Mental workload analysis on fruit truck suppliers using NASA-TLX method in giwangan market area

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Abstract. Several times the truck driver received complaints from consumers (merchants) related to the inaccuracy in delivering the goods, and the quality of the goods declined. The driver stated that most of this happened because of the unfavorable market conditions so that it was not possible for drivers who arrived at the Giwangan market to carry out the loading and unloading process directly. That is because drivers are forced to wait up to 1-5 hours in the Giwangan market area to unload goods. These things are thought to add to the mental workload of truck drivers. The method used to measure mental workload using a questionnaire on the NASA-TLX method. The number of respondents sampled in this study were 20 (twenty) people, and all male. The respondents’ age is divided into two categories, namely early adulthood (18-40) and middle adulthood (40-60). The NASA-TLX calculation results stated that the workload of fruit truck drivers on the market during normal day conditions is classified as "High" with a score obtained of 70.26. The correlation test has resulted in the more age of the fruit truck driver, the lower the workload's value.

1. Introduction
All human activities must have a light, moderate, or heavy workload. The workload is an effort that must be expended by someone to fulfill the purpose of the work. The workload is also defined as a person's limited capacity to carry out their duties [1]. In work, someone gets physical and mental workload that directly or indirectly affects work productivity, where the heavier workload will reduce worker productivity. The physical workload can be measured using medical devices, so it tends to be easy to see how heavy and large the level of fatigue is caused by these workers and can even be seen in plain view even though not using medical devices. This is different from mental workloads, where mental workloads expended relatively less energy than physical workloads. However, roles and mental workload responsibilities are clear and more massive than the physical workload. This is because a heavy mental workload will have an impact on work stress. Therefore, so that workers can work and produce an optimal output, it will be essential to consider various aspects of humans and their work [2].

Giwangan Market is one of the leading markets for fruit and vegetables in the Special Region of Yogyakarta (DIY). The market is a fruit and vegetable primary market located at Jalan Imogori No. 212, Yogyakarta City. This market has a land area of 24,594 m² and a building area of 18,984 m² utilized by 981 vegetable and fruit merchants who originally came from 3 traditional markets, namely: Sri Wedani Market, Shopping Center, and Jalan Pabringan. This market has a hangar, a place for loading and unloading fruits and vegetables from and in goods transport vehicles such as pick-up
In the beginning, the hangar function's planning could run well by the layout arranged by the City Government, but over time the market conditions became more dense and irregular. This happened because merchants traded in parking lots, loading and unloading goods, and roads that were supposed to cross vehicles, and many vehicles parked in places that were not supposed. This happened because merchants already occupied their parking spaces. The current condition around the giwangan market has become dense and irregular, making it difficult for vehicles to get in and out. This makes the market participants feel pressurized, especially fruit truck drivers. The truck driver is responsible for delivering the fruit to the hands of consumers (merchants). Some consumers ask to deliver their goods on time and ask to maintain the quality of goods ordered. The truck driver received complaints from consumers (merchants) several times related to the inaccuracy in delivering the goods, and the quality of the goods declined. The driver stated that most of this happened because of the unfavorable market conditions so that it was not possible for drivers who arrived at the Giwangan market to carry out the loading and unloading process directly. Several places should be designated for loading and unloading of goods but it has been occupied by merchants who sell using their vehicles such as tosa or open shanties so that there is less space for loading and unloading for truck drivers. This is because drivers are forced to wait up to 1-5 hours in the Giwangan market area to unload goods. These things are thought to add to the mental workload of truck drivers. Meanwhile, a worker certainly has different capacities in accepting workloads.

One factor in the difference in the capacity of workers is age. The age of truck drivers who carry out the loading and unloading process in the Giwangan market also varies from 22-60 years. The age of adulthood is divided into three namely early adulthood is 18-40 years, middle adulthood is 4-60 years, and advanced adults > 60 years [3]. Each age group has its capacity for receiving workload, so it is necessary to look at the relationship between age and mental workload score.

So that in solving these problems, it is necessary to measure the mental workload of the drivers of fruit transport trucks in the Giwangan market. Several methods can do measurement of mental workload, one of which is the National Administration Task Load Index (NASA-TLX) developed by Sandra G. Hart of NASA-Ames Research Center and Lowel E. Staveland from San Jose State University in 1981. This method is in the form of a questionnaire developed based on the emergence of subjective measurement needs that are easier but more sensitive to workload measurement [4]. This method was developed based on the need for subjective measurements consisting of a scale of nine factors (task difficulty, time pressure, type of activity, physical effort, mental effort, performance, frustration, stress, and fatigue).

By knowing the level of mental workload of fruit truck drivers, these results can be used to consider further decision-making, whether re-structuring the access road in the Giwangan market hangar and strategies for implementing workers for drivers that the driver's mental workload score can be reduced. Through measurements can also be known as indicators that dominate the mental workload of the driver. So that it can be made a recommendation for market managers to improve accessibility to reduce the mental workload of fruit truck drivers in the Giwangan market.

2. Literature Review
Analysis of work mental load on the study program admin at the industrial technology faculties of Staff’s mental workload analysis in the study program of the private educational organization was conducted by [5]. Study program worker in managing the management contained in the study program often gets high enough pressure so that the admin's mental workload increases. This study will determine the mental workload of the questionnaire distribution to study program administrators because remembering this research is subjective. The questionnaire was then analyzed using the NASA-TLX method and statistics such as different tests, correlations, regression.

In the case study of PT. PAHALA KENCANA Bandung Branch is one of the inter-city intercity bus transportation service companies serving routes to 35 destinations on Sumatra, Java, Madura, and Bali [6]. One of the routes investigated is the driver activity of the Bandung-Denpasar route. This route is the longest to be sure that the workload on this route is very high. Therefore the bus driver needs high physical and concentration needs to control the bus properly so that the safety and comfort of
passengers can be maintained. This research is also motivated by the number of accidents that have increased from year to year. Therefore the mental workload of bus drivers needs to be done to reduce the risk of accidents.

The workload is a term used to refer to the price or cost of achieving an activity target. PT. ABC is a company that manufactures mobile phones [7]. This research is motivated by the high demand every day, making workers in the logistics department unable to complete the work according to the specified schedule, so workers must work overtime to complete the work. Frequent overtime can have an impact on workers, both physically and mentally. To determine the amount of mental workload of employees in the logistics department, measurements were made using the NASA-TLX (National Aeronautical and Space Administration Task Load Index) method. Based on the scores obtained, it is known that 38.10% of employees have high mental workloads, 57.41% have moderate mental workloads, and 4.76% have mild mental workloads. The solution given in this research is to add workers, especially helper and scanner, who have the highest mental workload.

Analysis of mental workload on PT. DBM cargo operators were once conducted by [1]. In carrying out its activities the cargo operator PT. DBM is not uncommon to get high enough pressure so that the mental workload of operators increases. Data collection is carried out by distributing questionnaires in the data uniformity test and the data's adequacy to ensure that the data taken is uniform and sufficient. After that data, it is used to calculate NASA-TLX scores to see the operator's classification of workload. The NASA-TLX calculation results obtained mental workload values for all workers at the level of "medium" with the largest mental workload indicator on the operator of PT. DBM is the scale of PD (Physical Demand) and MD (Mental Demand). Proposed improvements are given, namely dividing the work and rotating work.

Mental workload as an evaluation of the operator of marginal load (the difference between his motivational capacity and the tasks are given) when carrying out work quite well in motivating conditions [4]. The concept emphasized here is the marginal workload which is the difference between workload demands of a task with maximum capacity (motivated) one's mental load in motivated conditions. The mental workload of someone in handling work is influenced by work situation and type of activity, response time and completion time available, individual factors such as motivation level, expertise, fatigue/boredom, and allowable performance tolerance. The physical workload measurement can be done by measuring energy consumption and / or oxygen consumption during the activity [8]. However, the subjective workload measurement can be done and is a measure of mental workload based on the respondent/worker's subjective perception.

3. Research Methodology

3.1. Research Object
The study object was the mental workload of fruit transport truck drivers at the Giwangan market from outside the city of Yogyakarta.

3.2. Data Collection Methods
Interviews and questionnaires are active primary data collection by questioning respondents. Interviews and questionnaires, conducted by giving NASA-TLX questionnaires that have been made to truck drivers who are willing to provide responses relating to the mental workload they receive while working [9].

3.3. NASA TLX
The method used to measure mental workload using a questionnaire on the NASA-TLX method. This method is done with a subjective approach to statements representing the conditions of work in the field [10].

The factors namely Mental Demand (MD), Physical Demand (PD), Temporal Demand (TD), Performance (P), Effort (EF), and Frustration Level (FR) [4]. Mental Demand (MD) with its low - high rating. MD is how much mental and perceptual activity it takes to see, remember, and search. Is the job simple or complex? Physical Demand (PD) with a low - high rating. PD is how workers need much
physical activity (for example attracting, encouraging, etc.). Temporal Demand (TD) with a low - high rating. TD is how much time pressure is felt during the work takes place. Is the work can be done slowly, or quickly so that it feels tiring. Own Performance (OP) with an incorrect rating - perfect. OP is how much the success rate of workers in carrying out their duties and how satisfaction with their work results. Effort (E) uses a rating from low to high. E is how much effort or hard work is needed to achieve the required level of performance. Frustration (FR) uses a low-high rating. FR is how many workers feel insecure, hopeless, offended, or disturbed while doing their job.

NASA-TLX measurements have five stages [4]. The weighting phase is carried out by filling in by selecting one of the two most dominant indicators felt during work. After the respondent successfully fills out the 15 comparison indicators, a weighting is done by adding each selected indicator's total. After that, add up each mental workload indicator that the respondent has chosen to get the indicator's weight.

In the rating phase, respondents are asked to choose a rating value from the range of scores from 100 to 100 in each mental workload indicator statement. The product rating phase is multiplying the rating by the indicator weights for each scale of mental workload. calculating the average weighted workload (WWL) phase is done by adding up the product value of each indicator and dividing the results of the sum of the indicators by the number of respondents. After obtaining the average WWL from each factor, the next is to determine the average value of the total WWL by dividing the total value of the average WWL by a value of 15 (derived from the sum of the total weights from the pairwise comparison of the NASA-TLX workload mental scale on the questionnaire). Score interpretation is divided into several categories [4].

| Workload Group | Score |
|----------------|-------|
| Low            | 0-9   |
| Middle         | 10-29 |
| Rather High    | 30-49 |
| High           | 50-79 |
| Very high      | 80-100|

3.4. Statistic Test
Mann-Whitney difference test use between early adult and intermediate age groups. There are testing to find differences in mental workload scores between early adult and middle adulthood. The division of adulthood is divided into three [3]. First, early adulthood begins at the age of 18 years to approximately age 40 years. When the physical and psychological changes that accompany a decrease in reproductive capacity. Middle adulthood begins at the age of 40 years until the age of 60, which is when both physical and psychological abilities are declining, which is see in everyone. Advanced adulthood begins at the age of 60 years until death. At this time, both physical and psychological abilities are rapidly declining, but modern medical techniques and efforts in dressing and grooming enable men and women to look, act and feel like they were when they were young.

Besides that, using the correlation test to test the relationship between age and mental workload scores obtained. Before conducting the correlation test, the data must be tested for normality first. This is done to be able to determine what correlation method is suitable to use.

4. Result

4.1. Population Fruit Truck Driver
In determining the number of drivers of fruit transport truck drivers from outside the Yogyakarta city, observations were made based on expert judgment by taking as many as eight respondents who were market participants who had worked for a very long time in the area around the Giwangan market.
hangar. Market participants who take questionnaires were often in direct contact with fruit transport truck drivers such as ticket attendants, parking attendants, fruit merchants, and truck drivers. Based on Table 2, the minimum respondent sample is seven people. However, the number of respondents sampled in this study were 20 (twenty) people.

**Table 2. The population of Fruit Truck Drivers Based on Expert Judgement**

| Respondent Expert | Age (year) | Job               | Started Working at Giwangan Market (year) | Number of tracks originating from outside the city/day (unit) | Most Likely (per day) |
|-------------------|------------|-------------------|------------------------------------------|-------------------------------------------------------------|----------------------|
|                   |            |                   |                                          | Lowest | Highest |                      |
| E1                | 58         | Ticket Attendant  | 2005                                     | 5      | 7       | 6                     |
| E2                | 52         | Fruit Merchant    | 2004                                     | 5      | 7       | 6                     |
| E3                | 50         | Fruit Merchant    | 2004                                     | 5      | 9       | 7                     |
| E4                | 33         | Fruit Merchant    | 2000                                     | 5      | 8       | 6,5                   |
| E5                | 70         | Parking Attendant | 2004                                     | 4      | 10      | 7                     |
| E6                | 46         | Fruit Merchant    | 2004                                     | 6      | 8       | 7                     |
| E7                | 56         | Fruit Merchant    | 2001                                     | 5      | 10      | 7,5                   |
| E8                | 58         | Truck Driver      | 2005                                     | 5      | 8       | 6,5                   |
|                   |            |                   |                                          |        |         |                      |
|                   |            | Popluation Average|                                          |        |         | 6.68 ≈ 8              |

**Table 3. Respondent Profile**

| Respondent | Sex | Age (year) | Place of Delivery |
|------------|-----|------------|-------------------|
| R1         | Male | 35         | Banyuwangi        |
| R2         | Male | 29         | Kediri            |
| R3         | Male | 31         | Lampung           |
| R4         | Male | 38         | Malang            |
| R5         | Male | 22         | Jember            |
| R6         | Male | 51         | Palembang         |
| R7         | Male | 59         | Madura            |
| R8         | Male | 46         | Malang            |
| R9         | Male | 39         | Banyuwangi        |
| R10        | Male | 30         | Jember            |
| R11        | Male | 44         | Palembang         |
| R12        | Male | 38         | Kediri            |
The respondents' age is divided into two categories, namely early adulthood (18-40) and middle adulthood (40-60). The following are the results of age acquisition based on age categories shown in Table 4.

| Driver ID | Gender | Age | Location |
|-----------|--------|-----|----------|
| R13       | Male   | 35  | Jember   |
| R14       | Male   | 25  | Jember   |
| R15       | Male   | 32  | Lampung  |
| R16       | Male   | 50  | Madura   |
| R17       | Male   | 46  | Malang   |
| R18       | Male   | 54  | Malang   |
| R19       | Male   | 42  | Palembang|
| R20       | Male   | 55  | Banyuwangi|

**Figure 1. Percentage of Driver Age Group**

4.2. **Score Interpretation**

WWL average calculation results are obtained from the sum of each indicator's average scores divided by 15, which is the total initial weighting of each indicator. Before calculating the average, WWL must calculate the average score of the indicator workload by dividing the total number of indicator product values by the number of respondents. The average score of workload (weighted workload) and the interpretation of these values can be seen in Table 4.

| Table 4. Interpretation Score |
|-------------------------------|
| **Truck Driver**              |
| **Total** | **Average** |
| MD        | 5760     | 288     |
| PD        | 1180     | 59      |
| TD        | 5420     | 271     |
| OP        | 4260     | 213     |
| E         | 3470     | 173.5   |
| FR        | 990      | 49.5    |
| Average WWL |         | 70.26   |
| Interpretation          | High    |
4.3. Mann-Whitney Test in Workload Score Between Early Age Groups and Intermediate Adults

This test is conducted to determine whether there is a difference in NASA-TLX scores between the early adult (18-40 years) and middle adulthood (41-60 years) groups. To prove this, the nonparametric difference test is used, the Mann-Whitney test. The average WWL score for each respondent is obtained by adding up the respondent's product scores and divided by 15 (total comparison of NASA-TLX indicators). Based on these tests, it can be seen that asymp.Sig. (2-tailed) for the two-tailed test is 0.381, or the probability is above 0.05 (0.381 > 0.05). So H0 is accepted or indeed, the mental workload received by the first adult trucker group is the same as the mental workload received by the middle adult trucker group.

4.4. Correlation Test Between Truck Driver Mental Workload Scores and Truck Driver Age

A correlation test is done between age and mental workload acquisition. Furthermore, the correlation test with the Spearman method is performed using SPSS 23 software because of the two data that is not normally distributed [11].

| Table 5. Correlation Test |
|---------------------------|
|                          | Age          | Mental Workload Score   |
| Spearman's rho Age       | Correlation Coefficient | 1.000 | -0.321 |
|                          | Sig. (2-tailed) |                   .167 |
|                          | N             |   20                |        |
| Mental Workload Score    | Correlation Coefficient | -0.321 | 1.000 |
|                          | Sig. (2-tailed) |                   .167 |
|                          | N             |   20                |        |

Based on Table 5, it can be seen that the age with a mental workload value has -0.321. This figure shows the weak relationship between age and the value of mental workload (under 0.5), while the negative sign (-) indicates that the more age of the fruit truck driver, the lower the value of the workload.

5. Discussion

Based on the calculation of each NASA-TLX indicator’s average workload, the Mental Demand score obtained or the greatest mental needs of the truck driver's are 288. So it can be concluded that the work as a fruit truck driver has high mental needs even though it is not so complex or difficult. The score not only obtained from the job activities as a driver, but external factors at work can also influence the high level of mental needs of truck drivers, such as the current market conditions in Giwangan.

Based on the calculation of each NASA-TLX indicator’s average workload, the Temporal Demand score or time requirement is quite large, namely 251. This is triggered because in delivering fruit, the driver must be on time and work as a driver will require hours of work. long. Truck drivers are sometimes required to carry out the loading and unloading process immediately, but there are still long enough queues before arriving at the loading and unloading location.

Based on the calculation of each NASA-TLX indicator's average workload, the Own Performance score for truck drivers is 213. This shows that truck drivers are not very satisfied with their business. Drivers delivering fruit to the hands of consumers (merchants) are often not on time. One of the drivers' causes is not on time because the market conditions are too crowded and irregular that does not allow drivers to be able to directly complete the work of delivering goods to consumers so that the time for loading and unloading takes a long time. Consumers (merchants) complaints related to the quality of goods to truck drivers. For example, such as chili and tomatoes that almost rot because of too long a fall, due to waiting for the turn of loading and unloading goods.
Based on the calculation of the average workload of each NASA-TLX indicator, it obtained an Effort or effort score of 173.5. This shows that the driver's business is good at delivering fruit to the Giwangan market but cannot reach the consumers (merchants) due to crowded market conditions and reduced loading and unloading places due to being occupied by merchants who make drivers forced to have to queue to do the process loading and unloading so that consumers sometimes complain because of old items that reach their hands.

Based on the calculation of each NASA-TLX indicator's average workload, the Physical Demand score or physical needs for truck drivers is obtained, which is 59. This shows that work as a fruit transport truck driver does not have a job that requires much physical activity. The work done is not heavy because the driver just sits driving the truck. The loading and unloading process is carried out by the porters in the market so that the truck drivers just sit and wait for the process to finish. Based on the results of interviews with the driver, the activity that requires the driver to do physical activity is to open a tarpaulin installed above the tub when he wants to load and unload goods that require the driver to expel his physical exertion.

Based on the calculation of each NASA-TLX indicator's average workload, the Frustration Level score for the truck driver is 49.5. This shows that the driver's work does not cause the driver to feel insecure, hopeless, offended, disturbed. Based on interviews, because the average driver feels that their work has become a hobby, it is not too stressful when carried out, although several factors make truck drivers feel stressed, such as market conditions. That thing might make them stress, but the stress is not prolonged because they realize they are making a living. So the Frustration Level (FR) value is at the lowest position among the six indicators.

The early adult age group, referred to as early adulthood, is starting at the age of 18 years to approximately 40 years. The category is when the physical and psychological changes accompany a decrease in reproductive capacity (Hurlock, 1980). At this age, the truck driver's motivation and enthusiasm is still high. During this time, truck drivers will learn a lot and adjust to the work done. This can make the new truck driver sometimes overwhelmed when faced with several situations at work. Giwangan market conditions are currently not good. Some merchants trade in places that are not supposed to be like parking lots and loading and unloading processes. As a result of this situation, locations to carry out the loading and unloading of goods will be increasingly reduced and some vehicles parked in places that are not supposed to be. This condition will certainly cause congestion in the Giwangan market so that when a truck driver arrives at the Giwangan market, he cannot immediately carry out the loading and unloading process but must wait his turn. This makes the driver at an early age adult will be depressed because of the difficulty of parking their vehicles, and also remember they have responsibility for the goods they carry that must be immediately delivered to the merchant.

The middle adulthood group is at the age of 40 to the age of 60, namely when both the decline in physical and psychological abilities are visible in everyone (Hurlock, 1980). There is a decline in physical and psychological abilities at this age, so drivers become easily tired and stressed when doing work, especially when facing the dense and irregular market conditions in Giwangan. At this age, drivers often experience physical pain such as muscle or bone when parking trucks in crowded market conditions. Of the two age groups, both early adulthood, and middle adulthood, they did not significantly differ in mental workload scores even though the two groups differed physically and psychologically. This shows that no matter how old a fruit truck driver is from out of town, the mental workload score caused by market conditions will be the same.

6. Conclusion and Recommendation
The NASA-TLX calculation results stated that the workload of fruit truck drivers on the market during normal day conditions is classified as "High" with a score obtained of 70.26. It can be concluded that current market conditions affect the high mental workload of fruit truck drivers from outside Yogyakarta. This is due to unfavorable market conditions where traders trade in places where they are not supposed to, so loading and unloading places are limited to fruit trucks. Therefore, the fruit truck driver who arrives at the Giwangan market is forced to wait his turn to carry out the loading and unloading of goods, making the time consumers (merchants) receive their goods for a long time. It is
then necessary to improve the layout and order in the Giwangan market area related to the layout of the facilities and market participants so that the mental workload of the fruit truck drivers can decrease.

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