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Predictive Model on the Severity of Musculoskeletal Disorder and Accidents of Truck Drivers in the Philippines

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Abstract

Truck driving is known as one of the occupations with the highest accident rate. Truck drivers have also shown to increase risk for developing musculoskeletal disorders. The risk for accident and musculoskeletal disorder were mostly attributed to factors such as human, vehicle, work conditions and other variables. Because of this, truck drivers face a variety of occupational risk. This paper aims to develop a predictive model on the severity of musculoskeletal disorders and severity of accidents encountered by truck drivers in the Philippines. To analyze this problem, literature review, survey, ergonomic evaluation and statistical analyses were used to verify significance of each factors in the occupational risk of truck drivers. This paper had found that significant factors that affect the musculoskeletal disorder of truck drivers are age, BMI, blood pressure, travel duration, frequency of deployment and truck ban. On the other hand, significant factors that affect the severity of accident are work shift, type of truck driven, driver mood, type of roadway, road character and traffic condition. To further address the problem, health guidelines, traffic regulations and safety precautions were developed by the researchers in order to minimize the risk of musculoskeletal disorder and accidents of truck drivers in the Philippines.

Keywords
occupational risk, musculoskeletal disorders, truck accidents, predictive model

1. Introduction

Land Transportation Office (LTO) statistical data shows that a total of 266, 915 trucks widely populate the entire country of the Philippines while a part from those are about 2.3 Million Filipinos employed as drivers, truckers and truck helpers dependent to the said industry. Workers in the trucking industry experienced the most fatalities of all occupations, accounting for 12% of all worker deaths. About two-thirds of fatally injured truckers were involved in highway crashes. Truck drivers also had more non-fatal injuries than workers in any other occupation. Half of the non-fatal injuries were serious sprains and strains that may be attributed to the fact that many truck drivers must unload the goods they transport (OSHA, 2016).

There are several occupational risk factors that may affect the work performance of truck drivers that may lead to health issues. According to Copsey et al. (2011), road transport drivers are regularly exposed not only to the dangers of the road but to a broad range of hazards associated with both driving and non-driving tasks. One of these issues is

the driver's exposure to Musculoskeletal Disorders (MSD). MSD are injuries and disorders that affect the human body's movement or musculoskeletal system. Backman (1983) and Hedberg (1988) pointed out that truck drivers possess the highest prevalence of MSD among professional drivers. This is due to the fact that truck drivers are often exposed to vibration, prolonged sitting and other postural factors. Some are related to the actual driving task, traffic situation, individual variability and cabin layout.

In 2014, the Canadian Centre for Occupational Health and Safety (CCOHS) claimed that musculoskeletal disorders are mostly associated with work postures and movements, repetitiveness and pace of work, force of movement, vibration, temperature, workplace layout and monotonous tasks. And these mentioned risk factors may affect not only the health issues of the truck drivers but may also cause related road accidents.

Various researchers and health experts stated that truck driving is one of the most dangerous occupations in the world and also ranked as having the greatest number of injuries and illnesses (Boyd, 2003; Brown, 2002; Pegula 2004; Wiatrowski, 2005). In the Philippines, there is a 12.12% reported occupational accidents that occur in the transportation and storage industry (OSHA, 2012). As reported on August 2015 by the Philippine National Police - Highway Patrol Group (PNP-HPG), the number of persons died were 567 while 5,220 others were injured in 11,285 traffic accidents nationwide in the first half of the year 2015.

There are numerous studies and researches that have been conducted for occupational risk of truck drivers. And majority of these are focused on the prevalence of musculoskeletal disorders due factors related to work posture. However, exposure data are minimal. The effects of other variables such as health condition of drivers, work-condition, vehicle condition and road conditions have not been assessed. Moreover, these variables were not also considered yet as significant contributor to the occurrence of accidents for truck drivers. Based from review of related studies of the researches, there are various sub-factors that can affect the occupational risks of truck drivers in terms of musculoskeletal disorders and accidents. These factors can be categorized and grouped into 4 major factors: health condition, working condition, vehicle condition and road condition.

Thus, this paper intends to answer the question; What are the occupational risk factors that affect the prevalence of musculoskeletal disorders and accidents of truck drivers in the Philippines?

In order to determine the occupational risk factors in such a rational way, the study intends to identify the current condition of truck drivers in relation to 4 major factors mentioned in the study. Furthermore, the study aims to determine the significant factors and sub-factors affecting the occurrence of musculoskeletal disorder and accident using ergonomic tools and statistical analyses. The study also intends to develop a predictive model on the severity of musculoskeletal disorder and accident of truck drivers. And finally, the study proposes to develop a risk mitigation plan that will minimize if not eliminate the occupational risk factors affecting truck drivers in the Philippines.

2. Methods

2.1. Data Collection

The researchers conducted the study among different locations in Metro Manila and Bulacan, wherein large numbers of truck operations are pooled. The participants of the study include truck drivers, truck operators and truck helpers. A total of 300 participants were involved in the study including 220 truck drivers, 33 truck operators and 47 truck helpers.

To process and select the factors that will be considered in the predictive model, the following sequence of steps was performed. First, the researchers conducted a thorough investigation and analysis from previous researches and studies. Moreover, survey forms and questionnaires were administered in the study such as Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) and Nordic Musculoskeletal Questionnaire (NMQ). These tools were used to determine the discomfort location and common types of MSDs among truck drivers and were used to assess the frequency and extent of pain felt in each body segment. Next, an onsite observation was done in the study for Rapid Upper Limb Assessment (RULA) to investigate the exposure of the driver to ergonomic risk factors associated with work-related upper extremity MSD. The blood pressure of each of the respondents and body-mass index ratio were

also collected. All the data were gathered using the apparatuses, devices and instrumentation. And finally, frequency count and rubrics scaling was used to standardize the interpretation of the collected data.

2.2. Statistical Analysis

Descriptive measures were used to provide an analysis of summary of collected data. This helped the researches to come up with analysis and draw appropriate conclusions without bias. Collected data from survey, interview and observations were arranged in a manner of which the data can be easily interpreted through the use of frequency count and percentage distribution.

In addition, the gathered data for major factors and sub-factors considered in the study were statistically treated and analyzed using correlation analysis and multiple regression method. Correlation analysis was used to establish the possible connections between the major factors and sub-factors to the severity of MSDs and severity of accidents of truck drivers. Moreover, the significant factors identified were further analyzed using multiple regression analysis to identify the relationship of the predictors and how they affect the dependent variables identified in the study. Stepwise backward elimination procedure was also done to simplify the multiple regression equation formulated in the study. This technique was used to identify the true significant risk factors as predictors of the severity of MSDs and accidents of truck drivers. This helped in formulating the predictive model that will be used as basis for developing a risk mitigation plan.

Finally, risk mitigation plans on traffic rules and regulations and safety precautions were developed in the study in order to lessen the risk of truck drivers in getting involved with accidents. For the trucking companies, strict monitoring and control is recommended in order to minimize the risk of the drivers getting involved in an accident as well as maintaining healthy stature for truck drivers to be able to perform well in their driving task.

3. Results and Discussion

The table below shows the overall summary of results of the CMDQ from the 300 respondents and ranked from the highest to lowest percentage of risk.

Table. 1. CMDQ Score

Body Part	Ave. Discomfort Score	% Risk	Cumulative %
Upper back	3.42	21.55%	21.55%
Shoulder (right)	2.28	14.37%	35.92%
Lower back	1.99	12.52%	48.44%
Upper arm (right)	1.63	10.20%	58.64%
Neck	1.49	9.38%	68.02%
Hip/buttocks	1.06	6.64%	74.66%
Lower leg (right)	0.47	2.96%	77.62%
Thigh (left)	0.43	2.70%	80.32%
Shoulder (left)	0.42	2.67%	82.99%
Lower leg (left)	0.41	2.61%	85.60%
Forearm (right)	0.39	2.45%	88.05%
Knee (left)	0.38	2.42%	90.47%
Thigh (right)	0.34	2.16%	92.63%
Upper arm (left)	0.33	2.10%	94.73%
Wrist (right)	0.31	1.97%	96.70%
Knee (right)	0.27	1.72%	98.42%
Wrist (left)	0.16	1.02%	99.44%
Forearm (left)	0.09	0.57%	100.01%

Based from the results of CMDQ, the most affected parts of the body during driving are upper back, right shoulder, lower back, upper arm, neck, hips, right lower leg and left thigh. This is due to the sedentary work posture of truck drivers while driving and frequent use of the gearshift since most of the trucks are manually operated.

The researchers also classified the severity of discomfort experienced by truck drivers based on the CMDQ score as presented in the table below.

Table. 2. CMDQ Score Range and Severity of Discomfort per Body Part

Body Part	CMDQ Score Range and Severity of Discomfort					
	0 to 30 (Mild)	%	31 to 60 (Moderate)	%	61 to 90 (Severe)	%
Upper back	98	99%	1	1%	0	0%
Shoulder (right)	98	99%	0	0%	1	1%
Lower back	99	100%	0	0%	0	0%
Upper arm (right)	99	100%	0	0%	0	0%
Neck	98	99%	0	0%	1	1%
Hip/buttocks	99	100%	0	0%	0	0%
Lower leg (right)	99	100%	0	0%	0	0%
Thigh (left)	99	100%	0	0%	0	0%
Shoulder (left)	99	100%	0	0%	0	0%
Lower leg (left)	99	100%	0	0%	0	0%
Forearm (right)	99	100%	0	0%	0	0%
Knee (left)	99	100%	0	0%	0	0%
Thigh (right)	99	100%	0	0%	0	0%
Upper arm (left)	99	100%	0	0%	0	0%
Wrist (right)	99	100%	0	0%	0	0%
Knee (right)	99	100%	0	0%	0	0%
Wrist (left)	99	100%	0	0%	0	0%
Forearm (left)	99	100%	0	0%	0	0%

The results show that majority of the truck drivers experienced mild pain among their body parts. The classification of the severity of discomfort was set by the researchers as the scores per body part ranges from zero (0) to ninety (90). This was done in order to categorize how much discomfort the drivers have experienced from the previous week of their work.

The researches also evaluate the driving posture of the worker to determine the exposure of the truck drivers to risk factors associated with work-related upper limb disorders. In this study, the work posture of the drivers during the driving task was observed as shown in table below using Rapid Upper Limb Assessment (RULA) tool.

Figure 1: Truck driver driving posture

The figure above displays a sedentary work posture of the drivers wherein they work on a sitting position while their arms, hands, legs, and feet are involved in the task. From the survey conducted by the researchers, it is found that most companies deploy common brands and series of trucks which are the Mitsubishi Fuso, Isuzu Giga, Isuzu Elf, and Hino. These truck models are most common types used in trucking operations because of the reliability and availability of parts in case of repairs or upgrades. These trucks are operated with manual transmission; the gearshift is manually operated with a lever and with the help of a clutch pedal in order to increase or decrease the speed of the truck. This means that it involves more physical work for the arms and legs.

Among the truck models, it was observed that the design of the cockpit seat and the position of the mechanisms such as steering wheel, gearshift lever, and pedals (gas, break, and clutch) are not ergonomically designed since they are not fit for the anthropometric measurements of Filipino population. With this, RULA observation was conducted that represents the working posture of all the respondents regardless of truck models they drive. The results are presented on the figure below.

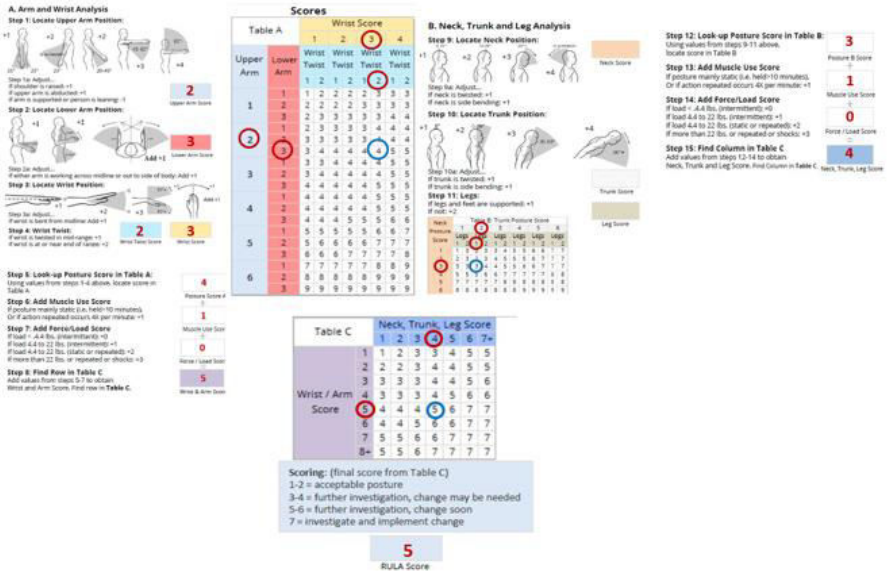

Figure 2: RULA Result

The result of the RULA indicated that the driving posture of drivers pose a medium risk to the truck drivers and needed further investigation to change the cockpit design soon.

All the data gathered from the initial assessment were used by the researchers to analyze the major factors and sub-factors that will be considered in the study to predict the severity of MSD and accident of truck drivers. The summary of the results is shown in the table below.

Table 3 Summary of Frequency Distribution and Rubrics Scale

Health Condition Factors			**Working Condition Factors**		
Age		**Rubrics Scale**	**Years of Driving Experience**		**Rubrics Scale**
Age below 30	25.30%	0	< 7	49.50%	1
Age 30 and above	74.70%	1	7 to 13	17.20%	2
BMI Category			14 to 20	8.10%	3
Underweight	0.00%	1	21 to 26	12.10%	4
Normal weight	57.60%	2	> 26	13.10%	5
Overweight	33.30%	3	**Work Shift**		
Obese	9.10%	4	Day shift	30%	0

Extremely obese	0.00%	5	Night shift	70%	1
Years of Smoking			**Ave. Frequency of Deployment**		
< 9	38%	1	1 time	0%	1
9 to 17	19%	2	2 times	0%	2
18 to 25	10%	3	3 times	42%	3
26 to 34	17%	4	4 times	22%	4
> 34	15%	5	5 or more times	35%	5
Blood Pressure of Drivers			**Training**		
Normal	59%	1	With training	21%	0
Prehypertension	19%	2	Without training	79%	1
Hypertension stg 1	16%	3	**Travel Duration**		
Hypertension stg 2	6%	4	0 to 2 hours	28%	1
Hypertensive crisis	0%	5	3 o 5 hours	24%	2
Vehicle Condition Factors			6 to 7 hours	19%	3
			8 to 10 hours	10%	4
Brand/Series			>= 11 hours	18%	5
Mitsubishi Fuso	58%	- na -	**Driver's Mood**		
Isuzu Giga	14%	- na -	Relaxed	45%	1
Isuzu Elf	24%	- na -	Cautious	35%	2
Hino	4%	- na -	Confident	12%	3
Others	0%	- na -	Risk taker	4%	4
Model Size and Capacity			Hot head	4%	5
Light	0%	1	**Drivers Involved in Accident**		
Medium	42%	2	Yes	49%	1
Heavy	58%	3	No	51%	0
Age of Truck			**Road Condition Factors**		
Below 15 years	25%	0			
15 years and above	75%	1	**Type of Roadway**		
Type of Truck			Intersection	6%	1
Trailer	34%	0	Multiple lanes	35%	2
Straight	66%	1	One-way	2%	3
Type of Maintenance			Two-way	57%	4
Preventive	36%	0	Others	0%	5
Breakdown	64%	1	**Road Character**		
Speed of Truck			Straight	45%	1
<20 kph	0%	1	Inclined	10%	2
20-39 kph	20%	2	Curved	33%	3
40-59 kph	57%	3	Inclined and Curved	12%	4
60-79 kph	18%	4	Others	0%	5
>=80 kph	4%	5	**Time of Day**		
Affected by Truck Ban			Morning	6%	1
No	26%	0	Noon	10%	2
Yes	74%	1	Afternoon	24%	3
Road Condition Factors			Evening	41%	4
			Midnight	18%	5

Road Lighting Condition			Traffic Condition		
Day light	39%	1	No vehicle	10%	1
Dawn light	2%	2	Light traffic	39%	2
Night with good lighting	22%	3	Moderate traffic	47%	3
Night with poor lighting	24%	4	Heavy traffic	4%	4
Night without light	12%	5	Stand still	0%	5
Road Condition			**Weather Condition**		
Dry	65%	1	Clear	49%	1
Wet	20%	2	Cloudy	18%	2
Uneven	6%	3	Drizzle	12%	3
Muddy	4%	4	Moderate rain	16%	4
Flooded	4%	5	Heavy rain	4%	5

The result of descriptive data for truck drivers indicated that for health condition factors; majority of the drivers are above 30 y/o, with normal weight, smoking for less than 9 years and with normal blood pressure level. Similarly, for working condition factors; majority of truck drivers only started working for less than 7 years, working in night shift, are deployed 3 times a day, received no formal training, driving on the average of 2 hours per shift, feel relax while driving and were already involved in an accident. Additionally, for vehicle condition factors: most of the trucks are Mitsubishi Fuso with heavy capacity, used for more than 15 years, straight type, only maintained after breakdown, running between 40-59 kph and affected by truck ban. And finally, for road condition factors: majority of the trucks are driven in a two-way and straight road during the evening, with daylight, in moderate traffic, in dry road and clear weather condition.

All major factors and sub-factors considered in the study were statistically treated using multiple regression and backward stepwise analysis. With the help of Minitab software, the significance and relationship of independent variables were determined and was used as the working equations for the basis in the interpretation of the impact of the independent variables to the dependent variable. In this study, the result of the CMDQ score was identified as the dependent variable for the severity of MSD while that of the fatality for the severity of accident. With the help of Minitab software, the researchers were able to determine the general equation for each of the predictive model of the severity of MSD as well as that of the severity of accident. The equation below represents the general predictive model for the severity of MSD.

Severity of MSD = -96.8 + 0.368*Age + 1.416*BMI – 0.191*Years of driving experience – 0.020*Years of smoking + 3.43*Blood pressure + 2.599*Most frequent continuous travel + 1.73*Work shift + 8.41*Ave. frequency of deployment + 2.11*Truck ban + 1.78*Training – 1.54*Type of truck + 0.189*Age of truck + 0.000024*Capacity – 0.64*Type of maintenance + 1.07*Vehicle condition

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The model summary for the multiple regression equation incurred an adjusted R^2 of 82.62% that gives a coefficient of correlation (R) value of 0.91 which means that all independent variables for the severity of MSD have strong relationship with the CMDQ score of truck drivers.

Meanwhile, the same analysis was done to determine the predictive model for the severity of accident. The equation below represents the general predictive model for the severity of accident.

Severity of Accident = 3.05 – 0.0114*Age + 0.0104*BMI – 0.0310*Years of driving experience – 0.0234*Years of smoking + 0.017*Blood pressure + 0.0221*Most frequent continuous travel – 0.571*Work shift - 0.198*Ave. frequency of deployment – 0.146*Truck ban – 0.463*Type of truck + 0.0065*Age of truck + 0.0000017*Capacity - 0.70*Type of maintenance – 0.040*Vehicle condition – 0.027*Training + 0.163*Driver mood – 0.066*Time of day + 0.1028*Weather condition – 0.070*Road condition – 0.145*Type of roadway + 0.232*Road character – 0.121*Road lighting condition – 0.234*Traffic condition + 0.146*Speed of truck

The model summary for the equation incurred an adjusted R^2 of 16.65% that gives a coefficient of correlation (R) value of 0.41. This means that all of the independent variables for the severity of accident have only moderate relationship with the severity of accident.

Similarly, to be able to identify the significant factors among the predictors on the severity of musculoskeletal disorders as well as severity of accidents, a backward elimination was done. Stepwise backward elimination was used in the exploratory stages of model building to identify a useful subset of predictors. The equation is shown below.

Severity of MSD = -83.0 + 0.230*Age + 1.410*BMI + 2.74*Blood Pressure + 2.523* Travel Duration + 7.40* Frequency of Deployment + 2.49*Truck Ban

The results of the analysis show that the identified significant factors for the severity of MSD that fall under personal factors are age, BMI and blood pressure; under working condition factors are travel duration, frequency of deployment and truck ban. The predictive model above resulted in the R value of 0.91 which shows that the considered significant factors have strong relationship with the dependent variable and are enough to affect the change in its value.

Meanwhile, the predictive model for the severity of accident using the same backward elimination process is shown below.

Severity of Accident = 2.010 – 0.207*Work shift – 0.451*Type of Truck + 0.0929*Driver Mood - 0.1589*Type of Roadway + 0.1220*Road Character – 0.0818*Traffic Condition

The results of the analysis show that the identified significant actors for the severity of accident that fall under physical working condition factors are work shift and driver's mood; under vehicle factors is the type of truck while under the road condition factors are type of roadway, road character, and traffic condition. The predictive model above resulted in the R value of 0.57 which implied that all of the considered significant factors have a strong relationship with the dependent variable.

In addition, the researchers validated if the values used in the analyses are normally distributed even after eliminating all the outliers. The figures (Figure 3 & 4) below show that the residuals for both MSD and accident are normally distributed and the points are randomly scattered around the line which indicates that there was no violation in terms of normality which is a requirement for multiple regression analysis.

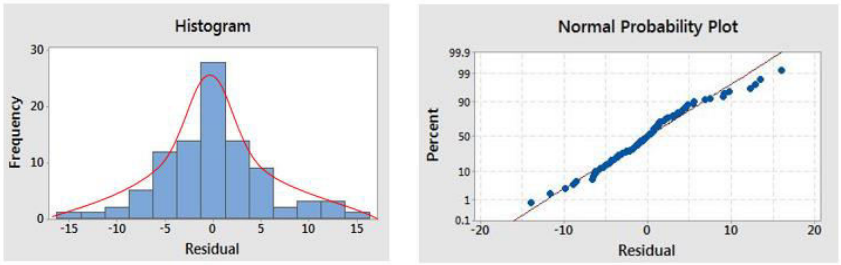

Figure 3: Normal Distribution and Probability of Residuals for MSD

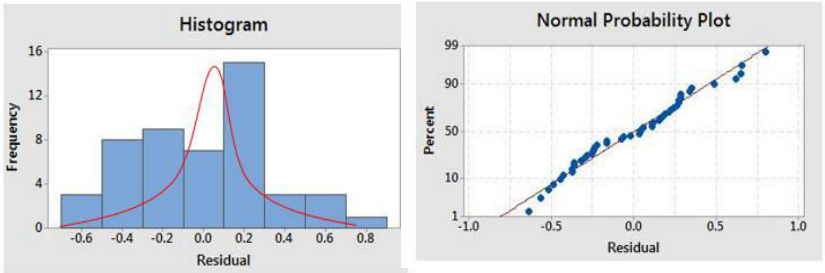

Figure 4: Normal Distribution and Probability of Residuals for Accident

3. 1. Ergonomic Assistive Tool for Truck Cockpit Design Specification

Based on observations on the actual truck seat (Figure 1) and from the interviews with the drivers, most seats differ from the other in terms of design, material, and adjustability; since most of the trucks used by most companies are pre-owned and most have been used in logistics operations for several years already. Most trucking companies acquire pre-owned or auctioned trucks since brand new ones are too costly. The owners opted having old trucks for as long as the vehicles can still run and load items for deliveries. However, the trucks being old have downsides especially from the preference of the drivers. This downsides compromise driver's comfort and performance of the vehicle. As such, the researchers proposed to redesign the truck seats for the convenience and comfort of the drivers. The specifications and details of the truck seat design are based from the analysis using Quality Function Deployment (QFD) tool. Below is the QFD diagram which shows the relationship of the customer requirements with the technical requirements.

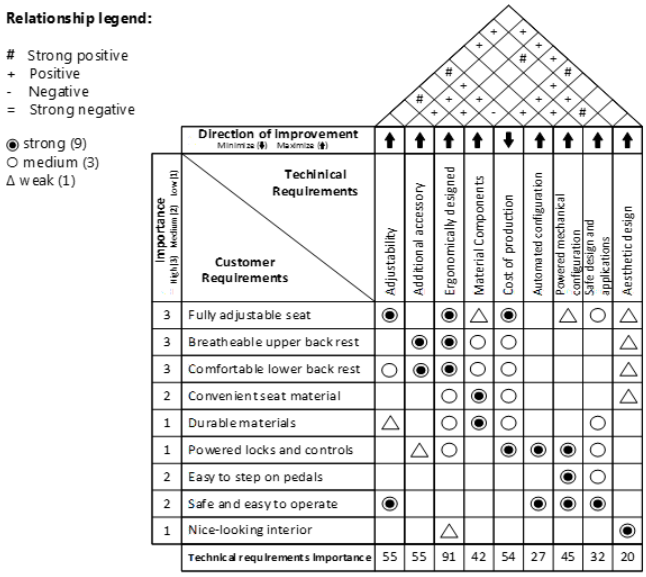

Figure 5. Quality Function Deployment (QFD) Result

In order to address the driver's preferences based on the importance as presented in the QFD, the researcher provided appropriate guidelines based from the three (3) highest ranking technical requirements. And based from ergonomic assessment, it was determined that the current driving posture of drivers pose an occupational risk of musculoskeletal disorder, and therefore, the researchers proposed a new truck seat design based from anthropometric measurement of truck drivers. Presented in the figure below, is the standard seat design that supports the driver's lumbar area, bolsters and spinal posture correction.

Figure 8. Recommended Truck Seat Design

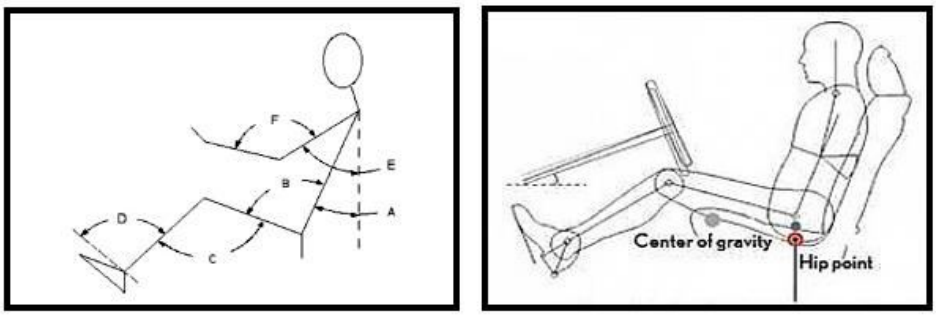

Figure 9. Ergonomic Consideration for Driving Position

Furthermore, the angle measurement of driving position was also emphasized on the study as shown in Table 5. Shown in Figure 9 is the important angles measurement and the corresponding value considered is presented in Table 5. H-point or hip-point is the theoretical, relative location of an occupant's hip, specifically the pivot point between the torso and upper leg portions of the body. It is said that the position of H-point must be as close as possible to the center of gravity. It is also suggested to use cushions to help ease back pain and alleviate hip pain and allow better circulation of blood in the legs.

Table 5. Angle Consideration for the Seat Design

Notation	Description	Value Considered
A	Back angle	15-20 degree
B	Thigh angle	90-95 degree
C	Knee angle	95-100 degree
D	Ankle angle	90-95 degree
E	Upper Arm angle	13-35 degree
F	Elbow angle	60-83 degree

3. 2. Recommendation for Deployment and Shift Schedule

As previously discussed in the study, it was concluded that prolonged driving of eight (8) hours or more increases the risk of occupational injuries. It can be observed that the age group of 40 and above were being deployed with an average continuous driving of eleven (11) hours per day within an average of three (3) days per week. It may imply that those drivers were entrusted to be assigned on farther locations because of their long years of experience in driving and handling the transport operations. Furthermore, most of the drivers among the respondents were affected by truck ban. This means that they were being deployed on night shifts. Since the trucking companies have different deployment schedule in their operations depending on the demand on the industry, the following are recommended: (i) assign two (2) drivers per truck in which the drivers take turns on driving for a maximum of four (4) hours each; (ii) provide a well-prepared schedule and inform the drivers of the nature of the deployment ahead of time; (iii) for drivers who will be assigned for long travel duration of at least eight (8) hours, provide the schedule with at least one (1) rest day before the deployment and (iv) encourage the drivers to take rest breaks every after about three (3) to four (4) hours of driving.

3.3 Recommendation for the Monitoring and Control of Health of Truck Drivers

Each employee is responsible for their own health and wellness especially when it comes to work condition that requires physical and mental strength. However, employers are also responsible for the welfare of their employees. In this study, the researchers propose programs that will promote health and wellness of truck drivers. These programs are encouraged to be applied by the trucking companies when deemed necessary such as (i) conduct of an annual physical examination for all drivers (ii) pre-check-up of blood pressure before deployment and drivers should not be deployed when found with high blood pressure (iii) preparation of appropriate schedules of deployment that impose more time to rest (iv) conduct of activities that will promote health and wellness for the drivers like regular

exercise program, health seminars and wellness trainings and (v) suggestion to change the food choices and menu choices for large truck stops.

4 Conclusion

The objectives of the study were all met with the use of tools and techniques relative to data gathering, analysis, and proposition of feasible solutions. Using a survey questionnaire, the researcher was able to gather information on the drivers' personal profile, working condition, and details on accident involvement. With this, it helped the proponent to identify the risk factors present in logistics operations. With the use of Cornell Musculoskeletal Discomfort Questionnaire, it was found that upper back (21.55%), followed by right shoulder (14.37%), lower back (12.52%), and right upper arm (10.20%) are the body parts of the drivers that are most exposed to musculoskeletal disorders. It was also found that 79% of the respondents did not have any proper training since they have engaged in driving profession. Hence, many were not practicing proper seating adjustment that may lead to discomfort and potential accidents. Furthermore, there were two (2) types of trucks used in logistics operations: straight truck and trailer truck, although may have same design of the cockpit but have different sizes and load capacities. Also, most of the trucks used in logistics operations were acquired from auction dealers or private owners hence, the trucks are old and 75% are 15 years and above.

Moreover, the number of drivers among the respondents who were involved in accident was also collected wherein 49% were involved, in which 4% of the severity were fatal, and that 67% were due to human factors. Accident sub factors were also collected in order to determine the significant predictors of the accidents.

With the use of ergonomic tools and techniques the researchers were able to determine the significant factors affecting the severity of musculoskeletal disorders and the severity of accidents. The final RULA score for the driving posture of the respondents pose medium risk to MSD that led the researchers to recommend an ergonomic truck seat based on the technical and customer requirements and anthropometric measurements of truck drivers.

Additionally, it was identified that personal factors, physical working condition factors, and vehicle factors appear to be good predictors to the severity of musculoskeletal disorders while vehicle factors and accident sub factors are significant to the severity of accidents. With the help of the Minitab software, it was determined that age, BMI (obesity), blood pressure, most frequent continuous travel, average frequency of deployment, and truck ban are significant factors affecting the severity of musculoskeletal disorders.

Meanwhile, the work shift, type of truck, driver mood, type of roadway, road character, and traffic condition were found to be significant factors to the severity of accident.

Since most of the drivers did not undergo proper training in driving profession, the researchers recommended that trucking companies must require their existing drivers and potential applicants to take the Driving (Articulated Vehicle) NC III offered by the Technical Education and Skills Development Authority (TESDA). With this, the drivers will be educated on restrictions codes, minor repairs on the assigned vehicle, and compliance with traffic rules/regulations and ordinances.

Relative to the training and development of the drivers, this study also provides guidelines on traffic regulations and safety precautions to minimize the risk of getting involved in accidents. As per the predictive model, the identified significant factors to the severity of accidents are the type of roadway and road character. From this, the researchers collected information in order to serve as guide for the drivers. This include the maximum allowable speed limit depending on the type of roadway, proper overtaking and passing, right of way and signals, proper turning at intersections, and being aware of blind spot.

By following these recommendations and guidelines, it is expected that the severity of musculoskeletal disorders as well as the severity of accidents will at least be minimized if not eliminated.

From the computation of the sample values from the actual data and comparing the results to the recommended target results, the researchers were able to show that the severity of accident show that the fatality from 2.86 (Fatal) was reduced to 1.09 (Non-fatal) under the circumstances that the drivers travel at night, using a straight truck, with a relaxed mood, on a two-way lane and straight road, and when on a standstill or unmoving position.

Furthermore, the researchers have validated the effect of the recommended truck seat, seat accessories, and ideal seat angle adjustment. From the initial assessment with the final score of five (5) which indicates a "medium risk, further investigation, change soon" level of MSD risk, the final score yielded in the post assessment has reduced to two (2) which indicates an acceptable posture or a negligible risk and no action is required.

Generally, the researchers therefore conclude that all of the objectives were satisfied with the help of appropriate tools despite the constraints on the conduct of this study.

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