

## REMODELLING THE MAINTENANCE PERFORMANCE MANAGEMENT SYSTEM

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### ABSTRACT

*The purpose of this research are remodelling the maintenance performance management system. Remodelling will begin with separated the EN15341 indicators to lagging and leading indicators. After that, indicators will be separated again to organization level, strategic, tactical, and operational. Relationship between indicators on the same level organizations will be defined and re-configure using Interpretive Structural Modelling. Model reporting will be rearrange into Balanced Scorecard model for strategic level and modification model for tactical and operational level to communicated it horizontally and vertical. Lastly it's validated by Structural Equation Modelling method. Use data from random generator to rise data for simulate this model.*

**Key words** : remodeling, the maintenance performance management system, the EN15341

### 1. INTRODUCTION

Availability and Maintenance Management System of operational equipments are liability on organizational safety and sustainable operational, because is direct casuality on human safety and economical organizational. In the other side system failure cases which bring fatality, accident, and lost in Indonesia frequently and repetitively happened. This casues occured happen (generally) if the systems of maintenance were negelected. Beside of human live which high correlated with safety system, loss of production from the breakdown system is the other effect that can influence the human itself. Main responsibility is on the main organization, after that its on Government responsibilty for the law enforcement and monitoring the organization activity. If the evaluation and monitoring system are implemented well by internal organization or by government then the halfy way the journey of safety and reliable system have been achieved. Thats way the maintenance performance management system needed.

Wireman (1994) in Kumar (2009) said that mostly maintenance management measurement system has been

misintepretated and mis-use in operational. Measurment should not be only to point that the worker are been or not to been done their assignment/job, or in the other satisfy the organization ego of excellence performance. Measurement if using properly are can be open some opportunity to make improvement, early problems detection, and find their solutions.

Some problem arise on designing and implementation of maintenance performance measurement system are :

- Too much data and too little information.
- Performance indicators quantity, the owners, and their scope of indicators.
- Objectivity and measurement technique.
- Lead time between operational action and monitoring results.
- Cost and data gathering.

One can be added is every area have different characteristic that must be suitable the design system so the measurement is not too complex and can represent the maintenance operational are requirements that difficult enough to fulfill.

Kumar (2009), many attempt that have been made in development an effective maintenance performance management system that can create value on

organization. The topics includes how to suite the organization strategic with maintenance function strategic; how to related maintenance performance measurement with organization hirarchy and built the efective communication between it ; and how translate the maintenance work indicators at operational level from strategic/corporate level or vise versa. But mostly researcher built framework base on financial parameter that always effective in level organization, especially tactical and operational level.

The purpose of this research are remodelling the maintenance performance management system. Model can be use as maintenance operational control with goal to achieve effectivity on equipments and assets use that main object on organize maintenance system.

## 2. THEORETICAL BACKGROUND

Maintenance Management Process follow three different level in its activity : strategic level, tactical level, and operational level (Marquez, 2007). The model can be seen on Figure 1 below, at strategic level, asset priority, modelling, planning, performance measurement, etc are doing at this level, at tactical level resource distribution, work distribution, etc, are doing and at operational level execution, data recording, etc are must be completed to this level.

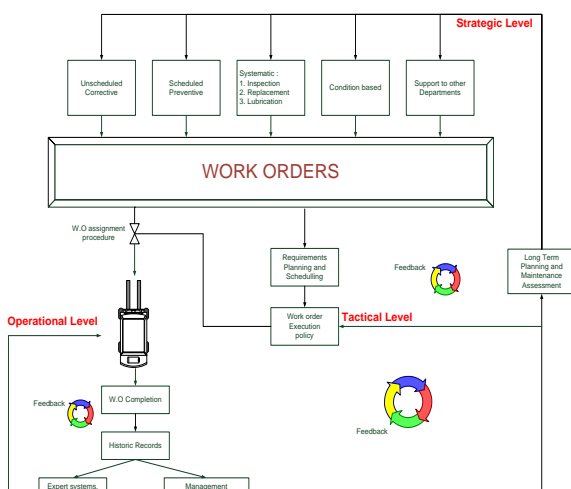


Figure 1. Maintenance Management Process ( Marquez ,2007).

In the other hand Jardine (2006) says that to achieve an excellence maintenance performance then maintenance management structure must be approach as in Figure 2.

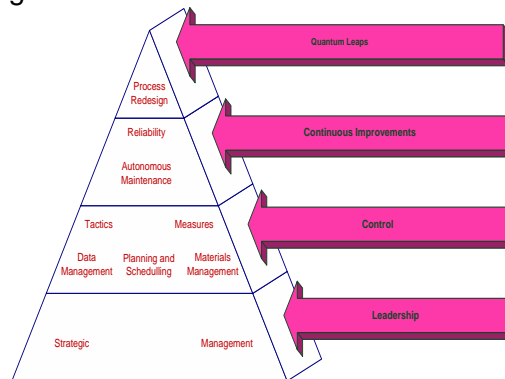


Figure 2. Maintenance Management Model (Jardine,2006).

Where the structure consist of strategic, tactical, operational, continuous improvement, and quantum leap level. The model is slight different with Marquez model because Jardine model separated continuous improvement and process redesign with strategic issue. This perspective model of Jardine achieve from focusing control on management only, different with Marquez, the model start from the maintenance process, repairing, and then how to improve the process maintenance.

In general its known on maintenance management that there are three level process, they are strategic level, tactical level, and operational level. This levels are well recognized too in other division organization process such as production division.

Maintenance Influencing Factors and Maintenance Key Performance Indicators

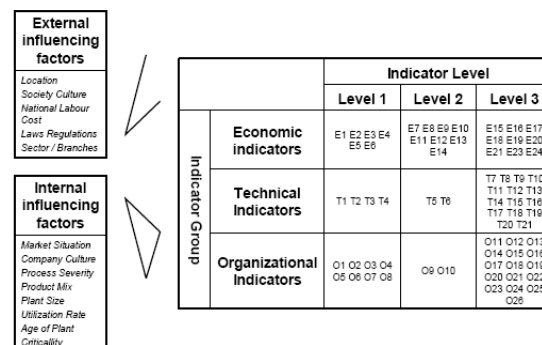


Figure 3. KPI Architecture EN15341 standard

EN15341 is a Key Performance Indicator standard for maintenance management from the European Committee for Standardization (CEN). In this standard maintenance indicators divide it into three categories which is :

1. Economy
2. Technical
3. Organization

Where this categorized purposes are to make management achieved operational and equipments maximum effectivity.

An architecture of maintenance management KPI from standard EN15341 can be seen on Figure 3.

Level 1, 2, and 3 are indicated of strategic, tactical, and operational level. It can be seen in EN15341 that the indicators are complex enough to implemented. Need scalable resources too operated and implemented it. In the system more simple, the standard EN15341 can not be easily to installed it, the indicators must be more simple. Another factor is the man power competences that operated the indicators, in third and development country complexity EN15341 can not be direct implemented as on wealth country. Some factors are :

1. Education background.
2. Skillfull level.
3. Exeperience on complex equipments.

Salimifard et al (2010), ISM or Interpretive Structural Modeling is one of method to mapping the relationships between the system elements of a complex decesion making process condition. ISM first time introduce by Warfield at 1973 and usually use to get complex system behaviour understanding and solve its problems. ISM Method transform unrecognized complex system models, chaos, etc to become structured, visible, and definitive.

ISM method consist of :

1. Structural Self-Interaction Matrix.
2. Reachability Matrix.
3. Level Partitions.
4. Model Development.
5. Analysis.

### 3. RESEARCH METHOD

Remodelling will begin with separated the EN15341 indicators to lagging and leading indicators. After that, indicators will be separated again to organization level, strategic, tactical, and operational. After categorized the indicators, relationship between indicators on the same level organizations will be defined and re-configure using ISM method. ISM Method in this research are to search correlation between indicators that can fullfill the purpose of needed more grip or controlling on maintenance performance and optimization. Model reporting will be rearrange into BSC model for strategic level and MSC (modification) model for tactical and operational level to communicated it horizontally and vertical. Lastly it's validated by SEM method. Use data from random ganagerator to rise data for simulate this model.

### 4. RESULT AND DISCUSSION

To separated EN15341 indicators to leading, lagging indicators then to straegic, tactical, and operational level are need class requirements as mention below :

1. Time measurement, effective indicators measurement at maintenance process that there are on begining (input) of the process, or in the middle, or in the end (output). Base on leading and lagging indicators definition that leading indicators usually are using on the begining (input) or middle of the process rather than lagging indicators that measures at the end (output) of the process. Leading also usually influence lagging indicators and can be improve then can be impact on process performance improvement.
2. Indicators influences on every level, can be explain as influence at every strategic level, tactical level, and operational level direcly or not directly ?. If direct influence then that can be assume the indicator have strong correlation to the certain level.
3. Can be use as Continuous Improvement feedback and modelling, if the indicators can be use as input variables of

maintenance model and continuous improvement then the indicators can be assume as lagging indicators and on strategic or tactical level.

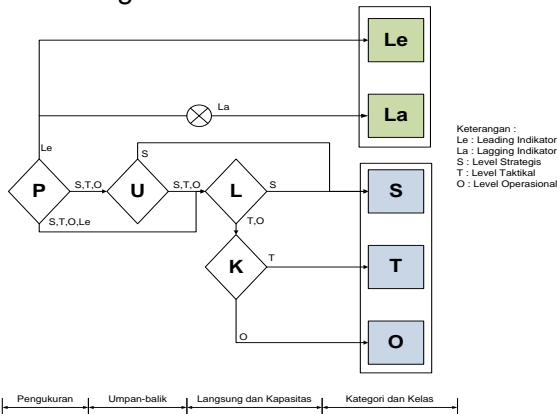


Figure 4. Flowchart or algorithm of indicators separation to lagging, leading indicators and strategic, tactical, operational level.

Separation flowchart can be see in Figure 4. And the result can be seen on table 1 below.

Table 1. EN15341 Indicators on leading, lagging, and three level organization.

No	Level Organisasi	Pengendali	Indikator
1	Level Strategis	Lagging Indikator	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E13, E14, E16, E17, E18, E19, E20, E21, T1, T2, T5, T6, T17, O8, O15, O18, O19, O20, O24, O26.
		Leading Indikator	T15, T18, T19, T20, O1, O2, O3, O5, O23.
2	Level Taktikal	Lagging Indikator	E12, E15, T14, T16, T21, O16, O17, O21, O25.
		Leading Indikator	T3, T4, T10, T12, T11, T13, O10, O12, O13, O14.
3	Level Operasional	Lagging Indikator	T7, T8, T9, O11, O22.
		Leading Indikator	O6, O7.

Before doing ISM method on table 1. The indicators been categorized and rename again for simplicity, as table 2, 3, and 4.

Table 2. Indicators on Strategic level.

Indicator	category	code	Note
E1,E2,E3,E4,E5	Performance Cost	S-1	
E6	Availability Effectiveness	S-2	
E7	Maintenance Inventory Cost	S-3	
E8,E9,E10,E11,E13 E22,E23,E24	Resource Cost	S-4	
E14	Energy used	S-5	
E16,E17,E18,E19,E 20	Maintenance Planned and Scheduled Cost	S-6	
E21, O8	Training and CI	S-7	
T1,T2,T5,T6	Availability	S-8	
T17	Asset value with failure event	S-9	
O15,O24	Multi-skilled	S-10	
O5,O18,O19,O20,O 26	Planned and Scheduled man hours, and spare parts	S-11	
T15	WO Effectiveness	Se-1	
T18	Critical Analysis Effectiveness	Se-2	
T19,T20	Planned and Scheduled Time	Se-3	
O1,O2,O3	Internal Man Power	Se-4	
O23	Man hours Training Effectiveness	Se-5	

Table 3. Indicators on Tactical Level.

Indicator	category	code	Note
E12	Warehouse Turnover	T-1	
E15,O16,O17	Corrective Maintenance	T-2	
T14, T16	MTTF	T-3	
T21	MTTR	T-4	
O21,O25	Overtime	T-5	
T10,T12,T11,T13, T3,T4	Safety	Te-1	
O10,O12,O13,O14	Direct Personnel Man Hours	Te-2	

Table 4. Indicators on Operational Level.

Indicator	category	code	Note
T7,T8,T9	Maintenance Loss	O-1	
O11, O22	Maintenance Response	O-2	
O6,O7	Safety 2	Oe-1	Level ops Safety

After that per organizational level indicators simulate on ISM Method, as 5 phase step-by-step on 2.3.

Model results can be seen at Figure 5 for strategic level.

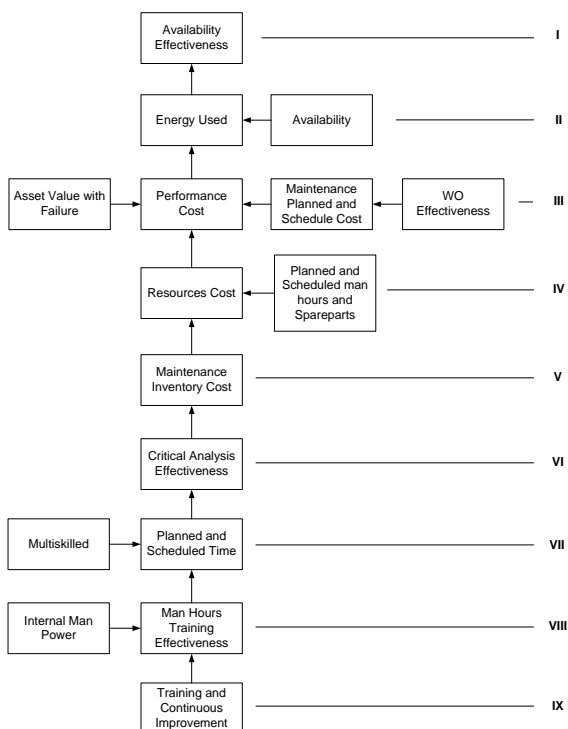


Figure 5. ISM Model at strategic level for maintenance performance management (mpm) system.

For tactical level where man distribution and restoring equipments time efficiency focus can be seen on Figure 6 and for operational level at Figure 7.

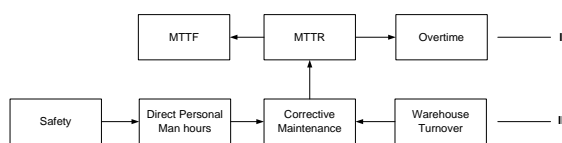


Figure 6. ISM Model at tactical level for mpm system.

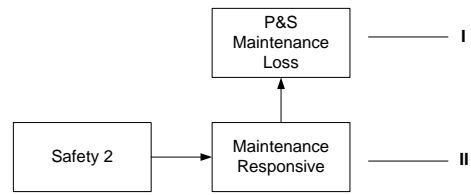


Figure 7. ISM Model at operational level for mpm system.

At general, summary of maintenance performance management system, in model Wibisono (2006) are call indicators relationship, can be submitted as Figure 8. Where all three level organization (strategic, tactical, operational) have been defined, including it's leading and lagging indicators.

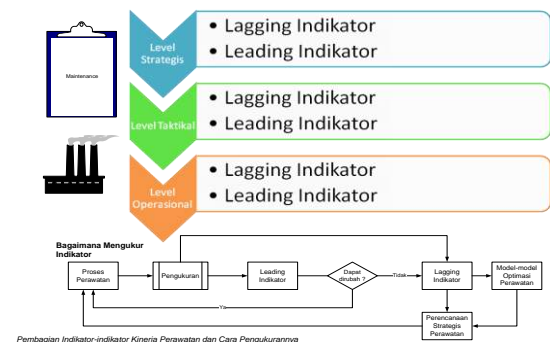


Figure 8. Maintenance Performance Management Model.

To communicate the result of model at Figure 8 then every level must be have their own characteristic so the other division or peak management can understand.

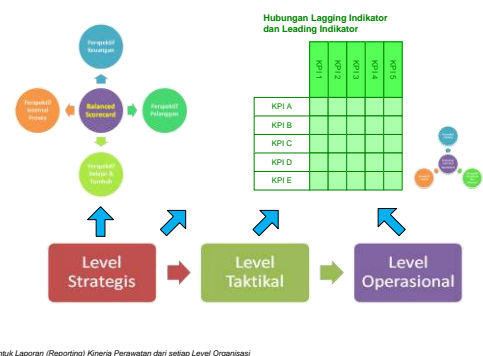


Figure 9. Reporting System base on BSC and MSC modification.

For strategic level, suitable method for reporting the measured indicators is Balanced Scorecard (BSC) Method because this method have wide known on upper level management and can be easily adjust with organization strategics and goals. In general reporting system can be seen on Figure 9, on the other BSC known well as on Figure 10.

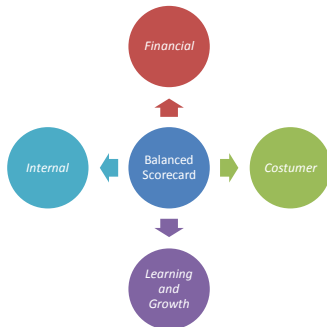


Figure 10. Balanced Scorecard Model.

That must be notice here are as report the BSC here not a performance framework method, but only as media or platform to presented maintenance performance indicators to managerial language rather than technical language.

And for tactical and operational level use similiar method but with a little modification that call Maintenance Scorecard (MSC). Original MSC have 6 perspective but on this case or model it reduce to 3 perspective as in Figure 11.

One point that must remind is simplicity in determined the framework or KPI structure must be notice because is very important for control in operational. Too many indicators will be bring chaotic on measuring the performance and feedback.

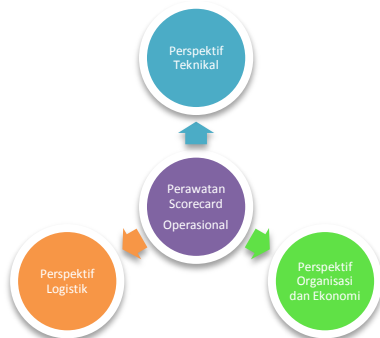


Figure 11. Maintenance Scorecard for tactical and operational level.

## 5. CONCLUSION

Maintenance Performance Management System Model have been build as presented on subbab before, where the indicators has been categorized in three level organizational (strategic, tactical, and operational) and two level time (leading and lagging). The purpose of the model (Figure 5 through 11) are maintenance operational control with goal to achieve effectivity on equipments and assets use that main object on organize maintenance system. Later, focus on controlling is not enough, and if can not communicated with other division on organization then all achievement will be nothing in production philosophy. Therefore, it needed a reporting system that can accomodate characteristics.

There is a statement that EN15341 not suitable for development country because gap education background on operational level. This can be seen on table 1 or table 2-4 that show many EN15341 indicators are trully a strategic level rather than a tactical or operational level, so there is a need additional indicators that measure tactical and operational level on maintenance system process then it can be used for production system in development country, as can be seen on table 5.

There are many lack on this research like benchmarking analysis was not included and limitation on validation model, but with that the model is keep to built even just with valid theories and assumptions from knowledge and researchs before.

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