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Effectiveness of Helmet in Two Wheeler using ANN Modelling

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Abstract:- Road safety is a major concern in all countries, and large efforts are constantly dedicated to create safer traffic environments. The use of helmet was deemed as one of the most effective ways to reduce the two wheeler accident fatalities. Tamil Nadu Government through legislation has promulgated a law for wearing the helmets for two wheel riders and seat belts for front seat users of car compulsory. In this study the feelings expressed by the commuters with respect to the use of helmet alone are studied in a scientific manner in order to bring out the true facts about the scenario.The study has been conducted at Chennai, capital of the State of Tamil Nadu. A sample of 550 questionnaires was collected for the analysis, which represents a homogeneous distribution of the population from the study area. The survey data were analyzed in order to bring out statistics about the present usage of the helmet among commuters. Nine variables were finally screened and selected for detailed analysis. Accident severity is a measure of the violence of crash. The present study focuses on this aspect also. A model has been developed using Artificial Neural Network (ANN) for predicting the intensity of severity of a crash. The analysis showed that compliance with helmet law was higher among young and above middle aged drivers. The results from the accident severity analysis show that, accident severity level mainly head injury is higher for those persons who were not wearing helmet during an accident

Keywords:- *Helmet; Injury severity; ANN; Head injury.*

I. INTRODUCTION

Personal lifestyle, behavior and the road conditions are associated with the leading causes of death in Chennai.Recently Central Government through legislation has promulgated a law for wearing the helmets for two wheel riders and seat belts for front seat users of car compulsory. There where lot of criticisms and comments from the public for and against these legislation. Some people feel that the law is for the good and others feel that is a sought of trouble to them. In this study the feelings expressed by the commuters with respect to the use of helmet are studied in a scientific manner in order to bring out the true facts about the situation.

Deaths due to unintentional injuries are ranked fifth among different causes of deaths, and motor vehiclecrashes are the leading cause of unintentional injuries. In addition, motor vehicle crashes are the leading cause of death among persons aged between 18 to 34 years. The economic impact due to highway crashes is enormous. Because of the impact of highway crashes, numerous efforts have been made to improve the safety of highway users. One of the remarkable steps in this regard is the introduction of seat belts in vehicles. It has been proven that helmet have saved many lives and prevented head injuries to occupants, and lakhs of rupees have been saved. Because of already existing benefits and potential benefits that could be achieved, many states have enactedlaws to increase the helmet usage among motorists

In the present study questionnaire surveys were conducted to access the usage of helmet among commuters and to bring out the fact as to its no usage. The data from the questionnaires were also analyzed in a step wise manner in order to bring out the most contributing subjective factors which influence an individual for the usage and non-usage of helmet. Nine variables were finally selected for detailed analysis. A model has been developed for predicting the head injury severity by way of the usage of with and without helmets.

- **Objectives of the study:**
  The objectives of the present study are:-
  - To find the public opinion towards the use of helmet.
  - To study the impact of legislation on helmet usage.
  - To find out whether there are any ill effects in using helmet under the present traffic scenario prevailing in the country.
  - To develop an ANN model to predict the different accident injury severity among drivers with and without usage of helmets.

II. DATA COLLECTION AND METHODOLOGY

In this study accident data was collected from the police records in order to access the effect of accident severity with and without the helmet usage. Data from January 2018- December 2018, January 2019- December 2019 and January 2020- December 2020 were collected from the city traffic police station. These details were used for the development of an accident severity prediction model. The category wise distribution of road accident shows that 46% were two wheeler accidents. Questionnaire survey was conducted to bring out the present statistics of helmet usage and the difficulties faced by the riders.

A. Data Collection

A questionnaire survey was conducted in Chennai city. A total of 550 questionnaires were collected for the analysis. The questionnaire contains the trip information as well as the personal information of the riders. For the ANN analysis two wheeler accident data were collected from the traffic police commissioner's office.

B. Study Methodology

- Artificial neural network:
  Neural networks have been applied very successfully in the identification and control of dynamic systems. The universal approximation capabilities of the multilayer perceptron make it a popular choice for modeling nonlinear systems and for implementing general-purpose nonlinear controllers.The neural network predictive controller that is implemented in the Neural Network Toolbox uses a neural network model of a nonlinear plant to predict future plant performance. The controller then calculates the control input that will optimize plant performance over a specified future time horizon. The first step in model predictive control is to determine the neural network plant model (system identification). Fig.1 shows the plant model used by the controller to predict future performance.

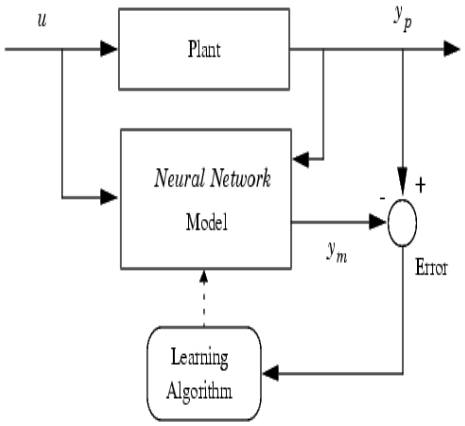

Fig. 1: Plant model used by the controller to predict future performance

III. ANALYSIS

Analysis of the sample yielded the following results. The sample consisted of 72%males and 28% females. The sex wise distribution of sample is shown in Fig .2.

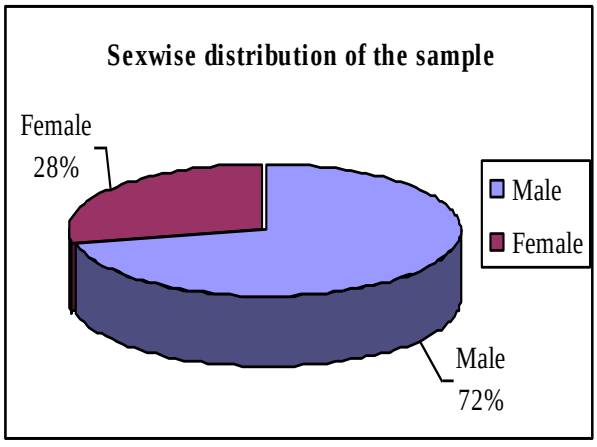

Fig. 2: Sex wise distribution of sample

From the total sample 83% 0f the respondents were daily commuters and the rest occasional riders. Fig.3 shows the distribution of type of riders.

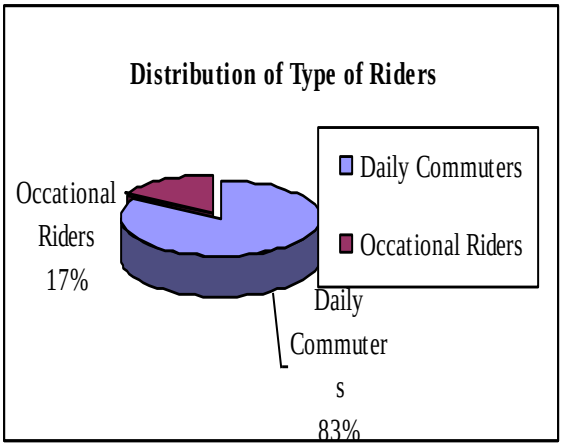

Fig. 3: Type of riders

The predominant purposes of trip made by the sample are as shown in Fig.4. It was found that majority of the trips were made for the purpose of work, followed by education, recreation, shopping and others.

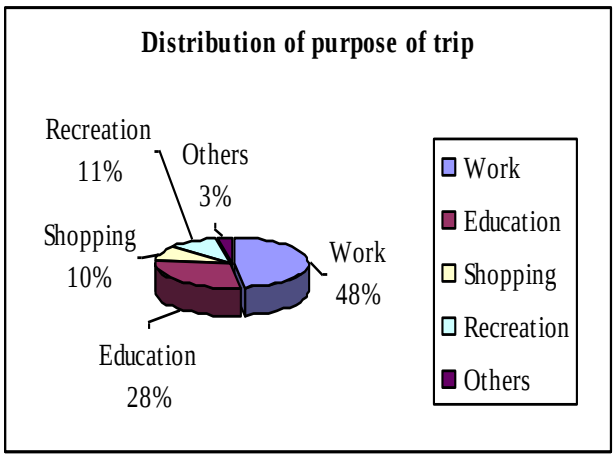

Fig. 4: Purposes of trip

A. Analysis On The Use of Helmets

Use of helmet was strictly enforced in Tamil Nadu from the year 2003. From the present questionnaire survey the percentage using helmet was found to be 72%, 28% of the respondents were not willing to use helmet because of hearing problem and vision restriction.

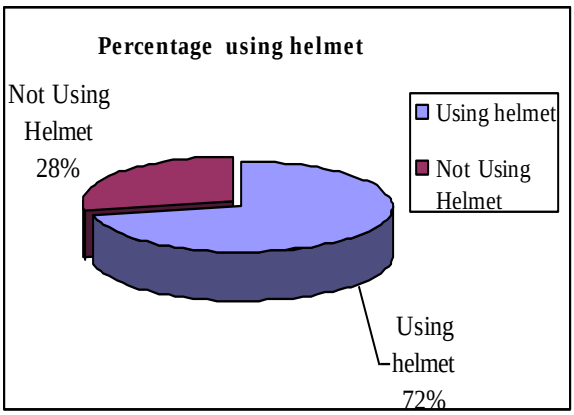

Fig. 5: Distribution on Helmet usage

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Variations in the percentage using helmets with respect to age, sex, employment status, purpose of trip, nature of trip, driving experience etc. were analysed. It was found that there was not much variation in the percentage with age, income, purpose of trip, driving experience etc. But the percentage using helmet was found to vary with gender, educational qualification, employment status, road type and marital status.

No	Variable description	Level description	Usage Rate (%)
1	Age	15-20 20-25 25-30 30-35 >35	85.0 0 71.61 69.00 71.68 80.84
2	Gender	Female Male	85.00 69.00
3	Educational qualification	Under graduate Graduate Post graduate	62.75 76.45 83.00
4	Employment status	Unemployed Employed Student	70.15 84.78 62.80
5	Income	<10000 10000-50000 >50000	66.00 79.14 72.73
6	Type of road	City street Rural roads Urban roads	86.00 57.74 79.33
7	Marital status	Married Unmarried	84.39 73.70
8	Purpose of trip	Work Education Recreation Shopping Others	74.63 69.00 71.00 62.97 66.63
9	Driving experience	<=1 1-5 5-10 10-15 15-20 20-25 25-30 >=30	77.00 79.76 73.00 74.79 69.59 71.46 73.33 70.58

Table 1: VARIATION IN HELMET USAGE FOR DIFFERENT VARIABLES

*Difficulties faced by helmet users***:** The common types of difficulties faced by the helmet users include

- Difficulty in hearing: About 97% of the helmet users complained about difficulties in hearing due to the use of helmet.
- Restricts the field of vision: The use of helmet restricts the field of vision. The problems encountered include difficulties in seeing towards the sides and seeing an overtaking vehicle. 91% complained about vision obstruction during bad weather like rain.
- Weight for the head: 72% of the respondents had a feeling of extra weight to the head due to the use of helmets.
- Pain in the neck: Another discomfort was pain to the neck both while using the helmet and later after removing it. 73% respondents complained about this defect.
- Loss of hair: About 51% experienced loss of hair on use of helmet.
- Difficulty to carry around: A large percentage experienced this difficulty. There is no lock provision in most of the helmets and vehicles too.

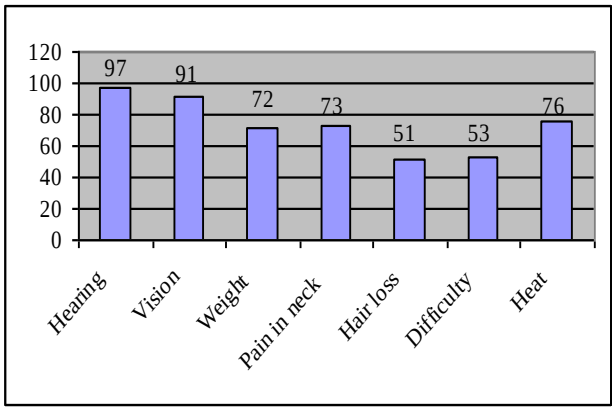

Fig. 6: Difficulties faced by helmet users

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About 29% of the respondents were of the opinion that the use of helmets led to higher speed. This was because they were not able to detect the increase in speed. Most of the two wheelers are reluctant to use helmets for night driving because of blurred vision due to on coming vehicle's head light.

B. Two wheeler accident analysis

From the total, 48% of the sample had met with accidents. The distribution of the percentage that had met with accidents is shown in Fig.7.

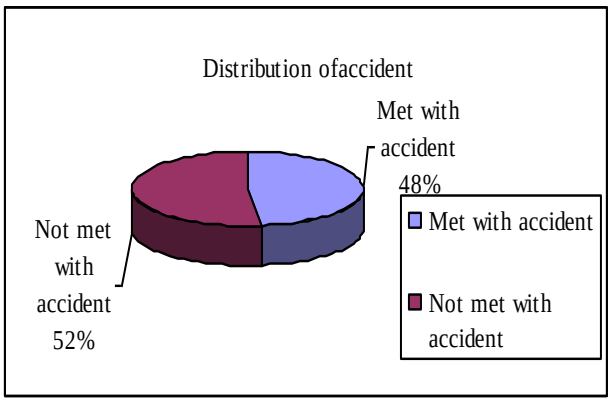

Fig. 7: Percentage met with accident

Majority of the accidents were minor accidents with injuries like fracture, dislocation, etc. Since the injuries were of minor nature, they believed that even if they had been wearing helmets, it would not have benefited them. From the total accident sample, 21% of those met with accident had suffered from head injury.

Of the victims of two wheeler accidents, 73% were riders and 28% were pillion riders. The split up of the victims into riders and pillion riders is shown in Fig.8.

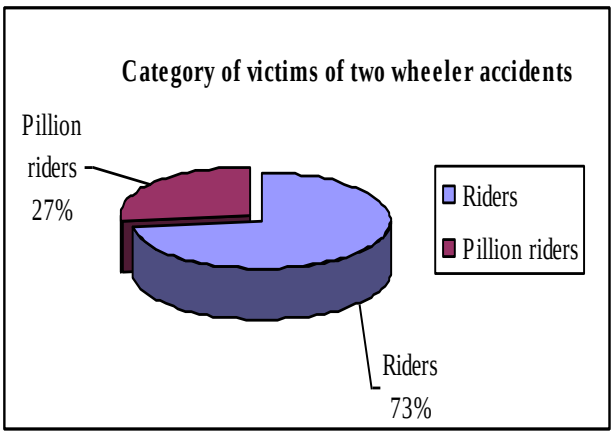

Fig. 8: Category of victims of two wheeler accidents

Analysis of the age groups of the victims showed that majority of the victims belonged to the age group of 20 – 30. The distribution of victims involved in the two wheeler accidents is shown in Fig.9

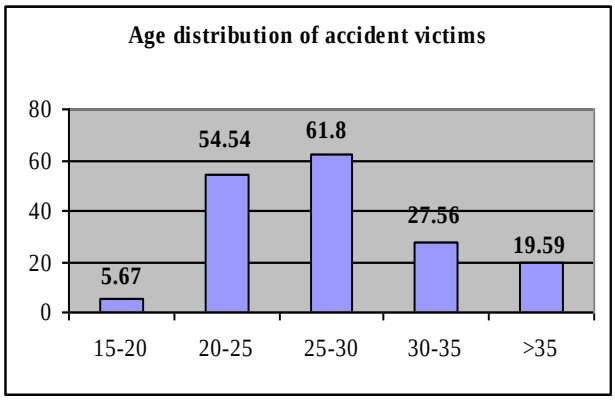

Fig. 9: Distribution of victims involved in two wheeler accidents

Males were more found to constitute a huge majority of the deaths due to wheeler accidents. They constituted 98.34% of the victims. The remaining 1.66% was females. The sex wise distribution of the accident victims is shown in Fig.10.

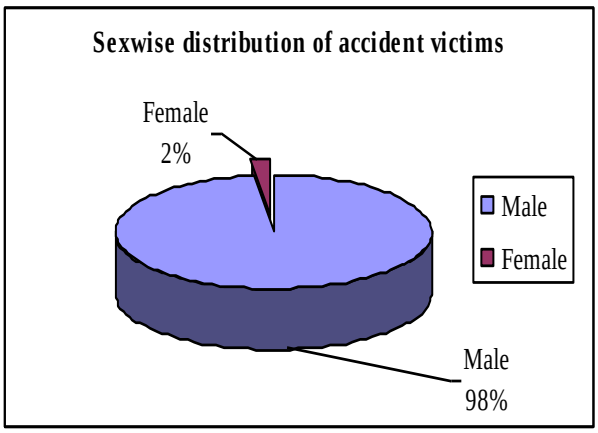

Fig. 10: Sex wise distribution of the accident victims

C. Head injury severity prediction model using ANN

The collected accident data was statistically analysed to evaluate the effect of the selected parameters on two wheeler accident severity. The relationship between the injury severity and various factors were also studied using Artificial Neural Network (ANN). The number of cases used for the process of learning of the neural network is 400 of which 340 cases were used for the training phase and 60 for the testing phase. Neural network was trained to map an input vector of dimensionality 9 in to an output vector of dimensionality one (i.e., a mapping problem from K9 to K1). The coding of input variables and output variable are described in TableII

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No.	Variable description	Level	Level description
1	Age	1 2 3 4 5	15-20 20-25 25-30 30-35 >35
2	Gender	0 1	Female Male
3	Time of accident occurrence	0 1	Off peak peak
4	Type of road	1 2 3	City street Rural roads Urban roads
5	Type of accident	1 2 3 4	Head on collision Rear end collision Skidding Side swipe
6	Vehicle speed	1 2 3 4	<=40 40-50 50-60 >60
7	Weather	1 2	Normal Rainy
8	Whether the helmet having BIS	0 1	No Yes
9	Wearing of helmet at the time of accident	0 1	Not use Use
10	Injury type	1 2 3 4	No injury Minor injury Head injury Maximum injury

Table 2: Data coding of input and output variables for ANN Analysi

D. A Layer of Neurons

The Neural Network Toolbox from the MATLAB library was used to train and test the MLP. The training algorithm used was the Levenberg-Marquardt algorithm. This training algorithm starts from an arbitrary set of interconnection weights that are randomly chosen from a uniform distribution of values between set as zero and one. Then, the algorithm tries to minimize the differences between the network output and the desired output. All runs have been carried out with a maximum number of epochs (a complete list presentation) of 100, and 0 mean squared errors as the global value. The input layer has 9 neurons that represent 9 different factors. The output layer has 1 neuron which represents the injury severity levels. All transfer functions at the hidden layer and the output layer are hyperbolic tangent sigmoid transfer function. This transfer function has the following form:

$$n\{1\} = net.IW\{1,1\}*p + net.b\{1\}; \quad (1)$$

Where net is the net input to a node, and a positive slope parameter that gives different looks for the sigmoid function. To select the number of hidden nodes, an experiment with different values of hidden nodes was carried out. Then, the number of hidden nodes was selected that gives the best network performance. The final model has 9 input nodes, one hidden layer with 5 hidden nodes, and 1 output node. The architecture of the network of the network is shown in Fig.11 Fig.12 shows results after training the network.

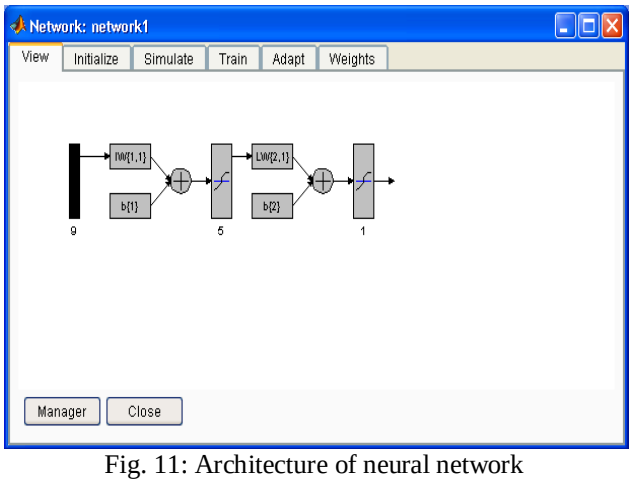

Fig. 11: Architecture of neural network

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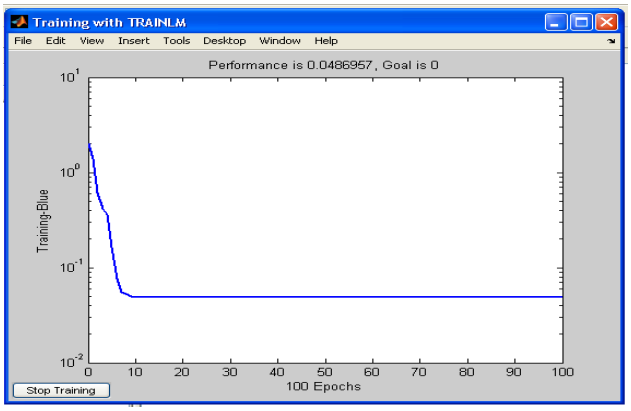

Fig. 12: Result of training the neural network

After giving all neuron layers train the network with and without initializing the weights and also fix the epochs. The output is obtained by fixing 100 epochs during training and also by initializing the weights. The obtained performance was 0.0486957.

No.	Observed accident severity (AIS)	Accident severity given by ANN	Wearing of helmet at the time of accident
1	2	2	Yes
2	2	2	No
3	1	1	Yes
4	**4**	**3.8889**	**No**
5	**3**	**3**	No
6	2	2	Yes
7	2	2	No
8	1	0.9999	Yes
9	**4**	**3.875**	**No**
10	1	1	Yes
11	2	2	Yes
12	**1**	**1**	No
13	**4**	**3.7778**	**No**
14	1	1	Yes
15	**3**	**3**	No
16	2	2	No
17	2	2	Yes
18	2	2	No
19	2	2	No
20	1	0.999	Yes
21	**4**	**3.875**	**No**
22	1	1	No
23	2	2	No
24	1	0.999	Yes
25	1	1	No

Table 3: Sample of observed accident severity and those given by ANN

E. Validation of algorithm

Validation of the algorithm was done and root mean square error between the observed and expected values were found out. For the validation twenty five hold out data sets were used. RMSE value was calculated by using the following equation.

$$\text{RMSE} = \sqrt{\left(\sum_{i=1}^{n}\left(O_i - E_i\right)^2 \Big/ n\right)} \quad (2)$$

Where,

RMSE – Root Mean Square Error Value
O_i – Observed accident severity
E_i - Expected accident severity
n – Number of data

RMSE value was observed as 0.007 which is very low and hence the developed model is valid.

IV. SUMMARY AND CONCLUSION

In the present analysis it was seen that the accident severity level is higher for the persons those who are not wearing the helmet at the time of accident. So by giving proper guidance and enforcement accident severity can be reduced up to a certain level. ANN models developed in this study can be used for predicting the injury severity levels by giving the selected input variables.From the study the following conclusions were drawn:-

- About 60% of the public are reluctant to use helmets.
- The percentage using helmets was found to vary with gender, educational qualification, employment status, road type and marital status.
- The major difficulties faced by the helmet users include problem in hearing, restricting the field of vision, weight to the head, and difficulty in carrying around.
- From the ANN analysis,head injury severity level was found to be higher for the persons who are not wearing the helmet at the time of accident and this trained model can be used for predicting the head injury severity level.

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