FRAMEWORK DEVELOPMENT AND MEASUREMENT OF OPERATOR WORKLOAD USING *MODIFIED COOPER HARPER SCALE METHOD* (CASE STUDY IN PT SINAR TERANG LOGAMJAYA BANDUNG WEST JAVA)

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ABSTRACT

PT Sinar Terang Logamjaya is an automotive components manufacturer for motorcycles and car). The industry is dealing with materials from iron plate and process with sheet metal shaping techniques to produce products. One of the product is a motorcycle component, is called Oil Lock Collar. This product is been made in large quantities to meet demands. Hence, it is resulted in the workload experienced by workers and will touch on the productivity of workers.

Modified Cooper Harper Scale (MCH) is a 10-point scale that was originally produced to assess the subjective workload of airplane pilots. The original index probes overall ease of handling of the selected task or required operation and asks more specific questions related to the aircraft characteristics, the demands on the pilot, and finally, the pilot rating. This method is fit to evaluate work activities with the manual controls. MCH scale decision tree shaped with a rating scale from very easy (point 1) to very difficult (10 points).

This study has two purposes. First wqs modified version of MCH scale which was used to measure the subjective workload of performing in industrial process. The second purpose was concerned with the categorizing task activities into under load category, optimal category, or overload category.

Based on the framework that has been built, 8 operators were selected and they have to fill up the form to be assessed by MCH to obtain operator feel about their tasks. The results of the data processing indicate that 12 task activities were under load categorized, 5 task activities were optimal category and 11 task activities were overload category. This result can be useful for the industry to change work processes or maximum demand of products.

***Keywords*:** *Subjective Workload, Framework, Measurement, Cooper Harper Scale*

1. INTRODUCTION

1.1 Introduction

Oil Lock Collar is one of high demand products, and its function is to regulate oil to lubricate shock absorber for automatic motor cycle. And it is ordered by PT. Honda Astra Motor, PT. Federal Motor, PT. Indomobil Suzuki International. And since this parts is highly demanded, so that it will affect the company to manage sources to meet the demand. Based on data collected on December 2012 – March 2013, there were reject average 7.20% as shown on table1

Table 1. Products and Reject Products Oil Lock Collar (December 2012 – March 2013)

Month	Productions (unit)	Total Reject (unit)	Passed QC (unit)	% Reject
Dec '12	135,945	6,045	129,900	4.45
Jan '13	145,881	7,917	137,964	5.43
Feb '13	136,676	16,152	120,524	11.82
Mar '13	127,419	9,049	118,370	7.10

Source: PT. Sinar Terang Logamjaya, 2013

The reject percentage was the problem for the company to meet the high demand. The biggest reject percentage was on February 2012 (11,82%) and still continued to March 2013 (7,10%). These high reject percentage was identified due to a high operator workload on shop floor.

Workload is a body ability accepting the work, this could be physical workload and psychology/mentally workload. Physical workload could be heavy lifting, maintaining,

or pushing. While psychology workload could be skill level and work performance which owned by person to another person (Manuaba, 2000). Cooper (1983), the over workload is a stress source and will causing productivity decline and work accident.

To maintain company productivity, in this research was done by calculating physical workload and psychology workload to operators who took handle on Oil Lock Collar production. When the workload was being identified then the company will be able to take proper actions.

1.2 Problem Identification

Oil Lock Collar production was done by 8 operators with 28 task activities. This research will conducting framework design and workload measurement for Oil Lock Collar operators. Using approximation proposed by Modified Cooper Harper Scale (MCHS) (Wierwille and Casali, 1983). Wierelli dan Cassali (1983) in Gawron (2000) stated that Cooper Harper Scale is approxiamation that consider scale combination between physical and mental workload. The scale will look like a tree decision.

Wierwille and Casali (1986) also stated that this paroximation is easy to conduct, efficient, and fit to variation tasks especially to the man-machine system that need perception, monitoring, evaluation, communication and man decision making. Some researchers were Cummings, Myers dan Stacey (2006) and Donmez et. al (2008), both were conducted research on interaction of pilot and monitor inside a plane.

1.3 Objectives

To have a result of,

1. Framework of workload measurement.
2. Operator physical workload and mentally workload.

2. THEORITICAL BACKGROUND

Subjective Mental Workload Measurements

1. NASA-TLX, was developed by NASA Ames Research Center USA, is a multi-dimensional rating procedure, that deviding workload into six subscale loading.
2. SWAT was developed by Reid and Nygran at Amstrong Medical Research Laboratory, based on kinjoin scale. SWAT was made as only 3 descriptors on each dimension.
3. Task Difficulty Scale, was used by AIRBUS Co., in French to test static workload for new aircraft model which were to be certified.
4. Modified Cooper Harper Scale, was first applied on managing air plane quality of pilot's decision to airborne the air plane. This method consist of ten rating numbers from the worst to the best one, and the possibility of managing the case. Cooper Harper Scale proposed ten questions to evaluator, which it has to show the best or approaching the best of statements for air plane handling quality. The MCH is suitable for evaluating of task with perception, meditation, and communication. The application with decision tree on subjective scale measurement will reduce tight structure variability, while bipolar scale usually leaves to many open scale for assessment and operator selection variability. However, a decision tree will only provide ordinal scale

3. METHODOLOGY

Developing Measurement Framework

Determining a Test For Adequacy for Selected Task or Required Operator

There are three decision statements are:

1. **Task statement decision on very heavy workload**
   This decision was measuring task with very heavy workload category, a decision beyond this category will be continued into point number 2.
2. **Task statement decision on heavy workload**
   This decision was measuring task with heavy workload category, a decision beyond this category will be continued into point number 3.
   Task statement decision on fair workload
   This decision was measuring task with fair workload category, a decision

beyond this category will be categorized as low workload.

Figure 1 shows statements line of testing statements or adequacy operations. Figure 2 shows task characteristics

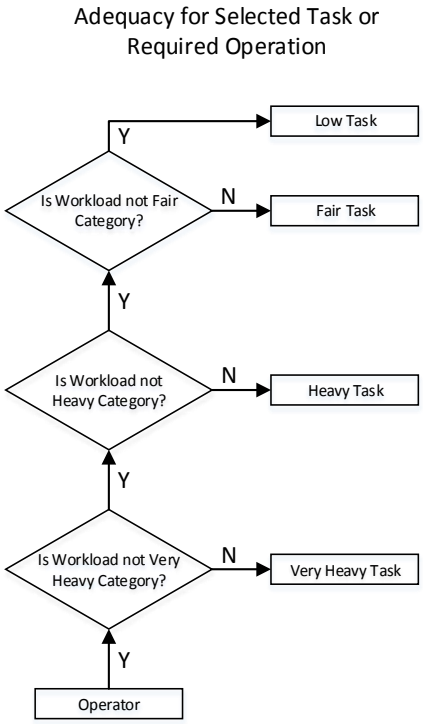

Figure 1. Testing Statement of Adequacy for Selected Task or Required Operator

Determining Task Characteristics

Task characteristic is a characteristic of task based on worklod chategories which are very heavy, heavy fair dan low workload. While the step of chategorizing as follows:

1. **Low Task**, divided into 3 chategories, which are very easy or most adequate, easy or adequate, and normal or low difficulty level.
2. **Fair Task**, divided into 3 chategories, wihic are low difficulty level but disturbing task, fair difficulty level, and almost heavy difficulty level.
3. **Heavy Task**, divided into 3 chategories, wihic are less heavy, fair heavy, and heavy.
4. **Very Heavy Task**, there is only one category, which is very heavy.

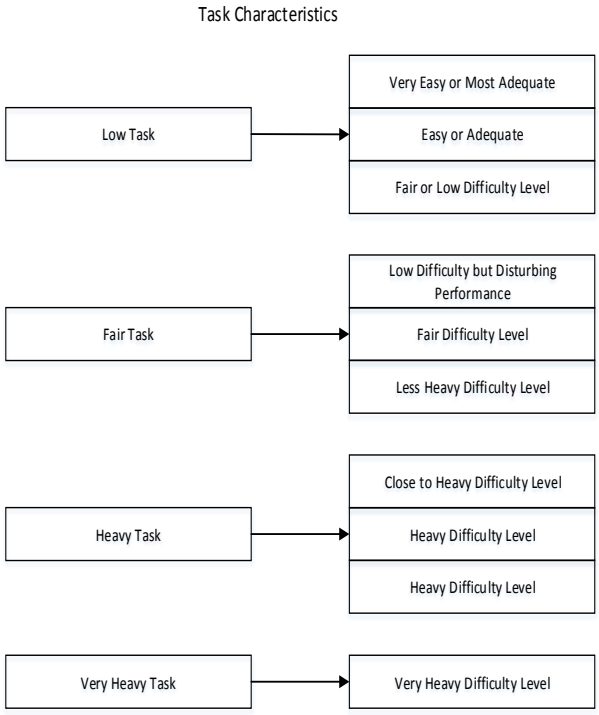

Figure 2. Task Characteristics

Determining Operator Reqired on Selecting Adequacy Tasks

Fullfillment of operators on selecting adequacy tasks is an adequacy operator activities to the tasks, as follows,

1. **Low Task**, with the charecteristics are **very easy or most adequacy**, so that operator's requirement is very easy to be achived and does not need task changing.
2. **Low Task**, with the charecteristics are **fair or low difficulty**, so that operator's requirement is very easy to be achived and does not need task changing.
3. **Low Task**, with the charecteristics are **easy or adequacy**, so that operator's requirement is fair to be achived by operators.
4. **Fair Task**, with the charecteristics are **low but not disturbing performance**, so that operator's requirement is need low effort to achive adequate performance.
5. **Fair Task**, with the charecteristics are **fair**, so that operator's requirement is fair effort to achive adequate performance.
6. **Fair Task**, with the charecteristics are **close to heavy**, so that operator's requirement is need high effort to achive adequate performance.

7. **Heavy Task**, with the charecteristics are **less heavy**, so that operator's requirement is need maximum effort to achive adequate performance and high workload level.
8. **Heavy Task**, with the charecteristics are **heavy**, so that operator's requirement is need maximum effort to achive adequate performance and high workload level.
9. **Heavy Task**, with the charecteristics are **heavy**, so that operator's requirement is need maximum effort to achive adequate performance and heavy workload level.
10. **Very Heavy Task** with the charecteristics are **heavy**, so that operator's requirement is a task with majority failure.

Workload Assessment

Determining Operator Workload Category to a Task Characteristic

Rating is given from 1 to 10, and it is adjusted to the categories for the operator. Figure 3 shows workload categories. Steps of workload mesurement based on Modified Cooper Harper Scale method is shown on Figure 4.

Test Characteristics	Demand On the Operator in Selected Task or Required Operation	Operator Rating
Very Easy or Most Adequate	the charecteristics are **very easy or most adequacy**, so that operator's requirement is very easy to be achived and does not need task changing	1
Easy or Adequate	the charecteristics are **fair or low difficulty**, so that operator's requirement is very easy to be achived and does not need task changing	2
Fair or Low Difficulty Level	the charecteristics are **easy or adequacy**, so that operator's requirement is fair to be achived by operators	3
Low Difficulty but Disturbing Performance	the charecteristics are **low but not disturbing performance**, so that operator's requirement is need low effort to achive adequate performance	4
Fair Difficulty Level	charecteristics are **fair**, so that operator's requirement is fair effort to achive adequate performance	5
Less Heavy Difficulty Level	the charecteristics are **close to heavy**, so that operator's requirement is need high effort to achive adequate performance	6
Close to Heavy Difficulty Level	the charecteristics are **less heavy**, so that operator's requirement is need maximum effort to achive adequate performance and high workload level	7
Heavy Difficulty Level	the charecteristics are **heavy**, so that operator's requirement is need maximum effort to achive adequate performance and high workload level	8
Heavy Difficulty Level	the charecteristics are **heavy**, so that operator's requirement is need maximum effort to achive adequate performance and heavy workload level	9
Very Heavy Difficulty Level	the charecteristics are **heavy**, so that operator's requirement is a task with majority failure	10

Figure 3. Assesment of Operator Workload Category to a Task Characteristic

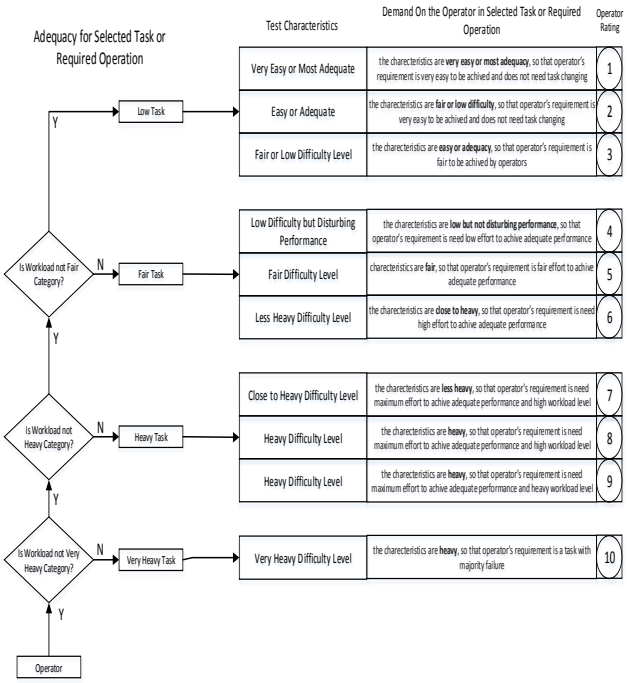

Figure 4. Steps of Workload Measurement

Determining Weighted on Operator's Workload

The next step of Cooper Harper Scale method is determining a weight on workload to operator based on a judgment from researcher by this statement as follows:

1. **Low Task Category**, with the task characteristic **very easy/most adequate**, the workload weight is less than 10% (≤ 10%).
2. **Low Task Category**, with the task characteristic **easy/adequate**, the workload weight is between 11% up to 20% (11% - 20%).
3. **Low Task Category**, with the task characteristic **fair/low difficulty**, the workload weight is between 21% up to 40% (21% - 40%).
4. **Fair Task Category**, with the characteristic **low difficulty but disturbing performance**, the workload weight is between 41% up to 45% (41% - 45%).
5. **Fair Task Category**, with the characteristic **fair difficulty**, the workload weight is between 46 % sampai dengan 55% (46% - 55%).
6. **Fair Task Category**, with the characteristic **fair difficulty**, the workload weight is between 56 % up to 60% (56% - 60%).

7. **Heavy Task Category**, with the characteristic **less heavy**, the workload weight is between 61 % up to 65 % (61% - 65%).
8. **Heavy Task Category**, with the characteristic **fair heavy**, the workload weight is between 66 % up to 75 % (66% - 75%).
9. **Heavy Task Category**, with the characteristic **heavy**, the workload weight is between 76 % up to 80 % (76 % - 80 %).
10. **Very Heavy Task Category**, with the characteristic **very heavy**, the workload weight is between 81 % up to 100 % (81 % - 100 %).

4. RESULT

Workload Measurement Framework
Based on identification and interview with the company, workload measurement framework is shown on Table 2.

Physical Workload and Mental Operator
After framework is done by Modified Cooper Harper Scale Method, then the workload measurement of Oil Lock Collar production process is conducted to all activities. The result is shown on Table 3.

Table 2. Workload Measurement Framework

Process	Number of Process Activity	Number of respondens (operators)
Blank Drawing	6	3
Drawing	6	3
Expand 1	4	4
Expand 2		4
Pierching	5	4

5. CONCLUSIONS

Conclusion can be drawn as follows,
1. Workload Measurement Framework using MCS is achieved by task process and information from company and operators.
2. Based on Workload Measurement Framework, 12 activities are under load, 5 activities are optimal load, and 11 activities are overload.

Table 3. Result of Workload Measurement

No	Process	Activity Process	Conclusion
1	Blank Drawing	1	Optimal
		2	Under
		3	Under
		4	Optimal
		5	Over
		6	Under
2	Drawing	1	Under
		2	Under
		3	Under
		4	Over
		5	Over
		6	Optimal
3	Expand 1	1	Under
		2	Over
		3	Over
		4	Over
4	Expand 2	1	Under
		2	Under
		3	Over
		4	Over
		5	Over
		6	Under
		7	Under
5	Pierching	1	Under
		2	Over
		3	Optimal
		4	Over
		5	Optimal

6. REFFERENCES

(a) Manuaba, A. 2000. Research and Application of Ergonomics in Developing Countries, with Special Reference to Indonesia. *Jurnal Ergonomi Indonesia* 1 (1-6), 24-30
(b) Cooper and Sutherland, 1983. *Stress Prevention in the Offshore Oil and Gas Eksploration and Productivity Industry*, University of Manchester. United Kingdom
(c) Cummings, M.L., Kevin Myers, Stacey D. Scott, 2006, *Modified Cooper Harper Evaluation Tool for Unmanned Vehicle Displays*, http://www.eng.uwaterloo.ca, [diakses 10 Juni 2012]
(d) Donmez et. al., 2008, *Modified Cooper Harper Scales for Assesing Unmaned Vehicles Display*, MIT, Cambridge.
(e) Gawron, V.J., 2000, *Human Performance Measures Handbook*, New Jersey.

(f) Syafe'i, Yani & Rizki Wahyuniardi, 2013, Analisis Pengukuran Beban Kerja Operator Mesin Press dengan Menggunakan Metoda Modified.

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