are eight experts who become respondents for weighting with pairwise comparison method. Data analysis used mean analysis and was represented in the form of a spider web.

For model validation, case studies of four contractors in Surabaya were used. Questionnaire for quality assessment at corporate level in this study were conducted on 4 contractors namely Contractor A (large state-owned contractor), Contractor B (large state-owned contractor), Contractor C (large state-owned contractor), and Contractor D (medium-sized private contractor). There are two respondents in each contractor. Then questionnaire for quality assessment at project level in this study were conducted on 4 project owners (from Contractor A,B,C,D). There are two respondents in each project owner.

The research flow diagram is shown in Figure 1.

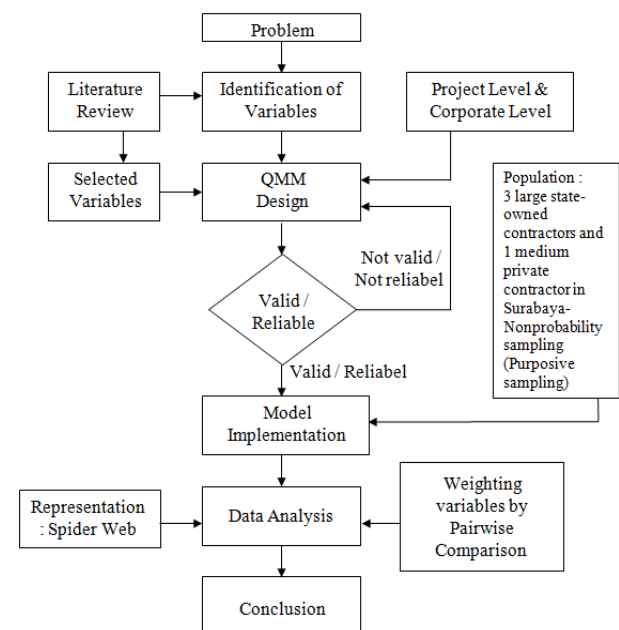


Figure 1. Research Flow Diagram

B. Research Variables

The research variables, shown in Table 1.

Table 1.
 Research Variables

No	Variable	Description
CORPORATE LEVEL VARIABLES [32],[34],[35],[36]		
C1	People and customer management	◆ Human resource management in line with company quality performance plans.
C2	Supplier partnership	◆ Employee recognition/ measurement to support quality/ performance objective.
C3	Communication of improvement information	◆ Management of customer relations.
C4	Customer satisfaction orientation	◆ Assurance of supplier quality.
C5	External Interface Management	◆ Action to assist and improve the quality and expensiveness of suppliers.
C6	Strategic Quality Management	◆ Strategic management of suppliers.
C7	Team work structures for improvement	◆ Determination of quality costs to support the prioritisation of improvements.
C8	Operational Quality Planning	◆ Assessment of needs for quality trailing and subsequent delivery and review.
C9	Quality improvement measurement system	◆ Benchmarking of processes in non-competing organizations.
C10	Corporate quality culture	◆ Promotion of quality improvement with outside groups.
PROJECT LEVEL : PRODUCT VARIABLES [34],[35],[37],[38],[39]		
P1	Performance	Basic functions of the facility meets the end-user's needs and intents.
P2	Features	Characteristics that supplement the basic functions of the facility.
P3	Reliability	The level of confidence with which end-users/ occupants can use the facility to the end of its design life, without failure.
P4	Conformance	The degree to which construction operations meet the design standards and specifications.
P5	Durability	The amount of time that occupants/ end-users can use the facility before replacement is preferred to continued repair.
P6	Serviceability	The speed and ease with which maintenance can be carried out.
P7	Aesthetics	The degree of satisfaction that occupants / end-user experience with the facility's look and feel.
P8	Perceived Quality	The degree of satisfaction that occupants / end-user experience with the facility's image and publicity.

PROJECT LEVEL : SERVICE VARIABLES [18],[34],[37],[40],[41],[42],[43],[44],[45],[46],[47],[48]		
S1	Service Reliability	The degree to which construction activities are correct, ability to perform the promised service dependably and accurately.
S2	Responsiveness	The ability to react to the unexpected problems encountered during the project. Willingness and readiness to provide prompt service.
S3	Assurance	Knowledge and courtesy of employees and their ability to inspire trust and confidence.
S4	Empathy	Caring, individualized attention the firm provides its customers.
S5	Tangibles	The appearance of both the personnel (appearance of employees) and the facilities (equipment) of the company to the customer.

C. Quality Management Maturity (QMM) Model

The overview of Quality Management Maturity (QMM) Model is shown in Figure 2.

III. RESULTS AND DISCUSSION

After performing weighting with Pairwise Comparison Method, the QMM diagram for weighting can be seen in Figure 2. It shows that the weighting of main level for QMM assessment on contractors is 43% on corporate level and 57% on project level, so the weighting for project level is higher than corporate level. Project level quality consists of 39% for product quality and 18% for service quality.

After the validity and reliability of the data (questionnaires for quality assessment at corporate level and project level) were conducted and then followed by data processing.

The following is calculated for Contractor A (large state-owned contractor). Assessment for corporate level quality is shown in Table 2 and Table 3, the maturity level is 4.52 (of 5 scales). The spider web representation can be seen in Figure 3.

Assessment for product quality in project level is shown in Table 4 and Table 5, the maturity level is 2.99 (of 5 scales), while the spider web representation can be seen in Figure 4.

Table 2.
 Contractor A's Score for Corporate Level Quality C1-C5

Contractor A's Score for Corporate Level Quality					
	C1	C2	C3	C4	C5
Mean (M)	4,8	4,5	4,4	4,0	4,3
Weighting (W)	0,07	0,04	0,06	0,12	0,03
M x W	0,33	0,16	0,24	0,49	0,13

Table 3.
 Contractor A's Score for Corporate Level Quality C6-C10

Contractor A's Score for Corporate Level Quality						
	C6	C7	C8	C9	C10	
Mean (M)	4,5	4,5	4,5	4,5	5,0	Σ
Weighting (W)	0,14	0,10	0,10	0,19	0,15	1,00
M x W	0,65	0,45	0,46	0,86	0,74	4,52

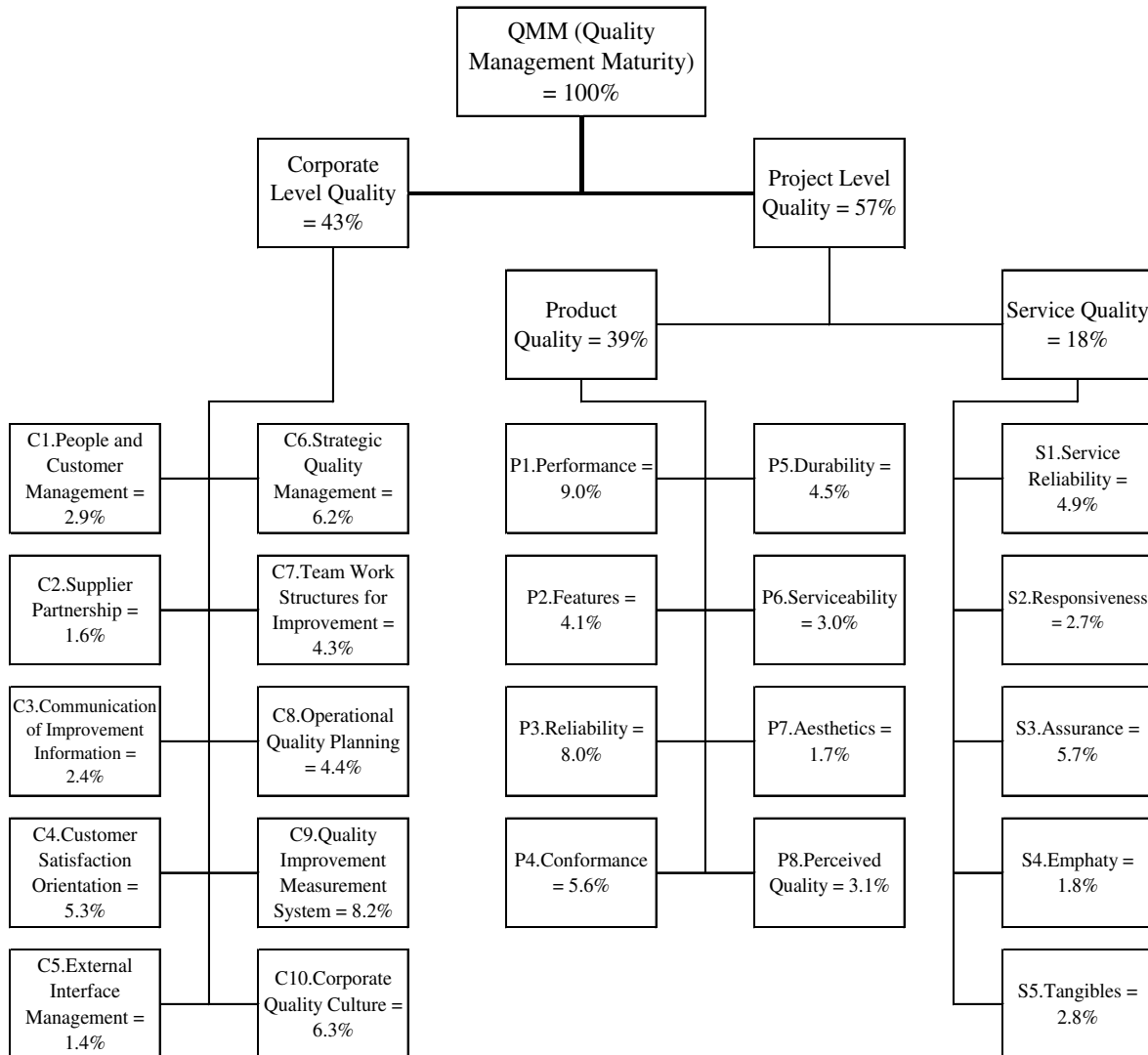


Figure 2. The overview of Quality Management Maturity (QMM) Model and Weighting

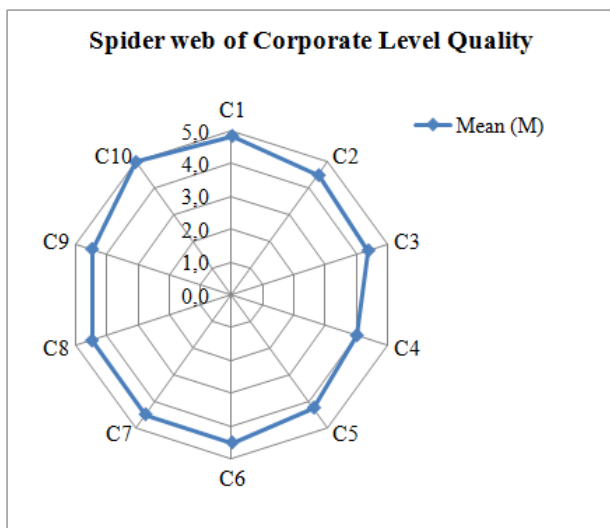


Figure 3. Spider web of Contractor A's Corporate Level Quality

Assessment for the service quality in project level is shown in Table 6, the maturity level is 3.47 (of 5 scales), and the spider web representation can be seen in Figure 5.

Table 4.
 Contractor A's Score for Project Level : Product Quality P1-P4

Contractor A's Score for Project Level : Product Quality				
	P1	P2	P3	P4
Project A	3,67	3,67	3,33	3,67
Project B	3,00	3,00	2,00	2,00
Mean (M)	3,3	3,3	2,7	2,8
Weighting (W)	0,23	0,11	0,21	0,14
M x W	0,77	0,35	0,55	0,41

For calculation of QMM, the maturity level of Contractor A can be seen in Table 7. It appears that the QMM level of contractor A is 3.73 (of 5 scales).

Table 5.
 Contractor A's Score for Project Level : Product Quality P5-P8

Contractor A's Score for Project Level : Product Quality					
	P5	P6	P7	P8	
Project A	2,67	3,00	3,33	3,33	
Project B	3,50	3,00	3,00	1,50	
Mean (M)	3,1	3,0	3,2	2,4	Σ
Weighting (W)	0,12	0,08	0,04	0,08	1,00
M x W	0,36	0,23	0,14	0,19	2,99

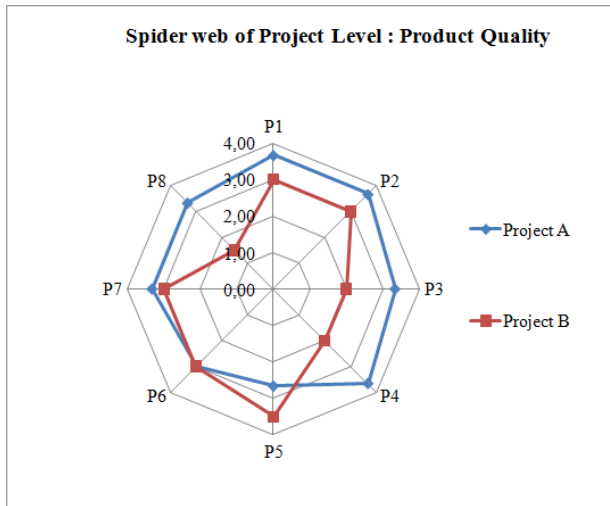


Figure 4. Spider web of Contractor A's Project Level : Product Quality

Table 6.
 Contractor A's Score for Project Level : Service Quality

Contractor A's Score for Project Level : Service Quality						
	S1	S2	S3	S4	S5	
Project A	3,44	3,78	4,17	4,00	4,33	
Project B	2,67	3,17	3,25	3,00	3,00	
Mean (M)	3,1	3,5	3,7	3,5	3,7	Σ
Weighting (W)	0,28	0,15	0,32	0,10	0,16	1,00
M x W	0,84	0,52	1,18	0,35	0,57	3,47

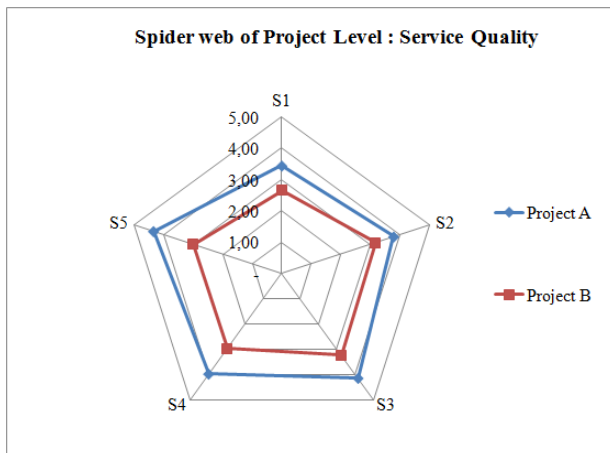


Figure 5. Spider web of Contractor A's Project Level : Service Quality

Table 7.
 QMM Assessment for Contractor A

Contractor A's Score for QMM (of 5 scales)	Corporate Level Quality	Project Level Quality		Σ
		Product	Service	
Score (S)	4,52	2,99	3,47	
Weighting (W)	0,43	0,39	0,18	1,00
S x W	1,95	1,16	0,62	3,73

Based on description of maturity levels for OPM3 [33], where there is a total of 5 levels, can be concluded that Contractor A (maturity level = 3.73) is between level 3 and level 4 that is more likely to level 4.

Level 4 means : Control (measured process is corrected for poor application of the standardized practice). Upper and lower limits are established and process is analyzed [33].

The following is calculated for Contractor B (large state-owned contractor). Assessment for corporate level quality is shown in Table 8 and Table 9, the maturity level is 4.45 (of 5 scales). The spider web representation can be seen in Figure 6.

Table 8.
 Contractor B's Score for Corporate Level Quality C1-C5

Contractor B's Score for Corporate Level Quality					
	C1	C2	C3	C4	C5
Mean (M)	4,0	4,0	4,6	4,5	4,8
Weighting (W)	0,07	0,04	0,06	0,12	0,03
M x W	0,27	0,14	0,26	0,55	0,15

Table 9.
 Contractor B's Score for Corporate Level Quality C6-C10

Contractor B's Score for Corporate Level Quality						
	C6	C7	C8	C9	C10	
Mean (M)	4,4	4,2	4,5	4,7	4,5	Σ
Weighting (W)	0,14	0,10	0,10	0,19	0,15	1,00
M x W	0,64	0,41	0,46	0,90	0,66	4,45

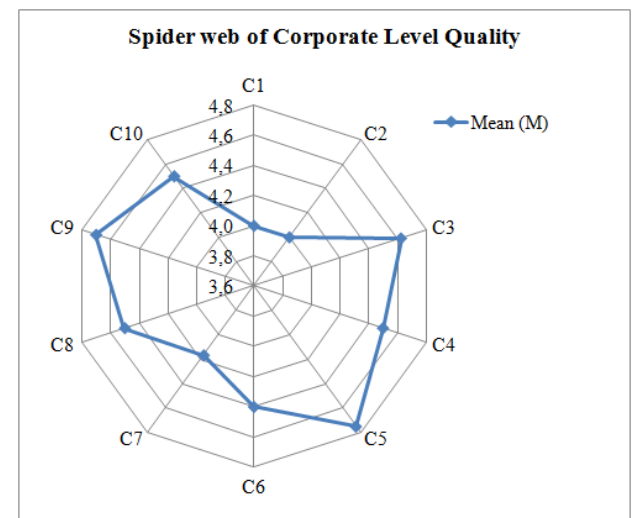


Figure 6. Spider web of Contractor B's Corporate Level Quality

Assessment for product quality in project level is shown in Table 10 and Table 11, the maturity level is 4.50 (of 5 scales), while the spider web representation can be seen in Figure 7.

Table 10.
 Contractor B's Score for Project Level : Product Quality P1-P4

Contractor B's Score for Project Level : Product Quality				
	P1	P2	P3	P4
Project A	4,00	4,00	4,00	5,00
Project B	5,00	5,00	5,00	5,00
Mean (M)	4,5	4,5	4,5	5,0
Weighting (W)	0,23	0,11	0,21	0,14
M x W	1,04	0,47	0,93	0,72

Table 11.
 Contractor B's Score for Project Level : Product Quality P5-P8

Contractor B's Score for Project Level : Product Quality					
	P5	P6	P7	P8	
Project A	4,00	3,00	4,00	4,00	
Project B	5,00	4,00	5,00	5,00	
Mean (M)	4,5	3,5	4,5	4,5	Σ
Weighting (W)	0,12	0,08	0,04	0,08	1,00
M x W	0,52	0,27	0,20	0,36	4,50

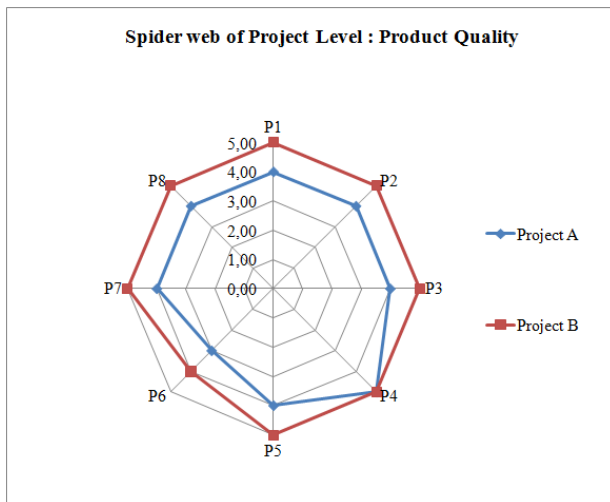


Figure 7. Spider web of Contractor B's Project Level : Product Quality

Assessment for the service quality in project level is shown in Table 12, the maturity level is 4.03 (of 5 scales), and the spider web representation can be seen in Figure 8. For calculation of QMM, the maturity level of Contractor B can be seen in Table 13. It appears that the QMM level of contractor B is 4.39 (of 5 scales).

Based on description of maturity levels for OPM3 [33], where there is a total of 5 levels, can be concluded that Contractor B (maturity level = 4.39) is between level 4 and level 5 that is more likely to level 4.

Table 12.
Contractor B's Score for Project Level : Service Quality

Contractor B's Score for Project Level : Service Quality						
	S1	S2	S3	S4	S5	
Project A	3,67	3,67	4,00	3,00	4,00	
Project B	4,33	4,33	4,50	4,00	4,00	
Mean (M)	4,0	4,0	4,3	3,5	4,0	Σ
Weighting (W)	0,28	0,15	0,32	0,10	0,16	1,00
M x W	1,10	0,60	1,35	0,35	0,62	4,03

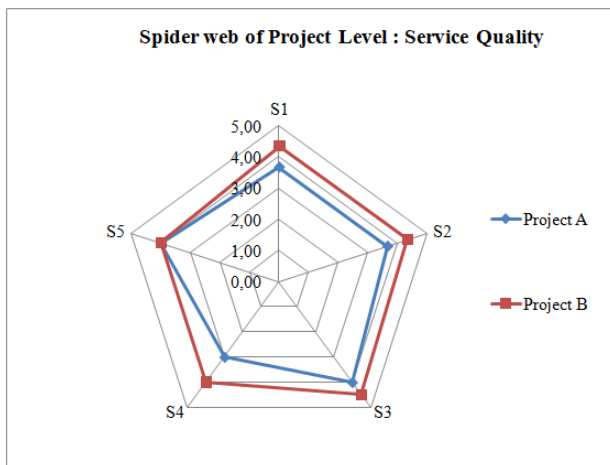


Figure 8. Spider web of Contractor B's Project Level : Service Quality

Table 13.
QMM Assessment for Contractor B

Contractor B's Score for QMM (of 5 scales)	Corporate Level Quality	Project Level Quality		Σ
		Product	Service	
Score (S)	4,45	4,50	4,03	
Weighting (W)	0,43	0,39	0,18	1,00
S x W	1,92	1,75	0,73	4,39

With the same method, the maturity level of Contractor C (large state-owned contractor) can be seen in Table 14. It appears that the QMM level of contractor C is 3.85 (of 5 scales). It can be concluded that Contractor C (maturity level = 3.85) is between level 3 and level 4 that is more likely to level 4.

Table 14.
QMM Assessment for Contractor C

Contractor C's Score for QMM (of 5 scales)	Corporate Level Quality	Project Level Quality		Σ
		Product	Service	
Score (S)	4,40	3,49	3,32	
Weighting (W)	0,43	0,39	0,18	1,00
S x W	1,89	1,36	0,60	3,85

For Contractor D (medium-sized private contractor), the maturity level can be seen in Table 15. It appears that the QMM level of contractor D is 2.88 (of 5 scales). It can be concluded that Contractor D (maturity level = 2.88) is between level 2 and level 3 that is more likely to level 3.

Table 15.
QMM Assessment for Contractor D

Contractor D's Score for QMM (of 5 scales)	Corporate Level Quality	Project Level Quality		Σ
		Product	Service	
Score (S)	2,79	3,04	2,73	
Weighting (W)	0,43	0,39	0,18	1,00
S x W	1,20	1,19	0,49	2,88

Level 3 means : Measure (Standardized process is used by all the projects within organization and processes are measured to evaluate effectiveness for organization) [33].

This research was conducted on 3 large state-owned contractors and 1 medium private contractor in Surabaya, Indonesia. This measurement is for a sample case study only, limited to one or two projects in each contractor. Further research can be developed for larger data samples, to further validate the model.

Project level quality is limited to project output based on the assessment of the owner. Further research can be developed by adding variables in the construction project process, not only project output.

IV. CONCLUSION

From the results of this research, the weighting for QMM assessment (Quality Management Maturity) on contractors is 43% on corporate level and 57% on project level. In corporate level there are 10 variables which each weighting is as follows: People and Customer Management (2.9%), Supplier Partnership (1.6%), Communication of Improvement Information (2.4%), Customer Satisfaction Orientation (5.3%), External Interface Management (1.4%), Strategic Quality Management (6.2%), Team Work Structures for Improvement (4.3%), Operational Quality Planning (4.4%), Quality Improvement Measurement System (8.2%), and Corporate Quality Culture (6.3%). Project level quality consists of 39% for product quality and 18% for service quality. In the project level there are 8 variables for product quality which each weighting is as follows: Performance (9.0%), Features (4.1%),

Reliability (8.0%), Conformance (5.6%), Durability (4.5%), Serviceability (3.0%), Aesthetics (1.7%), Perceived Quality (3.1%). While the service quality in project level consists of 5 variables which each weighting is as follows: Service Reliability (4.9%), Responsiveness (2.7%), Assurance (5.7%), Emphaty (1.8%), and Tangibles (2.8%).

This QMM assessment model after implemented on some Contractors can generate QMM (Quality Management Maturity) Score so that maturity level on the Contractor can be known. The QMM score can be a self assessment to describe how high the maturity level of the Contractor, it also can be as benchmarking by the Contractor and similar projects so that the Contractor can know their strength and weakness, as well as the corrective action to improve the quality performance in the Contractor company. This QMM rating model is beneficial to the Contractor, also beneficial to the owner (of the project) or Consultant.

The results showed that the implementation model for large contractors have an average maturity level at 4 of 5 scales. As for medium-sized contractor company is still less than 3 of 5 scales.

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