Development of Assessment System on Contractor Quality Safety Management System (CQSMS) Evaluation to Improve Vendor Performance at Construction Project of PT X Using Analytical Hierarchy Process (AHP) Method

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Abstract- The working relationship between contractor and subcontractor as their vendor is carried out with mutual benefit or is called a win-win solution (Winarta et al., 2022). Selection of the vendor shall always be considered by project manager because the vendor can have very positive or very harmful and negative impacts on the general performance of an organization. Identifying important criteria on the assessment system model using Contractor Quality Safety Management System (CQSMS) Evaluation, can minimize unsatisfactory quality and safety performance of the vendor. This study was conducted to identify assessment criteria and its rating on the assessment system model using Contractor Quality Safety Management System (CQSMS) Evaluation that affect quality and safety performance of the vendor. Then a number of 29 indicator/ sub-criteria was confirmed by using Delphi method and were turned into the AHP questionnaire and it was distributed among 4 of the practical experts and 1 member of the university. The 29 criteria classify into 6 perspective; (X1) Document of QHSE Plan, (X2) Implementation of QHSE Plan at Pre Job Activity, (X3) Implementation QHSE Plan at Work In Progress, (X4) Commitment of Defect Completion, (X5) Lagging Indicator QHSE Performance, (X6) Other Supporting Document. The proposed model was solved and some managerial implications were recommended.

Index Terms- Analytical Hierarchy Process, Contractor Quality Safety Management System, Construction project, Assessment system, Vendor performance

I. INTRODUCTION

Indonesia's infrastructure development is being carried out vigorously. It is presented by the construction services sector that contribute to 10% of the World GDP (Murie, 2007). In 2021, construction services sector in Indonesia contribute to 10,44% of the national GDP after the manufacturing industry is 19,25%, and trade is 12,97% (Badan Pusat Statistik, 2022). As a high demand in the construction industry, contractors has to improve their resources and management functions, so that they can always meet the requirements. That's one way of putting it, can be done through a strategic alliance between contractor and their vendors. Collaborative relationship between contractor and their vendors can be develop innovative products, boosting revenues and profits for both parties, or giving their best performance. There are many different specialties within the industry that are needed to bring a construction project to completion, one of them is subcontractor (Maulani et al., 2014). Subcontractors carry out a large part of the work done in construction projects, so that relationship quality between contractor and subcontractor significantly affect the cost, quality, and time of the construction projects (Winarta et al., 2022). For main contractor, good relationships with their subcontractors reduce the risk of poor quality work as well as cost and time overruns.

As a one of the Indonesian State-Owned Entreprises (BUMN) contractor, PT X requires many subcontractor services to support their construction project. So that subcontractors are required to be able to provide a high level of services. Therefore, an assessment system is needed that able to accommodate the process of procurement along with QHSE management. One of the appropriate assessment systems in Indonesian construction industry is CSMS (Contractor Safety Management System).

CSMS (Contractor Safety Management System) is a management system for managing contractors and subcontractors work, to pay attention to QHSE aspects and maintain the implementation of QHSE in the work process to avoid potential accidents and risks that may occur (Falenshina, 2012). CSMS as known as CQSMS (Contractor Quality Safety Management

System) in PT X with the idea of not separating aspects of quality and safety (QHSE Procedure Document PT X, 2020).

CQSMS aims to prevent and reduce the potential work accidents for contractor and subcontractor to create a safety climate, efficient and productive as a target (Basri, 2017). CQSMS also improving quality and safety performance in the workplace by assisting contractors and subcontractors for an effective QHSE management system (Falenshina, 2012). From the several objectives of implementing the CQSMS, it is known that the target of CQSMS is quality and safety performance.

Quality performance is described as all activities of the entire management function that establishes quality policies, objectives and responsibilities, also by implement them using quality planning and quality improvement (Jaya, 2013). Safety performance includes organization and QHSE management system, equipment, safety rules, number of accidents, training, evaluation of QHSE management systems, investigations, and implementation QHSE management systems (Nevhage & Lindahl, 2008). It is concluded that contractors should be selective in selecting subcontractors as vendors in order to achieve the target quality and safety performance.

The importance of assessing quality and safety performance in the procurement process which are related to CQSMS, it is required the development of assessment system in the final evaluation of CQSMS. By develop the model of assessment system that is right on the target, it is necessary to have a very detailed criteria on assessment process. Identification of critical criteria at each stage of CQSMS must be carried out. The rate (%) of each criteria must be determined to create a priority scale, so it will be affect to quality and safety performance. In this research, developing and determining the rate of criteria, the Analytical Hierarchy Process (AHP) method was used. The model proposed in this research consists of criteria that are used to assess the vendor performance and their priorities

II. THEORTCAL STUDY

Constructon Project

Project Management Institute (2017) defines a project as a temporary endeavor undertaken to create a unique result. The main characteristics of the project according to Gray & Larson (2011) are: having goals to be achieved, having a clear time duration (there is a start and finish time), limited budget and limited resources, can be defined clearly and can be implemented, the deliverable are measurable and can be quantified, and can be planned, implemented, and controlled.

It's the foremost preliminary step for proceeding with any research work writing. While doing this go through a complete thought process of your Journal subject and research for it's viability by following means:

1) Read already published work in the same field.
2) Goggling on the topic of your research work.
3) Attend conferences, workshops and symposiums on the same fields or on related counterparts.
4) Understand the scientific terms and jargon related to your research work.

Procurement Management

It includes the set of processes necessary to procure products, services or things that an organization demands to support its productivity. The purpose of procuring is to obtain goods and services at competitive prices, quality according to specifications, and acceptable (Novitaningrum, 2014). In the procurement management of PT X, 6 methods are used to do vendor selection. 3 of them which involved CQSMS; (1) vendor selection through synergy, (2) vendor selection through direct procurement, and (3) vendor selection through tenders (Procurement Procedure Document PT X, 2020)

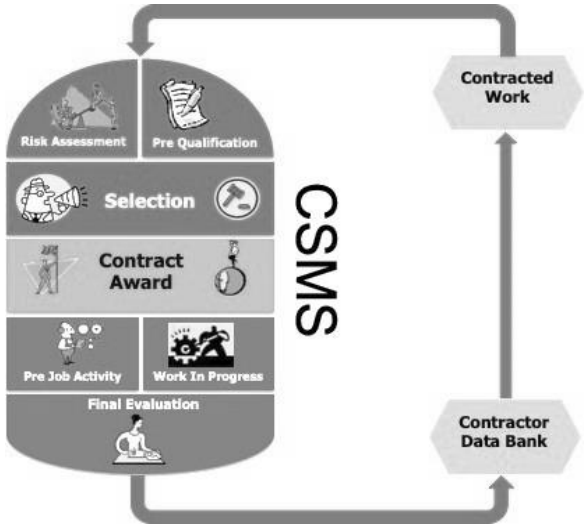

Figure 1. CSMS Process
Source: PT Pertamina, 2021

Contractor Quality and Safety Management System (CQSMS)

Contractor Quality Safety Management System (CQSMS) is a program in contractors/ subcontractors in project work so they can work safely according to Quality Health Safety and Environment (QHSE) aspects in the organization (Sari, 2017). Legal framework of implementation CQSMS in Indonesia are: (Endroyo, 2009)

1. Peraturan Menteri Tenaga Kerja 05/MEN/1996 Pasal 1
2. Peraturan Pemerintah No. 50 tahun 2012 concerning SMK3
3. Peraturan Menteri Tenaga Kerja, Transmigrasi dan Koperasi Republik Indonesia No : Per.03/Men/1978
4. Undang-Undang Republik Indonesia Nomor 1 Tahun 1970 concerning Keselamatan Kerja

CQSMS stages consist of: (PT. Pertamina, 2021)

1. *Risk Assessment*
   The project planner determines the influence of risk on the work and arranges the QHSE plan requirements into the terms of pre-qualification.
2. *Pre-Qualification*
   Vendor uploads their QHSE plan document through the CQSMS application and completes the evidence of implementation of their QHSE management systems.
3. *Selection*

This stage is carried out to select the best vendor among all participants in the tender. After the vendor is selected as a winner, a Contract Awarding stage is held, by signing a contract.

4. *Pre-Job Activity*
   Kick of meeting is held between contractors and vendors to see the gaps in the QHSE plan prepared by vendor, then comparing its bid with the QHSE plan prepared by the planner. Define a new QHSE plan based on the agreement for the work and signed by both parties. Then, vendor implementing the agreed QHSE Plan at pre-job activity stage.
5. *Work in Progress*
   The contractor conducts periodic monitoring and temporary assessment of the agreed QHSE plan in order to input for final evaluation. Vendor implementing the agreed QHSE Plan at work in progress stage.
6. *Final Evaluation*
   At the end of the contract, vendor is required to submit all activity reports related to quality and safety aspects to the contractor's supervisor of work. Activity reports includes the plan, do, check, and action (PDCA Process) of QHSE management. Therefore, the evaluation at least covers any criteria on the Table 1. The Project Manager evaluate and assess vendor performance on final evaluation stage within input from the QHSE Manager. The results of the evaluation will be stored in a data bank and will be taken into consideration whether the vendor is eligible for the future work.

Table 1. Important Criteria of CQSMS Final Evaluation

Criteria	Subcriteria	References
QHSE Plan Document	QHSE Management Commitment and Policy	*CQSMS Application PT X, Procurement Procedure Document PT X, QHSE Procedure Document PT X, Ibrahim (2020), K. Elibal and E. Ozceylan (2022), K. Versteeg, et al. (2019), J. Xu et al. (2021), H.A.E.M. Ali et al (2012), M.M.A. Abu Oda et al. (2022)*
	HIRADC	
	Targets and Objectives	
	Organizational Structure	
	Emergency Response Plan	
	Inspection Test Plan	
	Method Statement	
Implementation of QHSE Plan at Pre Job Activity	Medical / Health Report	*CQSMS Application PT X, Procurement Procedure Document PT X, QHSE Procedure Document PT X, Ibrahim (2020), K. Elibal and E. Ozceylan (2022), K. Versteeg, et al. (2019), J. Xu et al. (2021), H.A.E.M. Ali et al (2012), M.M.A. Abu Oda et al. (2022)*
	Worker Insurance	
	Heavy Equipment & Operator License (SIA & SIO)	
	Expertise Certificate (SKA & SKT)	
	Millsheet and Factory Test	
Implementation of QHSE Plan at Work In Progress	Safety Induction	*CQSMS Application PT X, Procurement Procedure Document PT X, QHSE Procedure Document PT X, Ibrahim (2020), K. Elibal and E. Ozceylan (2022), K. Versteeg, et al. (2019), J. Xu et al. (2021), H.A.E.M. Ali et al (2012), M.M.A. Abu Oda et al. (2022)*
	Safety Talk & Tool Box Meeting	
	Work Permit & CSA (Construction Safety Analysis)	
	QHSE Inspection	
	Work and Personal Protective Equipment (APK & APD)	
	Housekeeping (5R)	
	Eco-friendly Materials	
	Emergency Simulation	
	Coordination Meetings of QHSE	
	QHSE Report	
Commitment of Defect Completion	Corrective Action	*CQSMS Application PT X, Procurement Procedure Document PT X, QHSE Procedure Document PT X, M.M.A. Abu Oda et al. (2022)*
Lagging Indicator QHSE Performance	Non-Conformance Product	*CQSMS Application PT X, Procurement Procedure Document PT X, QHSE Procedure Document PT X, Ibrahim (2020), K. Versteeg, et al. (2019), H.A.E.M. Ali et al (2012), M.M.A. Abu Oda et al. (2022)*
	Fatalities / Catastrophes	
	FR (Frequency Rate)	
	SR (Severity Rate)	
	Environmental Damage	
Other Supporting Document	Average Score of Quarterly Evaluation	*CQSMS Application PT X, Procurement Procedure Document PT X, QHSE Procedure Document PT X*

Assessment System

PT X conducted an assessment at the final evaluation of the Contractor Quality Safety Management System (CQSMS) as written in Procurement Procedure Document PT X and QHSE Procedure Document PT X. Based on this regulation, vendors has been objectively assessed by the Project Manager (Procurement Procedure Document PT X, 2020). In this evaluation, an assessment of the vendor performance is carried out by PT X which includes 10 criteria, as shown in Table 2.

Table 2. Existing Criteria of Vendor Performance Assessment
Source: Procurement Procedure Document PT X, 2020

No	Critera	Priorties
1	HSE *Plan* Management System	15%
2	HSE Implementatoin	15%
3	*Quality Plan* Management System	10%
4	*Quality* Implementation	10%
5	Schedule (*Progress*)	10%
6	Delivery Time of Material Resources, Tools & Workers	10%
7	Staff Quality	10%
8	Labor Quality	5%
9	Commitment of Defect Completion	5%
10	Cost Commitment	10%

Vendor Performance

The vendor performance of CQSMS focused on quality performance and safety performance.

1. Quality Performance
   Quality performance defined as product quality and management quality that can be achieved by vendors within a certain period of time (Fajriani, 2017).
2. Safety Performance
   Safety Performance is the quality of work related to safety (Nevhage & Lindahl, 2008). In terms of safety, contractors also need to identify and select their vendor to eliminate hazards and reduce work risks.

III. METHOD

This research was conducted through data collection of the project, Delphi method, and AHP method through questionnaire survey. The data used in this study are primary data sourced from experts as respondent through questionnaires and discussion results, as well as secondary data sourced from the project of PT X in the form of Procurement Procedure document of PT X. Four experts involved were invited based on criteria (1) a minimum S1 educational qualification, (2) has at least 5 year experience in quality and safety division of construction projects, (3) Involved in CQSMS process and has a good reputation at PT X. One expert involved were invited form academic institution. This research is divided into 2 stages, the first stage is the identification and classify the criteria. Five experts were requested to deliberate all criteria related to quality safety

performance in assessment system. The results of classified criteria was developed using the AHP method at the second stage. In conclusion, using the Microsoft Excel 2013, the AHP model were suggested in addition to the discussion.

IV. RESULT AND DISCUSSION

As previously explained, develop the assessment system is carried out in 2 steps. The first is identification and classify criteria conducted to determine various criteria associated with quality and safety performance in assessment system. Identification and classify criteria using Delphi method. The Procurement flowchart using CQSMS scheme which the authors then used as a source to collect data on related criteria. These criteria are classified into six perspective; namely Document of QHSE Plan, Implementation of QHSE Plan at Pre Job Activity, Implementation QHSE Plan at Work In Progress, Commitment of Defect Completion, Lagging Indicator QHSE Performance, Other Supporting Document. The author validates criteria with 5 experts with experience data shown in Table 3.

Table 3. Expert experience and background data

Position	Number of Expert
QHSE Manager	1
Project Manager	1
QHSE Manager	1
QHSE Manager	1
Head Lecturer	1

*Experts have more than 5 year of experience

Validation of criteria was carried out through a questionnaire survey in which experts were asked to provide approval responses on a list of criteria related to quality and safety performance in assessment system. The data obtained from the validation results are shown in Table 4.

AHP method is carried out to determine hierarchy model and develop classified criteria to measure its priorities. It is intended to determine the important criteria in the assessment system. AHP method is carried out through questionnaire survey with five experts in which experts were asked the rating of importance criteria. Pair-wise comparison matrix is prepared for computation process. The priorities of each criteria is measured, it validated by consistency of the criteria rating. The results of the measurement can be seen in Table 5, Table 6, Table 7, Table 8, and Table 9.

Table 5. The Result of Measurement Criteria

Pair-wise comparison matrix for criteria							PRIORITIES (w)	EIGEN VALUE (λ. Max)	PARAMETER	
	X1	X2	X3	X4	X5	X6				
X1	1,000	0,811	0,400	0,544	0,305	1,140	0,091	0,978	CI	0,03
X2	1,234	1,000	0,450	0,514	0,312	1,623	0,106	1,041	RI	1,24
X3	2,502	2,221	1,000	2,408	1,644	4,755	0,316	0,975	CR	0,02
X4	1,838	1,947	0,415	1,000	0,709	2,605	0,170	1,065	CONSISTENT	
X5	3,277	3,201	0,608	1,411	1,000	2,141	0,240	1,066		
X6	0,877	0,616	0,210	0,384	0,467	1,000	0,076	1,005	CR <= 0,1 ; Consistent	
TOTAL	10,728	9,796	3,084	6,261	4,437	13,264	1,000	6,132		

Table 6. The Result of Measurement Subcriteria X1

Pair-wise comparison matrix for subcriteria X1								PRIORITIES (w)	EIGEN VALUE (λ. Max)	PARAMETER	
	X1.1	X1.2	X1.3	X1.4	X1.5	X1.6	X1.7				
X1.1	1,000	0,416	0,463	1,134	0,678	0,803	0,488	0,091	1,016	CI	0,05
X1.2	2,402	1,000	1,431	4,789	2,551	0,450	0,910	0,184	1,113	RI	1,32
X1.3	2,162	0,699	1,000	1,398	1,084	0,401	0,375	0,107	1,041	CR	0,04
X1.4	0,882	0,209	0,715	1,000	0,833	0,201	0,225	0,058	0,996	CONSISTENT	
X1.5	1,476	0,392	0,922	1,201	1,000	0,174	0,354	0,079	1,158		
X1.6	1,246	2,221	2,491	4,967	5,753	1,000	1,320	0,280	1,061		
X1.7	2,048	1,099	2,667	2,825	2,825	0,758	1,000	0,201	0,940	CR <= 0,1 ; Consistent	
TOTAL	11,215	6,035	9,690	17,315	14,723	3,787	4,672	1,000	7,326		

Table 7. The Result of Measurement Subcriteria X2

Pair-wise comparison matrix for subcriteria X2						PRIORITIES (w)	EIGEN VALUE (λ. Max)	PARAMETER	
	X2.1	X2.2	X2.3	X2.4	X2.5				
X2.1	1,000	0,211	0,392	0,375	0,416	0,078	1,046	CI	0,04
X2.2	4,743	1,000	0,784	0,668	1,024	0,222	1,102	RI	1,12
X2.3	2,551	1,275	1,000	0,450	1,149	0,198	1,045	CR	0,04
X2.4	2,667	1,496	2,221	1,000	2,091	0,326	0,967	CONSISTENT	
X2.5	2,402	0,977	0,871	0,478	1,000	0,176	0,999	CR <= 0,1 ; Consistent	
TOTAL	13,363	4,959	5,267	2,972	5,680	1,000	5,158		

Table 8. The Result of Measurement Subcriteria X3

Pair-wise comparison matrix for subcriteria X3											PRIORITIES (w)	EIGEN VALUE (λ. Max)	PARAMETER	
	X3.1	X3.2	X3.3	X3.4	X3.5	X3.6	X3.7	X3.8	X3.9	X3.10				
X3.1	1,000	0,871	0,189	0,295	1,149	1,320	3,104	1,000	0,194	0,169	0,047	0,935	CI	0,13
X3.2	1,149	1,000	0,176	0,306	1,246	1,516	2,667	1,000	0,194	0,169	0,048	1,186	RI	1,49
X3.3	5,305	5,674	1,000	3,594	4,441	4,704	5,335	5,186	2,091	1,552	0,243	0,870	CR	0,09
X3.4	3,393	3,272	0,278	1,000	2,862	2,048	4,852	2,605	1,380	1,380	0,138	1,980		
X3.5	0,871	0,803	0,225	0,349	1,000	1,431	1,888	1,246	0,326	0,253	0,048	0,953	CONSISTENT	
X3.6	0,758	0,660	0,213	0,488	0,699	1,000	1,516	0,758	0,211	0,193	0,038	0,911		
X3.7	0,322	0,375	0,187	0,530	0,530	0,660	1,000	0,253	0,174	0,162	0,027	0,968		
X3.8	1,000	1,000	0,193	0,803	0,803	1,320	3,949	1,000	0,478	0,425	0,060	1,044		
X3.9	1,000	5,144	0,478	3,064	3,064	4,743	5,753	2,091	1,000	0,699	0,149	1,112	CR <= 0,1 ; Consistent	
X3.10	5,144	5,933	0,644	3,949	3,949	5,186	6,188	2,352	1,431	1,000	0,203	1,219		
TOTAL	19,941	24,730	3,584	14,377	19,741	23,926	36,250	17,491	7,480	6,000	1,000	11,179		

Table 9. The Result of Measurement Subcriteria X5

Pair-wise comparison matrix for subcriteria X5						PRIORITIES (w)	EIGEN VALUE (λ. Max)	PARAMETER	
	X5.1	X5.2	X5.3	X5.4	X5.5				
X5.1	1,000	0,324	0,768	0,803	3,898	0,146	1,009	CI	0,06
X5.2	3,086	1,000	3,776	4,000	5,697	0,469	0,944	RI	1,12
X5.3	1,303	0,265	1,000	1,933	4,373	0,190	1,195	CR	0,05
X5.4	1,246	0,250	0,517	1,000	4,183	0,146	1,166	CONSISTENT	
X5.5	0,257	0,176	0,229	0,239	1,000	0,049	0,930	CR <= 0,1 ; Consistent	
TOTAL	6,891	2,014	6,290	7,975	19,151	1,000	5,245		

Based on the priorities measurement, ranking of each criteria obtained shown in Table 10.

Table 4. List of Validated Criteria from Procurement Flowchart using CQSMS Scheme

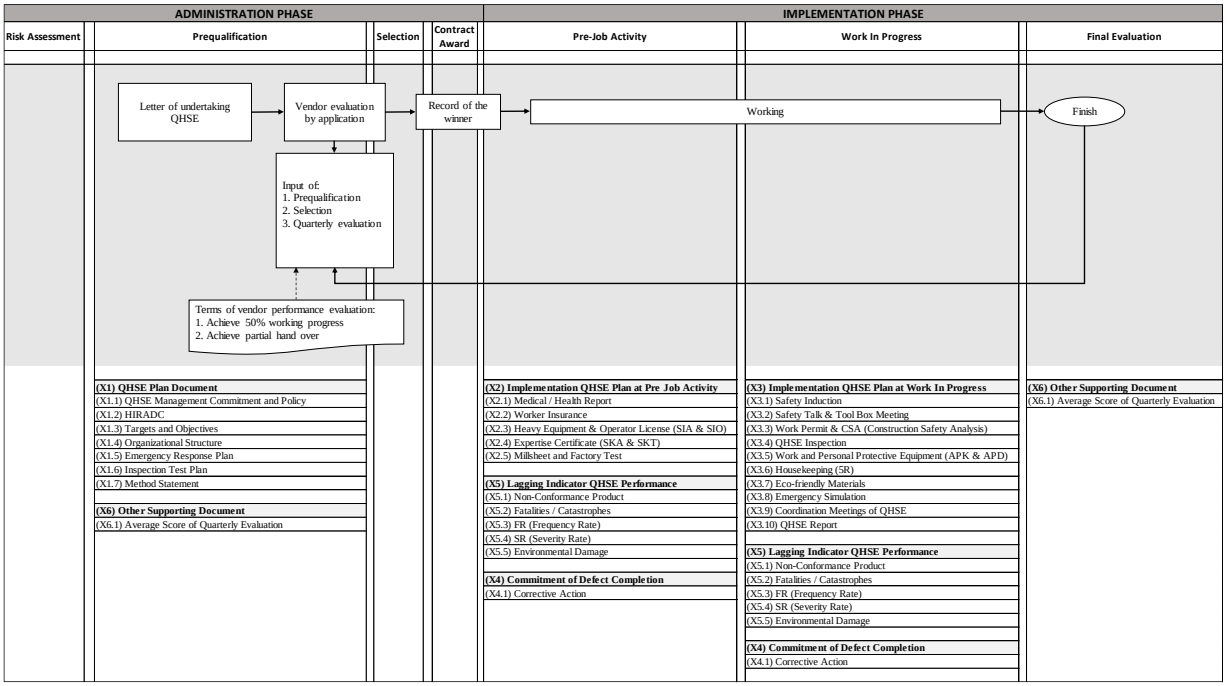

Table 10. The Ranking of Importance Criteria

	CRITERIA	RANKING	PRIORITIES (w)
X3	Implementation QHSE Plan at Work In Progress	**1**	**32%**
	X3.3 Work Permit & CSA (Construction Safety Analysis)	1	24%
	X3.10 QHSE Report	2	20%
	X3.9 Coordination Meetings of QHSE	3	15%
	X3.4 QHSE Inspection	4	14%
	X3.8 Emergency Simulation	5	6%
	X3.5 Work and Personal Protective Equipment (APK & APD)	6	5%
	X3.2 Safety Talk & Tool Box Meeting	7	5%
	X3.1 Safety Induction	8	5%
	X3.6 Housekeeping (5R)	9	4%
	X3.7 Eco-friendly Materials	10	3%
X5	Lagging Indicator QHSE Performance	**2**	**24%**
	X5.2 Fatalities / Catastrophes	1	47%
	X5.3 FR (Frequency Rate)	2	19%
	X5.1 Non-Conformance Product	3	15%
	X5.4 SR (Severity Rate)	4	15%
	X5.5 Environmental Damage	5	5%
X4	Commitment of Defect Completion	**3**	**17%**
	X4.1 Corrective Action		
X2	Implementation of QHSE Plan at Pre Job Activity	**4**	**11%**
	X2.4 SKA & SKT	1	33%
	X2.2 Jaminan Kesehatan Tenaga Kerja	2	22%
	X2.3 SIA & SIO / Lisensi	3	20%
	X2.5 Sertifikat Material (*millsheet*, *factory test*, dll)	4	18%
	X2.1 Laporan Pemeriksaan Kesehatan	5	8%
X1	Document of QHSE Plan	**5**	**9%**
	X1.6 Inspection Test Plan	1	28%
	X1.7 Method Statement	2	20%
	X1.2 HIRADC	3	18%
	X1.3 Objectives and Targets	4	11%
	X1.1 QHSE Commitment and Policy	5	9%
	X1.5 Emergency Response Plan	6	8%
	X1.4 Organizational Structure	7	6%
X6	Other Supporting Document	**6**	**8%**
	X6.1 Average Score of Quarterly Evaluation		

V. CONCLUSION

This study results in 2 conclusions. First from the stage of identification criteria, there were 29 validated criteria related to quality and safety performance in Assessment System of CQSMS. Second, according to the development classified criteria stage using AHP method, the ranking based on priorities of each criteria obtained; 1. (X3) Implementation QHSE Plan at Work In Progress – 32%, 2. (X5) Lagging Indicator QHSE Performance – 24%, 3. (X4) Commitment of Defect Completion – 17%, 4. (X2) Implementation of QHSE Plan at Pre Job Activity – 11%, 5. (X1) Document of QHSE Plan – 9%, 6. (X6) Other Supporting Document – 8%.

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