

Workload Analysis Using Cardiovascular Load, Nasa-TLX, and Fishbone Diagrams



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ABSTRACT: This study aims to analyze employees' physical and mental workload in the legal and business development division and look for factors that affect the workload of the two divisions. The research methods used are cardiovascular load, NASA-TLX, and the Fishbone diagram. The results showed that one employee from the legal division experienced physical exhaustion. In the mental workload study, two people experienced a high mental workload, while five experienced a very high one. The fishbone diagram analysis reveals several factors, such as unresponsive counterparts and conflicts of interest, and in the legal division, such as work patterns that are constantly changing and fast and coordinating company and divisional compliance. The conclusion is that companies should periodically measure mental workload.

KEYWORDS: Cardiovascular load, Fishbone diagram, Mental Workload, NASA-TLX, Physical Workload

I. INTRODUCTION

A dependable payment system is increasingly required to enable transaction development; hence, many e-commerce partners with Payment Gateways (PG) to increase the security and simplicity of consumer transactions. PG works as a third party, bridging transactions from beginning to end, ensuring that there are no substantial barriers that might result in losses for both parties, particularly in credit card transactions [1]. In this situation, the seller will collaborate with PG to give clients a safe and simple payment system.

This research was conducted at companies engaged in Payment Gateway (PG). The company was founded in 2003, and its headquarters are in Central Jakarta. According to the interviews with the Head of Business Development (BD), the company is presently dealing with the issue of realizing the cooperation is hampered due to the long time-consuming process of discussing the cooperation agreement. Before proceeding to the cooperation agreement discussion stage, the parties will engage in a legally enforceable NDA (Non-Disclosure Agreement) or Confidentiality Agreement to preserve sensitive information. If the NDA is not implemented, discussions related to the cooperation agreement will be impeded. The data was collected in November 2022; numerous NDA and cooperation agreement files still need to be realized, with agreements established from Q1 to Q4, including 11 NDA files that had not been identified and 34 cooperation agreement files that had not been discovered.

We conducted preliminary research on five employees in the BD and legal divisions. According to the study, employees require huge physical and mental activity and effort. Therefore, the company wants to find out whether the problems result from an excessive workload of employees, both physically and mentally.

According to [2], the problem that occurs is an ineffective and inefficient teaching system that has an impact on the level of concentration and fatigue of students, as well as mental and physical activity in laboratory work causes students to experience mental, emotional, and physical fatigue, which has an impact on student performance. As a result, they employed the NASA-TLX technique to assess mental workload and the Cardiovascular Load (CVL) approach to assess physical stress. Following the findings of his study, 40% of students reported a very high mental workload, 56% experienced a high mental workload, and just 4% experienced a moderate mental workload. Meanwhile, physical workload measurements suggest that just 20% of students have a physical workload that has to be improved, while the other 80% still need a substantial physical workload. Other research uses the CVL and NASA TLX methods, including [3.4.5].

The difficulty confronted in a recent study by [6] is the high incidence of accidents in handling sharp items that induce HIV infection among professional health workers in Brazil. As an outcome, researchers employed the Ishikawa Diagram to investigate the reasons and solutions for coping with HIV infection in trained health professionals due to handling sharp instruments. The findings revealed that the major causes of HIV infection were overwork, a lack of risk perception, reckless needle usage, and a lack of training. Furthermore, the answer necessitates implementing and monitoring safety standards, effective post-exposure treatment, and enhanced notification of sharps accidents.

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Based on the company's problems and previous research, the scientific approach used to overcome these problems is operations management, precisely work measurement using the NASA-TLX method to measure mental workload, Cardiovascular Load (CVL) to estimate physical workload, and Fishbone Diagrams to determine the root cause of the problem. In prior investigations, only the cardiovascular load technique and NASA-TLX were utilized to quantify workload. The cardiovascular load technique and NASA-TLX were also employed in this study. However, a fishbone diagram was used as a supplementary way to measure the elements that impact employee workload. Based on this, the purpose of this study was to determine the amount of physical workload experienced by employees in the business development and legal divisions using cardiovascular loads, the amount of mental workload experienced by employees in the business development and legal divisions using NASA-TLX, and the factors influencing employee workload in the business development and legal divisions using a fishbone diagram.

II. METHOD

The research approach employed in this study is a mixed method. The mixed method collects, analyzes, and combines qualitative and quantitative data in a single research or set of studies [7]. The research method employed is descriptive research. The group, namely the Business Development (BD) and Legal divisions, is the unit of analysis in this research. This study will use a cross-sectional approach to the time horizon.

This study's sample included four employees from the BD division and three from the legal division. This is because the personnel engaged are full-time employees, with four in the BD section and three in the legal division.

A. Cardiovascular Load [8,9]

- a) Record heart rate data while working and resting.

First, resting pulse data will be collected during the lunch break, and working pulse data will be collected following the lunch break during meeting times or while you are actively working. An oximeter is used to measure the pulse.

- b) Calculate the maximum pulse rate

Pulse data will be measured by the formula:

- Male maximum heart rate = 220 – Age

- Female maximum heart rate = 200 – Age

- c) Calculate the percentage of CVL (%CVL)

$$\%CVL = \frac{100 \times (\text{Pulse while working} - \text{Pulse while resting})}{\text{Maximum pulse rate} - \text{Pulse while resting}} \quad (1)$$

- d) %CVL classification

From the results of the %CVL calculation that has been carried out, it will then be classified as follows:

Table 1. %CVL Classification

%CVL	%CVL classification
$\%CVL \leq 30\%$	Fatigue does not occur in workers
$30\% \leq \%CVL \leq 60\%$	Improvement is required but not urgent
$60\% \leq \%CVL \leq 80\%$	Permission to work in short notice.
$80\% \leq \%CVL \leq 100\%$	Immediate improvement action is required
$\%CVL > 100\%$	Working activities may not be carried out

Sources: [8, 9]

B. NASA-TLX [8,10]

- a) Distributing weighting questionnaires

Delivering weighing questionnaires using the Google Form platform, a comparison assessment between two variables is used.

- b) Distributing ranking questionnaires

Distributing the rating questionnaire using the Google form platform with an assessment basis ranging from 0 to 10. Using the assessment basis affects the rating limits set by the Google form platform.

- c) Calculate the product value

$$\text{Product} = \text{Weight} \times \text{Rating} \quad (2)$$

- d) Calculate the WWL (Weighted Workload) value

$$\text{WWL} = \sum \text{Product} \quad (3)$$

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e) Calculate the average value of WWL/NASA-TLX value

$$\text{NASA-TLX} = \Sigma \text{Product} / 15 \quad (3)$$

f) Interpretate the NASA-TLX value

Table 2. NASA-TLX Value Classifications

No	Workload category	Value
1	Low	0 – 9
2	Moderate	10 – 29
3	Slightly high	30 – 49
4	High	50 – 79
5	Very high	80 – 100

Sources: [8, 10]

C. Fishbone diagram (Ishikawa diagram) [5]

- Identify the primary issue, which is the realization of the physical and mental workload
- Interview the parties involved
- Hold conversations with relevant parties about the acceptability of the conditions encountered using the information obtained.
- Create a fishbone diagram by linking the problems identified as the root causes of the major issues

III. RESULTS AND DISCUSSION

A. Cardiovascular load (CVL) calculation result

Physical workload measures will be taken at this point. The authors will apply the cardiovascular load technique to measure the physical workload of personnel in the business development and legal divisions, in which they will monitor the pulse per minute of rest and work. The author will use an oximeter to monitor pulse per minute of rest during lunch breaks and pulse per minute of work during meetings or while working. The findings of evaluating physical effort using the cardiovascular load technique are as follows:

Table 3. %CVL Data

Divisions	Respondent	Pulse while resting	Pulse while working	Maximum pulse	%CVL	Annotation
Business Development	1	80	90	174	10.64	Fatigue does not occur
	2	74	95	194	17.5	Fatigue does not occur
	3	86	96	188	9.8	Fatigue does not occur
	4	74	85	189	9.5	Fatigue does not occur
Legal	1	59	65	188	4.65	Fatigue does not occur
	2	59	103	194	32.59	Improvement is required but not urgent
	3	70	87	198	13.28	Fatigue does not occur

Source: Processed primary data (2023)

Table 3 shows the classification results where the respondents in the business development division are classified as not experiencing fatigue. In contrast, in the respondents in the legal division, one respondent is classified as needing improvement but not urgent.

B. NASA-TLX Measurement Result

The writer will assess the mental workload at this point. The authors use the NASA-TLX approach to calculate the mental effort of personnel in the business development and legal divisions. Data will be collected by distributing NASA-TLX surveys and then computing the questionnaire findings. NASA-TLX calculations generated the following results.

Table 4. Product Value Data of the NASA-TLX Questionnaire

Divisions	Respondent	KM	KKF	KW	TF	P	TU
Business	1	360	0	450	50	140	300
Development	2	450	0	180	160	180	240

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	3	180	50	280	0	320	240
	4	160	0	210	140	320	280
	Total	1150	50	1120	350	960	1060
	Average	287.5	12.5	280	87.5	240	265
<i>Legal</i>	1	360	0	300	160	500	100
	2	500	60	200	0	270	400
	3	360	0	400	70	320	160
	Total	1220	60	900	230	1090	660
	Average	406.67	20	300	76.67	363.33	220

Source: Processed primary data (2023)

Table 4 provided data from calculating the product value of the NASA-TLX question sent to respondents from the business development and legal divisions, with the two divisions having the greatest mental requirements indicator scores compared to the other five indicators. However, time needs are the second most crucial aspect in the business development division, while performance indicators are shown in the legal division. The NASA-TLX computations result in the following results:

Next, the author calculates WWL (Weighted Workload) and NASA-TLX values. The following are the results of WWL calculations and NASA-TLX values:

Table 5. Interpretation Result of NASA-TLX Values

Divisions	Respondent	WWL	NASA-TLX Value	Annotation
<i>Business</i>	1	1300	86.67	Very High
<i>Development</i>	2	1210	80.67	Very High
	3	1070	71.33	High
	4	1110	74	High
<i>Legal</i>	1	1420	94.67	Very High
	2	1430	95.33	Very High
	3	1310	87.33	Very High

Source: Processed primary data (2023)

Based on Table 5, the results of the NASA-TLX values obtained before will be interpreted where the respondents in the business development division are interpreted as having two respondents having a high mental load and two having a very high mental burden. Meanwhile, for respondents from the legal division, all respondents were interpreted to have a very high mental load.

C. Fishbone diagram analysis results

Based on the interviews conducted with employees from the business development and legal divisions, the causal factors that affect employee's workload in the business development and legal divisions can be identified. Following are the results of workload analysis using a fishbone diagram for employees in the business development and legal divisions:

a) Results of Business Development Division Employee Workload Analysis

A fishbone diagram showing the findings of staff workload analysis in the business development division is shown below.

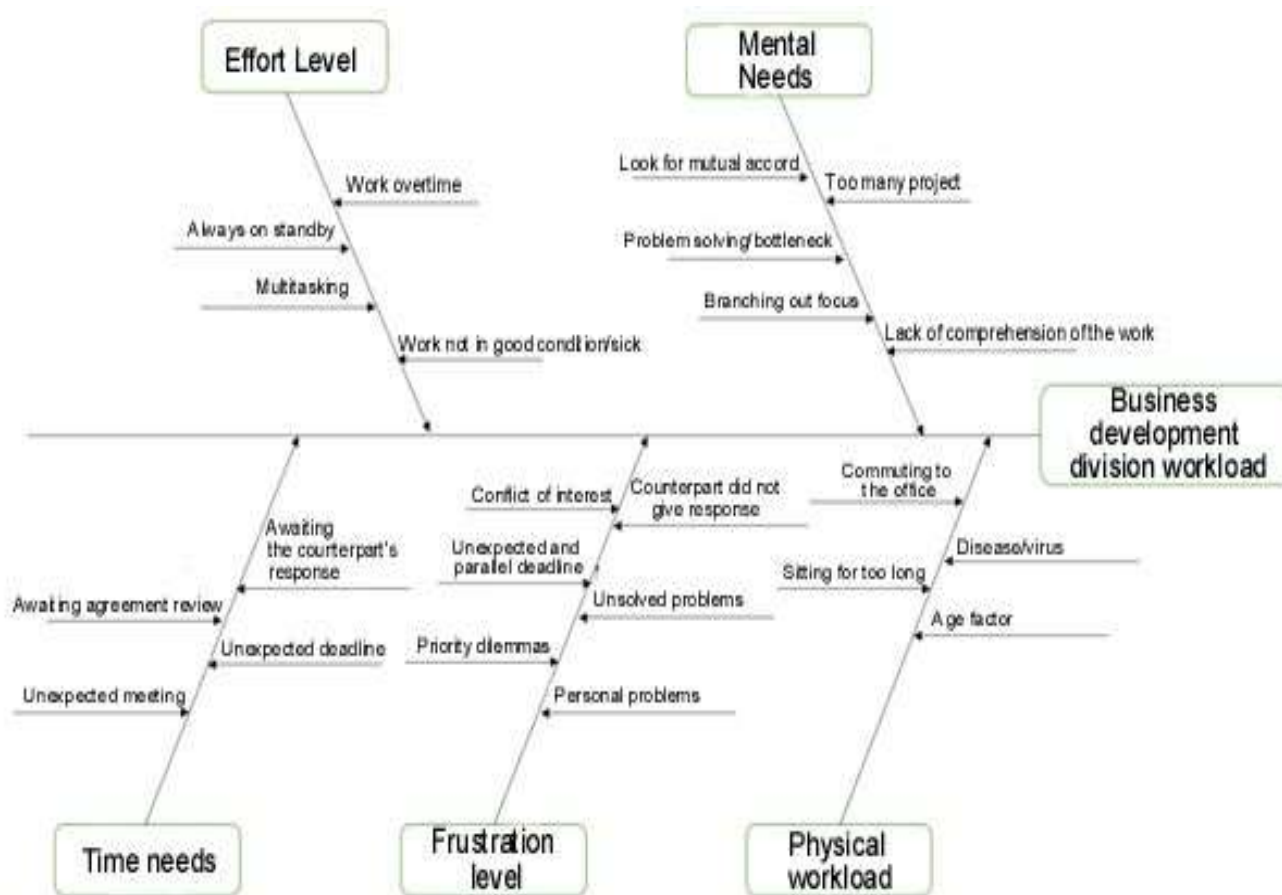


Figure 1. Fishbone Diagram of Employee Workload in the Business Development Division

Notes:

Effort level

- Work overtime
- Always on standby
- Multitasking
- Work not in good condition/sick

Mental needs

- Look for mutual accord
- Too many project
- Problem solving/bottleneck
- Branching out focus
- Lack of comprehension of the work

Time Needs

- Awaiting the counterpart's response
- Awaiting agreement review
- Unexpected deadline
- Unexpected meeting

Frustration Level

- Conflict of interest
- Counterpart did not give response
- Unexpected and parallel deadline
- Unsolved problems
- Priority dilemmas
- Personal problems

Physical workload

- Commuting to the office
- Disease/virus
- Sitting for too long
- Age factor

Figure 1 depicts the results of the fishbone diagram analysis where several factors affect the workload of employees in the business development division, starting from too many projects, problem-solving, branching out focus, unexpected and parallel deadlines, priority dilemmas, and counterparts who did not respond.

b) Results of Legal Division Employee Workload Analysis

The following is a fishbone diagram based on the findings of an employee workload study in the legal division.

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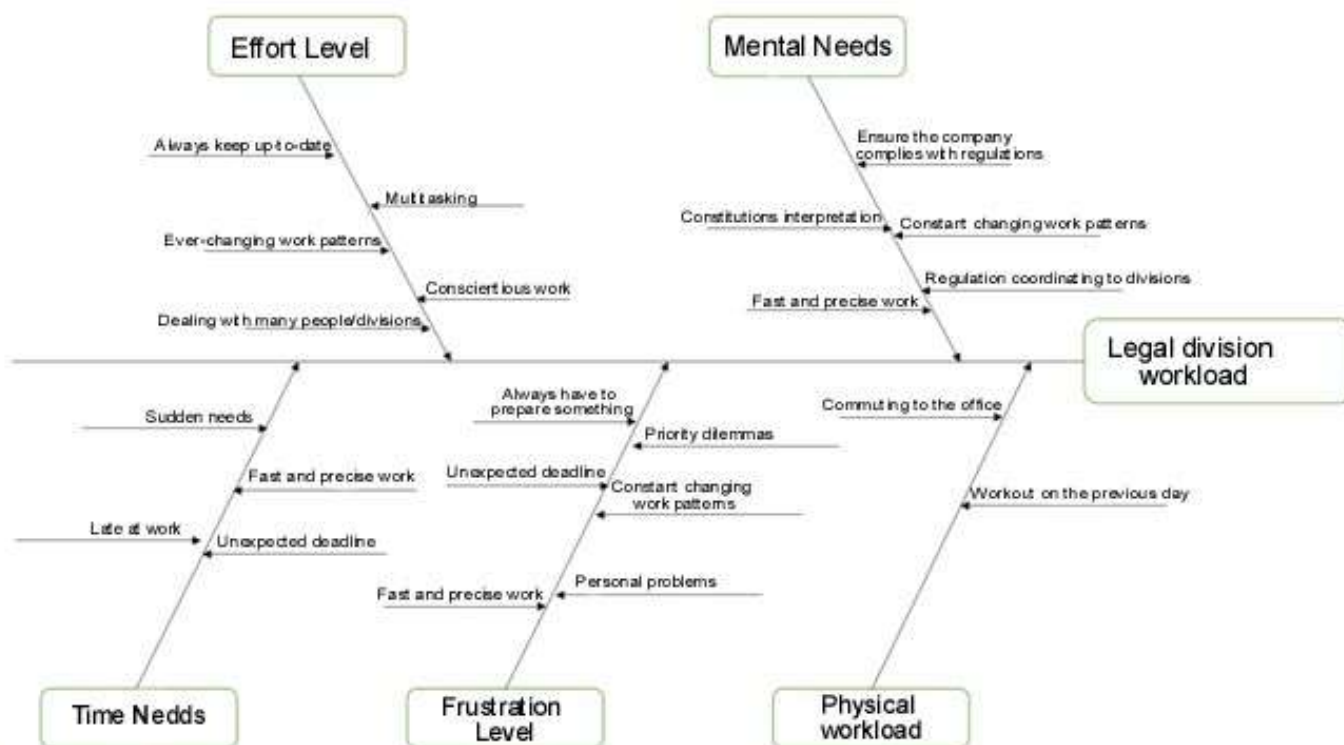


Figure 2. Fishbone Diagram of Employee Workload in the Legal Division

Notes

Effort level

- Always keep up-to-date
- Multitasking
- Ever-changing work patterns
- Conscientious work
- Dealing with many people/divisions

Time Needs

- Sudden needs
- Fast and precise work
- Late at work
- Unexpected deadline

Frustration Level

- Always must prepare something
- Priority dilemmas
- Unexpected deadline
- Constant changing work patterns
- Personal problems
- Fast and precise work

Mental needs

- Ensure the company complies with regulations
- Constitutions interpretation
- Constant changing work patterns
- Fast and precise work
- Regulation coordinating to divisions

Physical workload

- Commuting to the office
- Workout on the previous day

Figure 2 shows the results of the fishbone diagram analysis where several factors affect the workload on employees in the legal division, starting from changing work patterns, interpreting laws, starting work late, coordinating regulations between divisions, and ensuring company compliance with applicable regulations.

IV. CONCLUSION

Based on research conducted on employees in the business development and legal divisions, it can be concluded that from the results of physical workload research using the cardiovascular load method, the %CVL value in the business development division is interpreted as no fatigue. In contrast, in the legal division, where employees score more than 30, only one employee indicates physical fatigue and needs improvement but not urgent. From the results of the mental workload study using the NASA-TLX method on employees in the business development division, there are two employees classified as having a high mental workload, and two other employees experiencing a very high mental workload. Meanwhile, the legal division indicates that the mental

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workload of employees is very high. In the analysis of the fishbone diagram, both the business development division and the legal division have the same factors, such as multitasking, dealing with many divisions, branching out focus, unexpected meetings and deadlines, priority dilemmas, and personal issues which contribute to the workload of employees in the business development and legal divisions. We provide suggestions for companies, it is best to socialize employees to take a short break and do light exercise, and also companies should add employees to reduce the burden on existing employees. For the legal division, it is better to sleep early and arrive earlier to maximize working hours. In contrast, for the business development division, it is better to hold face-to-face meetings with related parties to get answers as soon as possible. And in both divisions, regarding the problem of priority dilemma over sudden deadlines or sudden meetings, we suggest you ask colleagues for help to back-up work so that it can be completed more effectively.

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