ANALYSIS OF WORKLOAD USING NASA-TLX METHOD TO DETERMINE THE NUMBER OF OPERATOR IN CIGANITRI PANTS GARMENT

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Abstract

Ciganitri Pants Garment is a home industry engaged in field jeans convection, the activity is to make several jeans for men of different types. In carrying out its activities the operator at Ciganitri Pants Garment gets a high customer demand and often does not fulfill it, making the operator's mental workload increase. So it is necessary to analyze how much mental workload is experienced and what factors that influence it. Therefore Ciganitri Pants Garment can determine the right steps to improve conditions. One of method that can be used to measure mental workloadn is NASA-TLX. The NASA-TLX method is a method of measuring mental workload that divides workload into 6 working element dimensions. From the results of NASA-TLX calculations, the value of mental workload for several operators Ciganitri Pants Garment is at a high level with the highest mental workload indicators are PD (Physical Demand) and MD (Mental Demand) scales. Therefore, it is necessary to add operators to 4 Work Stations, so that the operator, which originally 12, became 16 operators working on 10 Work Stations. Research of T.Fariz Hidayat, et al (2013) that conducted in one of the hospital in Indonesia showed that the results of workload measurement that dominant in physical needs (PD) factors affect the workload of nurses. The results obtained in Ciganitri Jeans Konveksi have in common with the results of research conducted in one of the hospital in Indonesia that physical needs are the most important factor that caused the high workload.

Keyword: Workload, NASA-TLX, Pants Garment.

1.   Introduction

Human use the physical and mind in their daily activities, the physical and mind power used depends on the level of difficulty of work done. Different levels of difficulty in each human activity cause different workloads. Workload is an effort that a person must incur to fulfill the 'purpose' of the job, the workload is defined as the limited capacity of a worker in performing his duties.

The workload experienced by human can be classified into two namely the physical workload and mental workload. Physical work load is workload due to the activity of muscle use or human strength. Meanwhile, the mental workload is the workload due to the activity of the use of the brain or the human mind. The workload of physical and mental can not be separated considering there is a close relationship between one another. When viewed from the energy released, then the physical work out more energy than mental work. But in terms of roles and responsibilities, mental work takes more energy than physical labor.

Human as an important part of an organization have a good difference in the capabilities and limitations of energy. In order for humans to work and produce optimal output is important to pay attention to various aspects related to the human work. To know the capacity of work load perceived by human, it is necessary to measure work load. Measurement of workload is necessary to know the ability of work and determine the number of workers right on each part within the company and organization.

To get the results of calculating the physical workload, the calculation is done using the indirect calculation method, which calculates the pulse of the employee in working to get the % CVL (Cardiovascular Load). On the measurement of physical workload the resulting output can be seen from the work of a operators (Kilbon, 1992). Meanwhile, it is rather difficult to perform mental workload measurements only with observations. Preliminary data shows that some operators are included in the high pulse range category so needed action immediately to reduce workload.
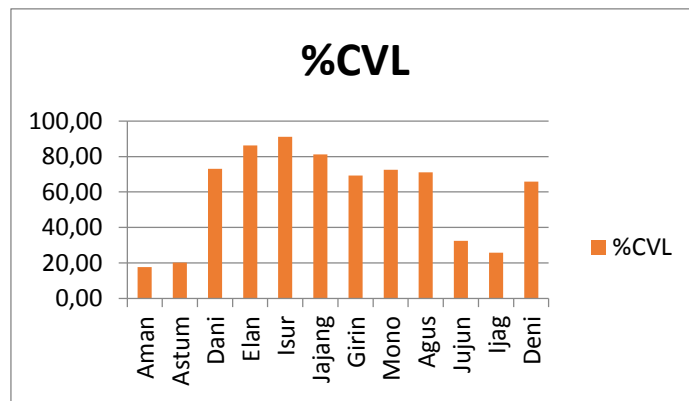
Figure I. 1 CVL Graph

Measurement of mental workload can be done using methods that take into consideration aspects in the measurement of mental workload. One example of a method that can be used is the NASA-TLX method. The NASA-TLX method is a method of measuring mental workload by considering six dimensions to assess mental burden. Of the six dimensions will be determined weighting dimensions that most affect the work, and continued with the calculation of the score from 10 - 100 on each scale.

Ciganitri Pants Garnent is a home industry that is engaged in the convection of jeans. Activities performed in Ciganitri Pants Garnent is making jeans with various types but is devoted to men. Based on interviews conducted to convection owners, in these few months often do not meet the targets that have been given to each worker. This causes workers have to take overtime to meet the sales targets provided by the owner of the convection. This results in fatigue in working both in physical and mental exhaustion at each worker.

It is therefore necessary to measure mental workloads on Ciganitri Pants Garnent operators to measure what aspects affect their work with the NASA-TLX method and from the scores obtained will be determined what improvement proposals can be provided for Ciganitri Pants Garnent operators.

2 Literature Review

2.1 NASA-TLX Method

NASA-TLX method was developed by Sandra G. Hart from the NASA-Ames Research Center and Lowell E. Staveland from San Jose State University in 1981. This method was developed based on the emergence of the need for easier, yet more sensitive measurement of workload measurements. NASA-TLX rating can be obtained quickly so that it is practical, it can be applied in operational environment and data analysis easier. (Hart, S. G & Staveland, L. E, 1988)

NASA-TLX uses six dimensions to assess mental burden: mental demand, physical demand, temporal demand, effort, and stress. Twenty steps are used to get ratings for this dimension. Scores from 0 to 100 are obtained on each scale. The weighting procedure is used to combine six individual scales into a final score; this procedure requires a pair-shaped comparison between the two dimensions before the assessment of the workload. A pairwise comparison requires the operator (respondent) to select a dimension more relevant to the workload in all pairs of the six dimensions. The number of dimensions selected as the more relevant weights as the dimensions of the dimensions for the task assigned to that Operator. A workload score of 10 to 100 is obtained for each dimension score by multiplying by the dimension (rating) scale, summing all dimensions, and dividing by 15 (total number of pairwise pairs) (Hart, S. G & Staveland, L. E, 1988).

2.2 Weight

Subjects can explain which factors or descriptors make the largest (and least) contribution to the workload they experience during the work. The subjective evaluation of the contribution of different workload sources varies between different tasks, which reflect objective experimental manipulation (mental, physical, and time needs) as well as the individual's response to task (performance, effort and frustration). (Hart, S. G & Staveland, L. E, 1988)

2.3 Ratings

Ranking on some of the six NASA-TLX subscales is significantly related, the sixth subscale appears more independently than against the Nine scales. For some factors (time and frustration requirements) the large ratings are closely related to the subjective interests placed on the factors as sources of workload. Task-related weights provide more sensitive workload estimates. (Hart, S. G & Staveland, L. E, 1988)
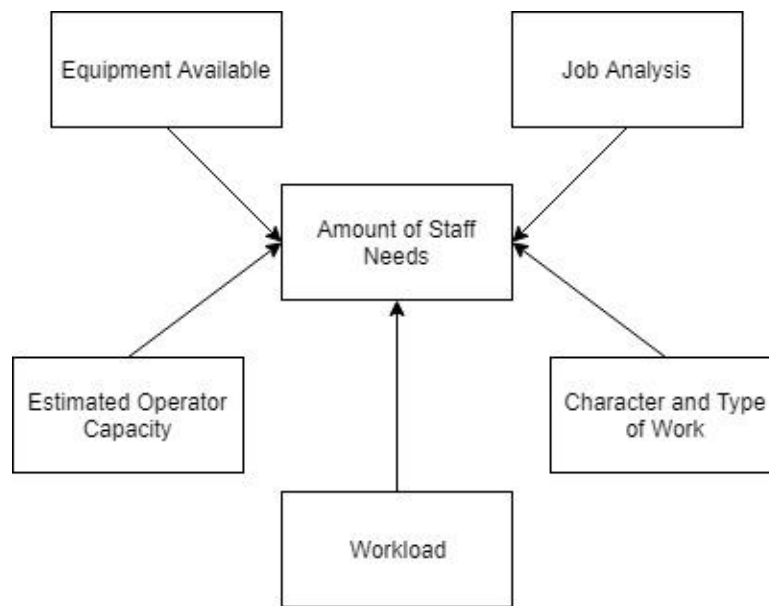
3. Research Method

Figure 3. 1 Conceptual Model

The needs of employees both in private companies as well as in the Government Service environment will always increase as the institution shines. The development of these companies / institutions inevitably requires new employees to fill in more and more part units. To recruit new employees, there are a few things that need to be examined about the analysis of amount of staff needs.

Amount of staff needs is the basis for formation. Employee requirement analysis is a logical calculation process of all foundations / factors determined to be able to determine the number and composition of the rank of staff required by a unit of organization to be able to perform its duties efficiently.

Some factors may affect the analysis of staff needs such as the type and character of the work. Type of work is the kind of work that must be done by an organizational unit in carrying out its main tasks. The characteristic of the work is the work that influences the determination of the formation, the character of the work in terms of time to perform the job.

The next factor is the estimated capacity of the employee. Estimated capacity of this employee is the average ability of an employee to complete a certain type of work within a certain period of time. In addition to the above two factors job analysis is an important factor in influencing the analysis of employee needs. Employee needs analysis can be obtained through job analysis to know concretely the number and qualifications of employees required by an organizational unit to be able to perform their duties.

The equipment available or which is expected to be available in completing the work according to the basic task will affect the amount and quality of the required employee. And also the last factor that influence the analysis of amount of staff needs is workload analysis. This study discusses the measurement of workload for each workstation Ciganitri Pants Garnent and the calculation of the ideal staff requirement for the convection company.

4. Analysis and Discussion

4.1 Uniformity Test

Uniformity test is performed to determine whether the data obtained is uniform and does not exceed the upper control limit (UCL) and the lower control limit (LCL) that has been specified. The data uniformity test was conducted on 12 operators in the research object. We get 63,57 as mean for NASA-TLX data in this research object. Further data must be obtained is the result of standard deviation calculation. So the result for the standard deviation of NASA-TLX is 11.8.

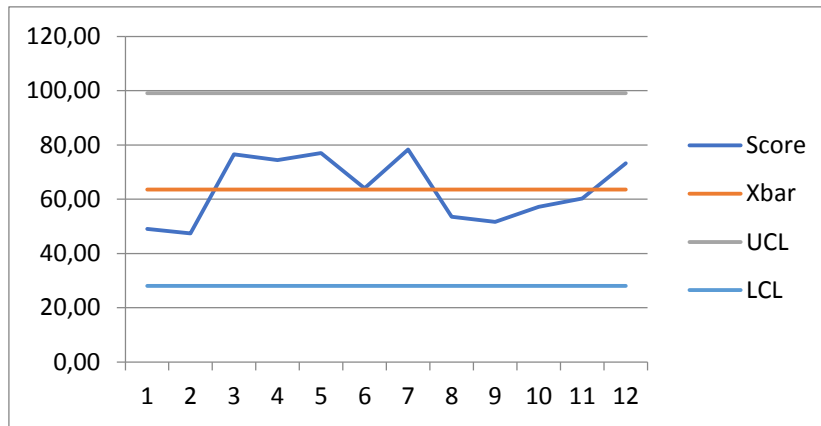So obtained UCL is equal to 99.09 and for LCL is equal to 28.04.

Figure 4. 1 Uniform Test Graph

Based on the graph of uniformity test obtained the maximum value of NASA TLX score of 78.27 and the minimum score of NASA TLX of 47.45. The calculated limit value is UCL of 99.09 and LCL of 28.04. So it is known that there is no score that is beyond the control limit. This means that data that has been processed in the previous stage can be said to be uniform. This is in accordance with the principle of uniformity test and the data can be used in subsequent tests.

4.2 Adequacy Test

Adequacy test was conducted to find out whether the number of measurements to the respondent of mental workload measurement with the NASA-TLX method that has been enough or not. Using 95% confidence level and 10% accuracy level.

The result for N 'is 11,80. When N '<N, so 11.80 <12, it can be said that the data is sufficient to use with a 95% confidence level and a precision level of 10%.

4.3 NASA-TLX Calculation

Tabel 4. 1 NASA-TLX Recapitulation

No	Name	Job	WWL	WWL Average	Score
1	Opr 1	Creating The Pattern	3680	245,333	49,0667
2	Opr 2	Cutting Process	3558,75	237,25	47,45
3	Opr 3	Pocket Making Process	5743,75	382,917	76,5833
4	Opr 4	Pocket Making Process	5585	372,333	74,4667
5	Opr 5	Front Detail Pants Making Process	5776,25	385,083	77,0167
6	Opr 6	Front Detail Pants Making Process	4807	320,467	64,0933
7	Opr 7	Merging Pants	5870,5	391,367	78,2733
8	Opr 8	Edge Pants Making Process	4015	267,667	53,5333
9	Opr 9	Waist Size Making Process	3876,25	258,417	51,6833
10	Opr 10	*Lilit Rantai*	4287,5	285,833	57,1667
11	Opr 11	Legs Part Making Process	4520	301,333	60,2667
12	Opr 12	Rope Belt Making Process	5491,25	366,083	73,2167

4.4 Calculation Number of Operator Needs

At this stage an ideal staff amount is calculated for each section. For calculations performed Workload Analysis in which there are several conversions.

Tabel 4. 2 Calculation of Operator Needs

WorkStation	Workload in a year	Work Time a Year	Number of Staff	Rounding	Existing Operator	Differences
A	18588,416	1894,2	0,98	1	1	0
B	17975,958	1894,2	0,95	1	1	0
C	57223,782	1894,2	3,02	3	2	1
D	53458,1124	1894,2	2,82	3	2	1
E	29653,0696	1894,2	1,57	2	1	1
F	20280,568	1894,2	1,07	1	1	0
G	19579,714	1894,2	1,03	1	1	0
H	21657,02	1894,2	1,14	1	1	0
I	22831,424	1894,2	1,21	1	1	0
J	27737,402	1894,2	1,46	2	1	1

From the table above can be seen that there is a difference between the number of staff needs calculations with the number of staff that already exist. Difference of calculation is found on workstation C and D that is part of Pocket Making Process, part E is part of Merging Process, and J is Rope Belt Making Process. While the other part of the calculation is equal to the number of existing operators at this time.

The calculation of the number of operators on workstation C is 3.02 which means 3 people should work on workstation C, workstation C does not need to add operator to 4 because adding too many operators, the workload will be very small so that the workload uneven and will experience a buildup of work. But for workstation J needs to adding 1 worker because according to the calculation of operator needs shows that J workstation requires 1.46 workers so that it can be rounded up to 2. This rounding is based on the computation of salary calculation when the add 1 person operators with salary when 1 person operator previously took overtime hours. If overtime is taken then the workload will be high.

Based on the calculation using NASA-TLX method to calculate the workload of each operator and each workstation part with the result of operator analysis needed by Ciganitri Pants Garnent is 16 operators for 10 workstations, hence need addition of operator counted 4 person from amount of labor which already exist is 12. If a convection keep on finishing their order from the client on time and decreasing the workload that can be feel by some of the operator that involves then it is a must to take some of necessary steps that exist :

Tabel 4. 3 Salary of Alternative Labor

No	Alternative Labor	Salary /month
1	Outsorce Labor	Rp 960.00
2	Contract Labor	Rp 960.00
3	Over Time Hours	Rp 7.200.000
4	Sub Contract	Rp 2.830.000

The table above shows the ratio of the amount of salary to be received by the new employee when convection decides to increase the number of operators. Not only the salary of new employees, the salary of employees who will be overtime must also be taken into account.

Most of Company analyzes the workload to obtain how much the relative workload of an employee, an occupation, a work unit (section, division, branch, region), even an organization/company as a whole. A workload analysis needs to be done to ensure that a person works on a portion of the job that suits their individual abilities. In this final project we try to analyze some matters relating to mental workload, especially factors that can affect the workload, and the use of NASA-TLX method that can be used in all work environments. Thus we can contribute in reducing the mental workload experienced by employees.

Physical tasks, such as work stations, workplace, work tools and equipment, working conditions, work attitude cause workload experienced by employees. Research conducted by Anton Marchno and Haryono (2015) at PT. Kutai Timber Indonesia shows that the value of allowance is very influential to the workload felt by the operator. So the Company needs to improve workplace conditions in the field. Better workplace conditions will affect the impairment of allowance. This relates to cases that occur in Ciganitri Pants Garnent, the placement and distance between work stations

will affect the workload received by the operators working in the convection. High allowance can cause a high physical workload from the operator, not only that the mental workload will increase when the allowance is high. In research conducted by Anton Marchno and Haryono (2015) focuses on the physical workload experienced by operators in the company. The results obtained have similarities with our research that the physical needs affect the high workload.

Psychological tasks, such as the complexity of the work, the level of difficulty, the job responsibilities become the next factor that is the focus in the factor of high workload as proved in research conducted by T.Fariz Hidayat, et al (2013), which was done in one of hospital in Indonesia shows that the result of workload measurement, the dominant physical demand (PD) affect the workload of nurses. The study also showed that NASA-TLX is directly applicable to the medical environment. The results obtained have similarities with the results of research conducted that the most physical workloads become the main factor of the high workload.

Research conducted by Rr. Dida Kurnia P, et al (2010) at PT. PLN (Persero). The results obtained that the Mental demand and frustration demand are more dominant in service companies. The results obtained from this study with our research is to discuss the amount of workload can be used to measure the addition of the number of operators in companies that provide services.

Not only to determine the number of operators, the workload analysis can be used to calculate the intensive for workers proved in research conducted by Raissa Putri Nanda Wibawa, et al (2016) in PT Barata Indonesia (Persero) engaged in engineering procurement and construction, manufacturing, and foundry. The results obtained in this study is the productive presentation of an operator affect the workload. In this study there is a difference with our research that is the amount of workload received by workers used to determine the amount of incentives provided.

5. Conclusion

The existing workload of 10 workstation are as follow: WS 1 is 49,07, WS 2 is 47,45, WS 3 is 151,05, WS 4 is 141,11, WS 5 78,27, WS 6 is 53,53, WS 7 is 51,68, WS 8 is 57,17, WS 9 is 60,27, and WS 10 is 72,22. It is known that WS pocket making, WS Detail Front Pants making, WS merging pants making and WS rope for the belt making is in the category of high workload so it needs to be reduced workload because all the work in the section was done only by one operator and two operators but still high workload.

The addition of the number of operators is done by recruitment of new staff as much as 4 people. So the number of staff originally 12 people increased to 16 people. The addition of staff numbers is expected to help reduce the workload to be borne by a staff in the section.

6. Bibliography

[1] Arasyand, Muhammad; Bakhtiar, Arfan;. (2015). Analisa Beban Kerja Mental dengan Menggunakan Metode NASA-TLX pada Operator Kargo di PT. Dharma Bandar Mandala (PT.DBM). *e-Journal Fakultas Teknik Universitas Diponegore*, 1-6.

[2] Armstrong. (2017). The Officer Placement. *Human Resource Management*, 36-45.

[3] Dessler, G. (2014). Job Analysis . In *Manajemen Sumber Daya Manusia.* Jakarta: PT. Indeks.

[4] Faris & Pujangkoro. (2013). Pengukuran beban kerja perawat menggunakan metode NASA-TLX di rumah sakit XYZ. *Jurnal Universitas Sumatra Utara*, 67-75.

[5] Hancock, P. A. (1988). *Human Mental Workload.* Nort Holland.

[6] Hart, S. G & Staveland, L. E. (1988). *Development of NASA-TLX.* New York: John Wiey.

[7] Hidayat, T Fariz; Pujangkoro, Sugiharto; , Anizar;. (2013). Pengukuran Beban Kerja Perawat Menggunakan Metode NASA-TLX di Rumah Sakit XYZ. *e-Jurnal Teknik Industri FT USU*, 42-47.

[8] Ivancevich, J. M. (2003). *Human Resource Management.* Jakarta: PT. Index.

[9] Kantowitz, B. a. (1988). *"Human Mental Worlkoad in Aviation," in EL Wiener and D.C. Nagel (Eds.).* San Diego: Academic Press.

[10] Kilbon. (1992). *Metode Penilaian Beban Kerja Melalui Pengukuran Denyut Jantung.* Jakarta: Erlangga.

[11] Nurvitarini, D. (2011). The Determination of The Number of Operators According to Physical Workload Analysis based on Cardiovascular Load. *Jurnal Rekayasa dan Manajemen Sistem Industri VOL. 3 Teknik Industri Universitas Brawijaya*, 536.

[12] Robbins, Stephen P. Judge & Timothy A. (2008). *Perilaku Organisasi Edisi 12.* Jakarta: Selemba Empat.

[13] Suhendra, A. A., & Kurnia P, R. D. (2010). Pengukuran Beban Kerja Menggunakan Metode NASA-TLX dan Perhitungan Kebutuhan Jumlah Staff pada Bagian di PT. PLN (Persero) APJ Majalaya dengan Analisis Beban Kerja. *STT Telkom*, 1-12.

[14] Wibawa, R. P., Sugiono, & Efranto, R. Y. (2015). Analisis Beban Kerja dengan Metode Workload Analysis Sebagai Petimbangan Pemberian Insentif Pekerja (Studi Kasus di Bidang PPIP PT Barata Indonesia (Persero) Gresik). *Journal of Industrial Engineering Brawijaya University*, 672-683.