A TRUCK TIRES USAGE WORTHINESS PREDICTION MODEL

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ABSTRACT

In business, the transport system cost is a significant part of business operation cost. In the transportation system, there are many variables in this research that will refer to the factor of truck tires used in transportation. This research created a model for worthiness prediction of truck tire usage in terms of distance and lifetime by using Artificial Neural Networks and Linear Regression. The accuracy of the predictions from the distance of truck tires by the Artificial Neural Network was 99.63% and lifetime was 99.54% with the same sample model. The results of the two models could be integrated for further worthiness business plan.

KEY WORDS: TRUCK TIRES / WORTHINESS PREDICTION MODEL / DISTANCE LIFETIME

34 pages

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บทคัดย่อ

ในปัจจุบันธุรกิจต่างๆ ระบบขนส่งเป็นหนึ่งในต้นทุนในการดำเนินธุรกิจการลดต้นทุนจะก่อให้เกิดความคุ้มค่าในการดำเนินธุรกิจในระบบขนส่งมีปัจจัยต่างๆมากมายซึ่งในงานวิจัยฉบับนี้จะกล่าวถึงปัจจัยของยางรถบรรทุกที่ใช้ในการขนส่ง ในการสร้างแบบจำลองสำหรับการทำนายความคุ้มค่าการใช้งานยางรถบรรทุกในแง่ของระยะทางการใช้งาน กับระยะเวลาของอายุยางโดยใช้วิธีโครงข่ายประสาทเทียม(Artificial Neural Network)และ การถอดถอยเชิงเส้น(Linear Regression)ในการทำนายความคุ้มค่าความแม่นยำในการทำนายจากมุมมองระยะการใช้งานยางรถบรรทุกด้วยวิธีโครงข่ายประสาทเทียมจะได้ 99.63% และ มุมมองเรื่องอายุยางจะได้ 99.54% ด้วย แบบจำลองเดียวกัน ซึ่งจากการทดลองเป็นวิธีที่ดีที่สุดที่ค่าความแม่นยำสูงสุดจากนั้นแบบจำลองทั้ง 2 ส่วนจะถูกนำมาทำบูรณาการเพื่อหาความคุ้มค่าเพื่อนำไปวางแผนในการดำเนินธุรกิจต่อไป

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CHAPTER I
INTRODUCTION

1.1 Background and statement of problems

Today, that is driving a business. The transport system implements plane terms of added drive to every business. The costof transport and logistics infrastructure are affected the organization. The transportation system impacts on business operation to relate.The cost of truck tire is a cost of doing business.

Businesses have a price and quality in competition control. The manufacturer has made continuous improvement. To allow, owner uses operators and achieve maximum value from their applications.Factors aredistance and lifetime of tires attributed to use it.This has studied research applications which caused worthwhile.So this research has studied the worthy of deployment truck tires.

From the study of the problem of truck tires, the need of factors is divided to two dimensions which are distance and lifetime for the most effective worth.The statistic collection and problems of working by data mining create the two-dimension model.Bring the result for a model's integration to evaluate the worthiness of real work and new knowledge for development of the research.

1.2 The objective of research

To develop the prediction model of truck tire and integrated model usage worthiness in two aspects: distance and lifetime.

1.3 Scope of Research

1. Usage data tries for distance and lifetime on database from logistic company.

2. Establish rules for worthiness prediction of tire distance and lifetime using classification data mining techniques.

1.4 The expected benefits

The benefit of the worthiness prediction of this research is to plan the most effectivetruck tires maintenance.

CHAPTER II
THEORY AND RELATED WORKS

This research will determine the worthiness prediction from the actual data used tires in the database. To assist is deciding on the choice of tires to suit your business.

2.1 Factors that affect truck tire usage

Tires are the most important part that makes the car move.The tire is the only car parts that touch the road.So when it uses infrequently that would wear and tear.If tirefrom use of drivers each a different way. How use maintenance critical on base.Which other factor that affects the wear is as follows [1].

1. Tire Pressure

Inflate tire weaker than the shorter sidewall tires made of old tires to overheat and deteriorate faster than other parts.This causes burns tire and structure of rubberdissociated from each other which will lead to swollen and burst of cuticles tires.It could result tire sidewall tirestear or broken, and also supplies fuel well in additional.

Tirepressure too much was bad either.Because the tangent space of tire and the road surface is reduced.When slipping easily and tire potentially explosive Easy to shock.That tire was spiking to expand fully flexible, low lifetimediminish.The treads are worn in middle than the rest.While driving dropped make softness

2. Payload

Conveyance overloaded a twisting area tire touches road surface lot.That heat easily as a result there, then wear of tire quickly.It will shorten their lifetime.

3. Speed

While the car is running at high speed there is friction and heat too. This makes affect wear resistance and the age of tire dropped down.

4. Braking and Start

The trucks are inertia on the road, which is higher than the speed. So when brake until the wheel stops spinning and inertia of the car to push. The wheel is slipping on the road surface, making tire wear.Which are depending on the speed and brake. Most of the violence makes the wheel spin. Front tire friction on road surface, then so hard tires wear faster.

5. State of Car

Such as the suspension and wheels have a dramatic effect on tire wear fast.If the system is faulty wheel to the specification of the car will cause friction and slipping the front tire than usual.

6. State of Road

The road surface is very smooth, then tiring wear will be even slower to use than driving on rough roads.The rolling smooth is resistance less than tire friction with the road surface, then move forward with a force less on the road.Also features path is taken effect as well. Drive on the right to wear slower than driving uphill, then driving on a winding road.

7. Weather

Tires are the main ingredient as natural rubber. It is resistant to high temperatures than synthetic resin.It will affect the wear faster so applications. If tire heat up.

2.2 Lifetime of tires

Usually, the lifetime of tires starts has since been deployed.After the tires to the wheels fitted to the vehicle and bring it to run applications.This tire will be warranty by the manufacturers every line.The details and conditions have from manual warranty [2].

The age of the tire is depending important on your active.It is a long and safe allowing for use.It is recommended to maintain correct tire.

For safety and extends are the lifetime usage along time.Thatshould increase attention more tires.And the choice of tires is reasonably correct.

2.3 Data Mining

Data Mining is a process that dealt with large amounts of data to find patterns and relationships then hidden in the data set.Currently, data mining has been applied in several categories both business to assist in management decisions, science and medicine, including the economy and society.Data mining is virtual the evolution of storage and interpretation of data.From the original data is store data simple into store in the database model.The Information Technology used to fetch data mining to discover knowledge hidden in the data.

The flow of the process shows the project non-stop data mining solution, particularly when is active.The results of data mining to new business questions, which can adopted to develop a model Figure 2.1.

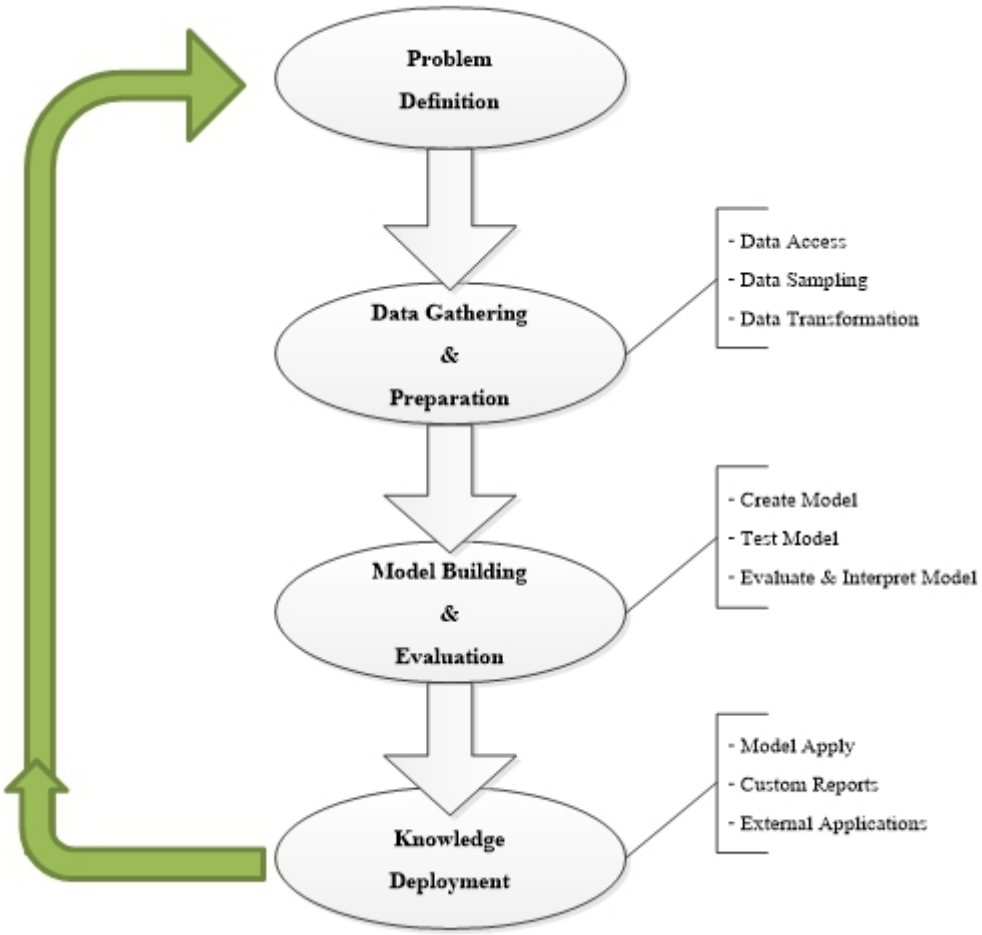

Figure 2.1 Data Mining Fundamental.

1. Problem Definition

The first phase of a data mining project is that focuses on understanding the project objectives and requirements. When you have identified a project from a business perspective, you can determine that is data mining and development plans, preliminary.

For example, that business issues you might have. The model predicts are most likely used to be created with data that describes the use of the product in the recent past. Before creating the form, you will need to gather data that is likely to be a relationship between those who use the product and unprocessed usage.

2. Data Gathering and Preparation

The process of data understanding is associated with the data collection and surveys. As you take a closer at look from the data, you can determine how to better it is a business issue. You might decide to remove some of the data or add additional. This is also the time to identify data quality issues and to scan for data patterns.

The process of preparing data includes all the tasks associated with creating a table if you will use in modeling. Data preparation tasks are likely to be performed multiple times, and not in any prescribed order. The schedule is for the selection of cases and attributes, as well as cleaning and changing data. Additionally you might add new computed attributes in an effort to tease information closer to the surface of the data. For example, rather than using the purchase amount, you might create a new attribute.

3. Model Building and Evaluation

This phase, you can select and use a variety of techniques for creating models and parameter adjustment of the best. If steps are required to transform the data you must step back to the past to implement them. It often makes sense to work with a reduced set of data in preliminary model building. In the process of this project, it is time to assess whether the scheme in line with business goals originally-stated. The model would be improved by adding text data. Then should transactional data such as purchases be included. That costs associated with false positives or false negatives are included in the model.

4. Knowledge Deployment

Knowledge deployment is the use of data mining within a target environment. In the process of deployment insight and actionable data will be obtained from data usage that can apply the new data model, or the integration of data mining models within applications, data warehouse infrastructure, or query and reporting tools. Scoring in real time: Data can be mined and the results returned within a single database transaction. For example, users can use a model that predicts the probability of damage in the context of doing business.

2.4 Neural network

The back propagation algorithm [3] performs learning on a multilayer feed-forward neural network. A multilayer feed-forward neural network consists of an input layer, one or more hidden layers, and an output layer. An example of a multilayer feed-forward network. Each layer is made up of units. These inputs pass through the input layer and are then weighted and fed simultaneously to a second layer, known as a hidden layer. The outputs of the hidden layer units can be input to another hidden layer, and so on. The number of hidden layers is arbitrary, although in practice, usually only one is used. The units in the input layer are called input units. The units in the hidden layers and output layer are sometimes referred, due to their symbolic biological basis, or as output units shown in Figure 2.2.

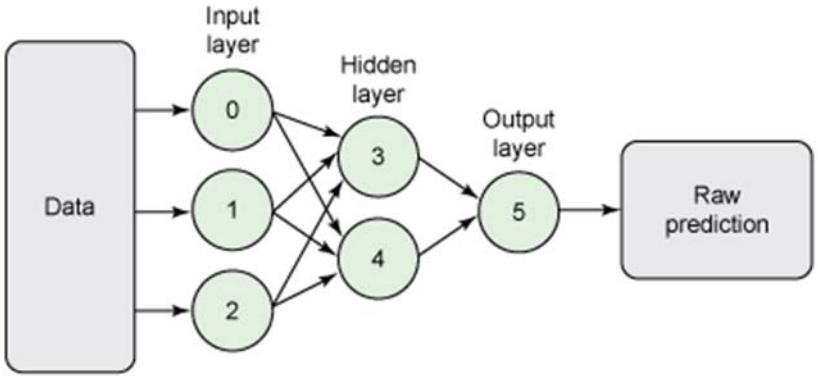

Figure 2.2 Driagram Work flow MLP Model.

The perceptron algorithm is a type of The Artificial Neural Network [4]. The perceptron used in any machine. The Artificial Neural Network has many layers (a single layer called perceptron). Perceptron is an algorithm to classifier. Perceptron could to learning linearly separable patterns. Single layer perceptron has artificial neurons or nerve cell. It can input values sent to output values by a set of weight (see Figure 2.3). Therefore, it is a basic feed forward network. Perceptron can apply with activation function. This could be called McCulloch-Pitts neurons or threshold neurons.

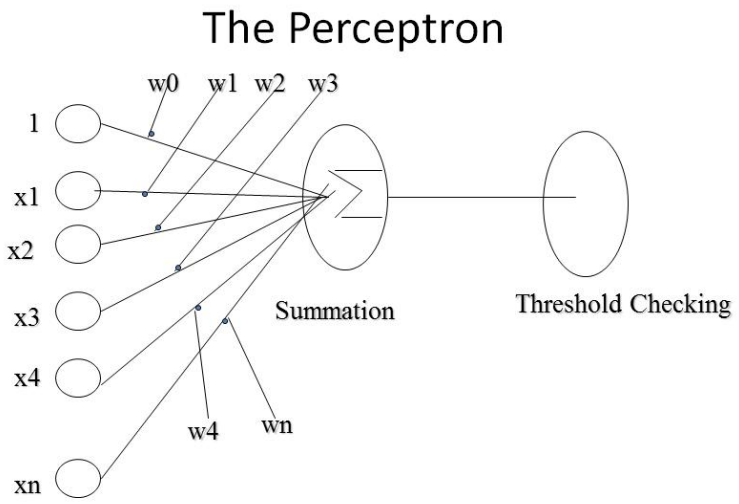

Figure 2.3 Process Hidden Node MLP Model to Output.

2.5 Regression

Straight-line regression analysis involves a response variable [5], y, and a single predictor variable, x. It is the simplest form of regression, and models y as a linear function of x. That is,

$$y = w_0 + w_1 x:$$

These coefficients can be solved for by the method of least squares, which estimates the best-fitting straight line as the one that minimizes the error between the

actual data and the estimate of the line (see Fig. 2.4). Let D be a training set consisting of values of predictor variable, x, for some population and their associated values for response variable, y. The training set contains jD_jdata points of the form(x_1, y_1), (x_2, y_2),: : : , (x_jD_j, y_jD_j).12 The regression coefficients can be estimated using this method with the following equations:

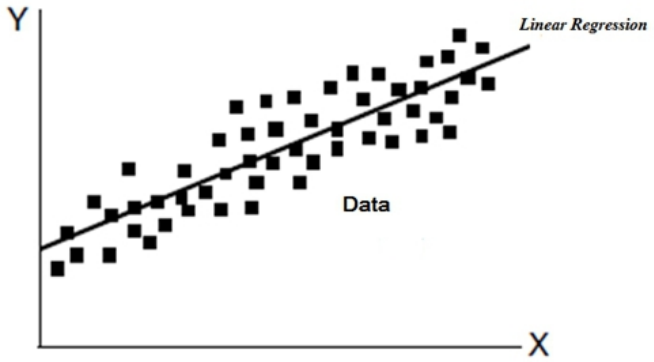

Figure 2.4 Linear Regression.

2.6 Related works

Researchers have studied the literature review and related works. The details as follows:

Al-Garni, Jamal, Ahmad and Tozan [6].For this purpose ANN model using back-propagation algorithm feeds forward while learning. The rules were developed in a certain narrow context. The results that the ANN predicts the failure rate better than the Weibull regression. A comparative study shows that the three input ANN model performs much better with lesser percentage error from the actual data than the two and one input models, and six intermediate neurons give much reasonable accuracy than lesser number of intermediate neurons as also verified by visual inspection. In the present study, both the flying time and the number of landings are used as indicators of operational lifetime of tires. Different is using variables in the distance used truck tires and lifetime, tire to use for research. The variables used to determine worth. There is extensive research documenting its safety profile. This paper is an overview of failure

rate for Boeing 737 tires that can be applied Data Mining. This researchhas adopted the applied ANN model using back-propagation algorithm feeds forward while learning.

Ahmed Z. Al-Garni et al., [7] model for predicting the failure rate of De Havilland Dash-8 airplane tires. The inputs to the neural network are independent variables and the output is the failure rate of the tires. Six years of data are used for model building and validation. The average percentage difference of the failure rate with that of the actual data is found to be 19.84%, 8.56% and 5.66% for neural networks having one, two and three inputs, respectively. Moreover, with informal visual Applications of us focused improved operating range rather than live there. It is worthwhile to use standard to reduce accidents involving truck tires. This paper is divided into several clusters as above, and classification the rule by using several algorithms, including The Artificial Neural network, Weibull Regression model. The most accuracy of the result has used ANNs for estimation or prediction of the problem for this algorithm. A truck tired usage prediction model has adopted to apply to this paper by using Regression model.

Factors wear of tires usage the distances, it is percussion of the tires on road. Jadranko Matusko et al., [8] tire/road friction force estimation. The main purpose of the simulation experiment was validation of the estimator robustness to changes of the friction model parameters. Four parameters of the friction model were changed. This research indicates the standard in the engineering design wear of the tires for use. Production used as a benchmark in automotive design. Entrepreneurs can choose tires for worthiness. This paper offers a novel approach by dividing tire/road friction force estimation. In devastated by the use of tires, which is a standard that indicates the over time to change the tire. But our research, the structure of the truck tire is different from the research.

A research study has model of the tire manufacturer's guarantee lifetime, tire at age 4 years. Krivtsov [9] Regression approach to tire reliability analysis. The paper considers how empirical analysis of the root causes you some type of tire failure. Lifetime can get information from laboratory tests that have been developed to repeat the failures the field. A number of parameters related to tire geometry and physical properties. This research used the weight of the tires and tire temperatures to

determine the lifetime. The result indicates the quality of the tires that has good quality as a result. Their lifetime is a variable that used, it is worth the distance. That is the choice of tires to the maximum worth of the distance. This research adds variables tire manufacturer guarantee lifetime. That is variables determine the worth use duration. When adding variables for determination it considered that the core patients and can be applied for a research about implementing the Regression approach match business requirements.

CHAPTER III
METHODLOGY

3.1 The steps of the research process

In this paper, we apply the data mining techniques to the database of trucks tires worthiness. The steps of the research process are as follows as show in Figure 3.1.

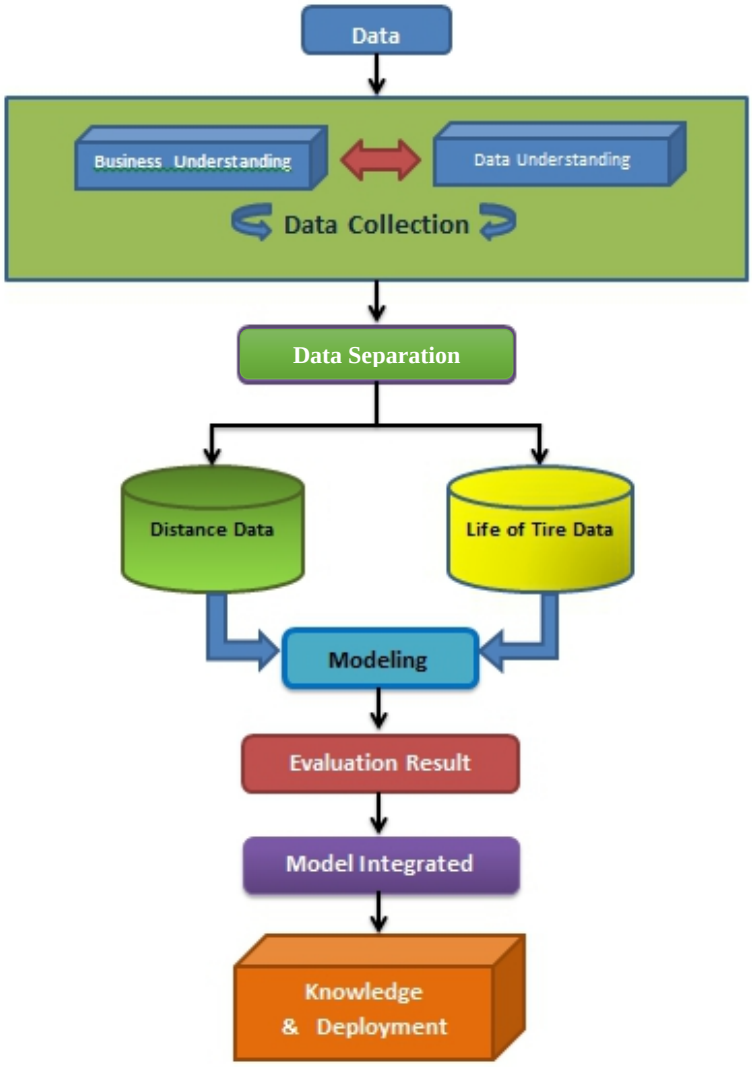

Figure 3.1 Research Methodlogy.

3.1.1 Data & Data Collection

Select related dataset to be used in case study of data mining. After making a selection data (Figure 3.2.), then process of data preprocessing for data mining is important step. Data preprocessing is Eliminate irrelevant data, for example data integration, data transformation, data reduction and so on. Data preparation is help optimize also affect the precision and accuracy in the processing.

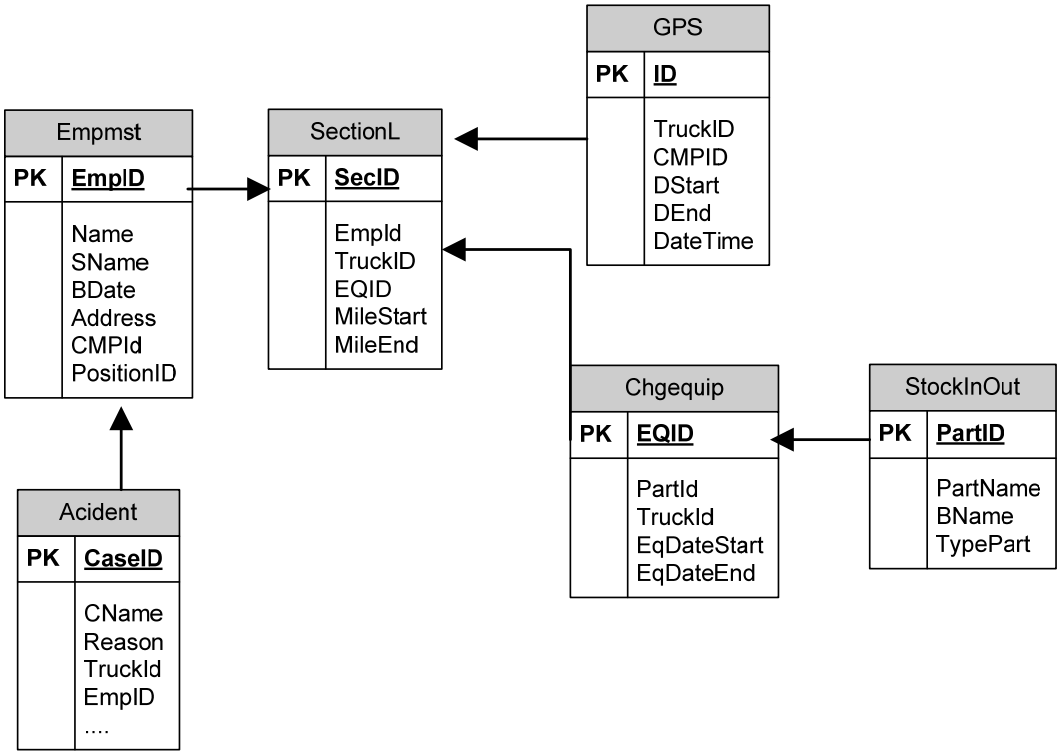

Figure 3.2 Data ER Diagram.

Data collection is irrelevant data, such as data integration eliminates, data reduction and other changes (Figure 3.3). The subject of maintenance have replacement truck tire on set, problem of the quality of tires and tire-related accidents. The variables data is the distance and lifetime of truck tire usage, as show in Table 3.1

Data Section	Attribute	Data Criteria	Detail
Distance of Trucks :	*DistanceU*	Numerical Km.	Distance Use Start to End
	CompanyU	10 Type	Company Of Use Tires
	UseL	168 - 944 Km.	Long Distance Use Tire
	UseS	5.9 - 159 Km.	Short Distance Use Tire
Life of Tire :	*NTire*	23 Type	Version Of Type from Band Tires
	TTire	T1,T2 and T3	Characteristics of Tires
	FTire	F1 and F2	Tires tread pattern
	BTire	7 Type	Band Of Use Tires
	ATire	Day	Day Of Use
	ETire	A1,C1,E1	Reason for Change

Figure 3.3 Data selection of distance and lifetime.

1. Business Understanding

By the study of the transportation business, that relate various to associated data and reasons driver, characteristics of tire and other systems. That is both associate with business worthy. Which are able to choose related data, analyze for the new knowledge and all of them remain to be further develop.

2. Data Understanding

The data collection relate to the cost of use truck tires. That about the issues, Compare the distance with the life of the tires. For deployment of the company tell the distance (near – far).Which is a measure of the worth for the truck tires. And also data are regarded characteristics of the driver. That could be an indicator in terms of usage as well.

Table 3.1 Preprocessing Data for usage.

NTire	ETire	CompanyU	- - - -	ATire	DistanceU
EMR1000A	E1	GSTEEL		1895	115375
MLXDE1000R	E1	GSTEEL		1456	213010
VT1000R	A1	SG		1266	244805
MLXDE1000R	E1	GSTEEL		1266	244805
VT1000	E1	GSTEEL		1379	111550
VT1000	A1	GSTEEL		1360	48809
MLXZE1000R	E1	GSTEEL		1327	249403
VT1000R	A1	TNC/TSL		1327	249403
MLXZE1000R	E1	BST		1400	224090
EMR1000A	E1	TNC/TSL		1400	115375
⋮	⋮	⋮		⋮	⋮

3.1.2 Data Saturation

From the data, that has choose for research. Then choose the database in a transportation system from the GPS system. There are total distance data and the tire truck take off in 2012.The features include the problem of different types of tire characteristics related to the drivers. The data will be divided into two parts by the distance and lifetime as show in Table 3.2.

Table 3.2 Data from database in company.

Tire Serial	Reason Problem	Face Tire	Band Tire	Tread Tire	Company Use	Short Distance	Long Distance	Old EMP	Distance Use	Life of Tire
EMR1000A	E1	T1	SIA	TC1	GSTEEL	6	318	33	115375	1895
MLXDE1000R	E1	T3	MIL	TC2	GSTEEL	6	318	53	213010	1456
VT1000R	A1	T2	OTH	TC2	SG	17.4	168	52	244805	1266
MLXDE1000R	E1	T3	MIL	TC2	GSTEEL	6	318	53	244805	1266
VT1000	E1	T1	OTH	TC1	GSTEEL	6	318	47	111550	1379
VT1000	A1	T1	OTH	TC1	GSTEEL	6	318	31	48809	1360
MLXZE1000R	E1	T3	MIL	TC2	GSTEEL	6	318	30	249403	1327
VT1000R	A1	T2	OTH	TC2	TNC/TSL	42.7	944	47	249403	1327
MLXZE1000R	E1	T3	MIL	TC2	BST	89.7	352	50	224090	1400
VT1000R	A1	T2	OTH	TC2	TNC/TSL	42.7	944	46	224090	1400
VT1000	A1	T1	OTH	TC1	MIX	35	355	53	8349	1231
VT1000	A1	T1	OTH	TC1	MIX	35	355	53	8349	1231
VT1000R	A1	T2	OTH	TC2	SG	17.4	168	39	218928	1179
MLXZY1000R	E1	T3	MIL	TC2	SG	17.4	168	41	218928	1179
MLXDE1000R	A1	T3	MIL	TC2	GSTEEL	6	318	54	218214	1159
MLXDE1000R	A1	T3	MIL	TC2	GSTEEL	6	318	54	218214	1159
MLXZY1000R	E1	T3	MIL	TC2	SG	17.4	168	43	176551	1174
MLXDE1000R	A1	T3	MIL	TC2	SG	17.4	168	47	231607	1158
MLXDE1000R	E1	T3	MIL	TC2	SG	17.4	168	47	224731	1299

The data are divide the distance that standard can usage at 120000 km. and standard differential usage a data from the manufacturer to the average by user as show in Table 3.3.

Table 3.3 Preprocessing selection for distance

NTire	ETire	TTire	BandTire	FTire	UseCompany	DistanceS	DistanceL	OldEmp	Distance
VT1000R	E1	T2	OTH	TC2	TNC/TSL	42.7	944	42	0.012373333
VT1000R	E1	T2	OTH	TC2	TNC/TSL	42.7	944	42	0.012373333
MLXDE1000R	A1	T3	MIL	TC2	SUS	5.9	205	39	0.013946667
VT1000R	C1	T2	OTH	TC2	SG	17.4	168	55	0.014166667
MLXZY1000R	E1	T3	MIL	TC2	SG	17.4	168	55	0.014166667
MLXZY1000R	E1	T3	MIL	TC2	SG	17.4	168	55	0.014166667
MLXZY1000R	E1	T3	MIL	TC2	SG	17.4	168	55	0.014166667
MLXZY1000R	E1	T3	MIL	TC2	SG	17.4	168	55	0.014166667
MLXZY1000R	E1	T3	MIL	TC2	SG	17.4	168	55	0.014166667
MLXZY1000R	E1	T3	MIL	TC2	SG	17.4	168	55	0.014166667
MLXDE1000R	A1	T3	MIL	TC2	STP	159	208	37	0.016253333
MLXDE1000R	A1	T3	MIL	TC2	STP	159	208	37	0.016253333
MLXMULTI 11R22.5	A1	T3	MIL	TC2	TNC/TSL	42.7	944	34	0.019293333
AS1000B	A1	T1	SIA	TC1	MIX	35	355	58	0.0218
AS1000B	A1	T1	SIA	TC1	MIX	35	355	58	0.0218

The other data have a choice the life of the tire. From a lifetime of Average at the factories is schedule to use not more than four years. But the tread is critical in determining of life, which relates to range of use as show in Table 3.4.

Table 3.4 Preprocessing selection for life of tire

NTire	ETire	TTire	BandTire	FTire	UseCompany	DistanceS	DistanceL	OldEmp	Life Tire
VT1000	A1	T1	OTH	TC1	MIX	35	355	55	0.145205479
VT1000	A1	T1	OTH	TC1	MIX	35	355	55	0.893835616
EMR1000A	E1	T1	SIA	TC1	GSTEEL	6	318	44	0.578767123
VT1000	A1	T1	OTH	TC1	MIX	35	355	55	0.578767123
EMR1000A	E1	T1	SIA	TC1	GSTEEL	6	318	44	0.23630137
VT1000	A1	T1	OTH	TC1	MIX	35	355	55	0.23630137
OTDCR20 RR9	A1	T2	OTA	TC2	TNC/TSL	42.7	944	31	0.495890411
OTDCR20 RR9	A1	T2	OTA	TC2	TNC/TSL	42.7	944	31	0.495890411
OTDCR20 RR9	A1	T2	OTA	TC2	TNC/TSL	42.7	944	31	0.484931507
OTDCR20 RR9	A1	T2	OTA	TC2	TNC/TSL	42.7	944	31	0.484931507
OTDCR20 RR9	A1	T2	OTA	TC2	TNC/TSL	42.7	944	31	0.484931507
OTDCR20 RR9	A1	T2	OTA	TC2	TNC/TSL	42.7	944	31	0.484931507
MLXDE1000R	E1	T3	MIL	TC2	GSTEEL	6	318	35	0.508219178
MLXDE1000R	E1	T3	MIL	TC2	BST	89.7	352	34	0.508219178

3.1.3 Model Building

In this process, we take the preprocessing to data form the data typeNumeric, Nominal, and Ordinal. We will bring it into the model of The Artificial Neural Network Model with built, we can create a table. This is weighing controller between Input node and Hidden node (for easier viewing to show only two decimal digits only) section weighing between hidden node to output node therefore completing the process. When you have decided to take Regression analysis to analyze

data and compare results. Process and sequence have analysis to ideal for Simple linear regression. Data will be analyzed according to the appropriate data to be used more than the other way around.

3.1.4 Evaluation

In our model, the 10-fold cross-validation technique proposed by DeryaBirant (2011), the dataset is divided into 10 subsets, and the method is repeated 10 times. In each time, one of those 10 subsets is used as the test set, and the other subsets are put together to form a training set. On the other hands, the percentage splitting method is to split up into sub-datasets for training set and testing set.

3.1.5 Integrated Model

As described in the previous section, we will study the following steps of the method in the preceding section. Take the best results, comes from the evaluation expert systems in integrating data.

The experimental results show that, in both evaluation methods, the proposed extended model is a little superior to the traditional approach, in terms of accuracy. Additionally, the extended model building provides more practical customer segmentation rules which are advantage in the final phase, the knowledge deployment.

3.1.6 Knowledge and Deployment

After that we have the results evaluated by the appearance of distance and lifetime. Allows find the cause of the tire problem. We will make the tire choice for the more worthwhile.That will make the tire choice for the more worthwhile. The data were analyzed to determine the Company's strategy to allocate funds for the business. This also helps to arrange their schedule to maintenance to achieve maximum benefit.

3.2 Research stages and duration of the research

Schedule of this research has start on August and uses 5 months for thesis with any topic in Figure 3.4.

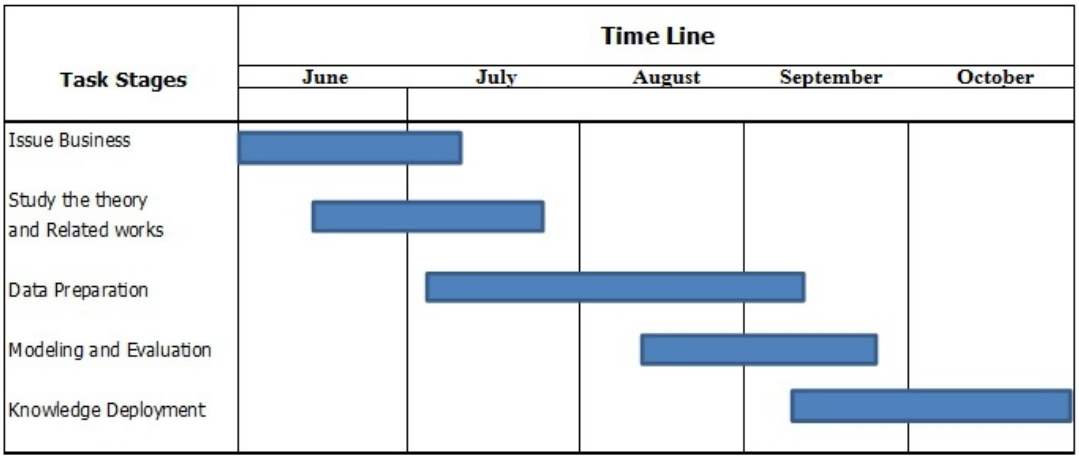

Figure 3.4 Schedule of research.

In this chapter, we discuss about steps of the research process. In the next chapter, we discuss analysis, results, and knowledge deployment for organizations.

CHAPTER IV
EXPERIMENTAL RESULTS

4.1 Data Mining Result

Theresult of modeluse three methods in two model building, as shown in Table 4.1.

Table 4.1 Model building: distance and lifetime of tires.

Data	Method	Model Building	
		Regression	Neural Network
Distance	Numerical (Root relative squared error)	74.30%	77.42% (hidden node 27)
	Nominal (Accuracy)	54.08%	65.60% (hidden node 31)
	Ordinal (Accuracy)	99.31%	99.63% (hidden node 36)
Lifetime of Tires	Numerical (Root relative squared error)	92.97%	109.90% (hidden node 27)
	Nominal (Accuracy)	42.75%	43.17% (hidden node 31)
	Ordinal (Accuracy)	99.49%	99.54% (hidden node 36)

Firstly, the 10-fold cross validation method is applied for the evaluation on a dataset (2,189 instances). The accuracy results of distance are given as 99.63% for ordinal data type, 65.60% for nominal data type and root relative squared error 77.42% for Numeric data type from MLP. Then model building from regression the accuracy results get value just less.

For life tires use as method distance, Then accuracy of Life tire results is 99.54% forordinal data type, 99.49% for nominal data type and root relative squared error 109.90% for type Numeric from MLP. Additionally, the extended model building provides more practical worthiness segmentation rules which are advantage in the final phase, the knowledge deployment

In this process, the data is divided into 2 groups according to the company type before using the MLP algorithm for classification company segment. As summarized in Table 4.1, the data type can be classified as: distance and lifetime of tire. We contain ordinaldata type iswith the total of 2189 instances, as shown in Table 4.2-4.3

Table 4.2 Hidden node output by MLP with distance.

Hidden Node	D1	D2	D3	D4
Node0-9	2.4022	2.2206	1.3912	1.6806
Node10-36 (weight)	0.1461	0.2387	0.0405	0.1195
Worthiness (output)	Very High	High	Medium	Low
Number of Integrated	3	2,3	1,2	1

Table 4.3 Hidden node output by MLP with lifetime of tires.

Hidden Node	L1	L2	L3	L4
Node0-9	2.6349	3.6679	1.5631	1.3142
Node10-36 (weight)	0.2132	0.4647	0.1332	0.2030
Worthiness (output)	Very High	High	Medium	Low
Number of Integrated	3,4	1,2,3,4	1,2,3,4	1,2

4.2 Integrated Model

After creating rules for distance and lifetime of tire segment, Tire data will be able to see the difference in various groups of worthiness according applications of the distance by different units. Can able to choose the format of tire to use with applications worth. (See Table 4.4)

Table 4.4 Expert system tire worthiness.

Life Time	**Distance**		
	Distance<100,000km	***100,000km <= Distance <= 150,000 km***	***Distance>150,000km***
year < 1	Low	Medium	High
1<= year <=2	Low	Medium	High
2<= year <=3	Medium	High	Very High
Year > 3	Medium	High	Very High

The experimental results show that, in both evaluation methods, the proposed extended model is a little superior to the traditional approach, in term of accuracy. Additionally, the extended model building provides more practical customer segmentation rules which are advantage in the final phase, the knowledge deployment.

4.3 Deployment for Application

After creating equation for the group of company segment, the company will be able to see the differences of various group customers rather than the uncategorized tire data with the type of tire segmentation. It would reach the more targeted company and worthiness according to the type of tire analysis. Moreover, it can upgrade or downgrade the type of tires, it depends on the strategies for the individual organizations, as shown in Figure 4.1.

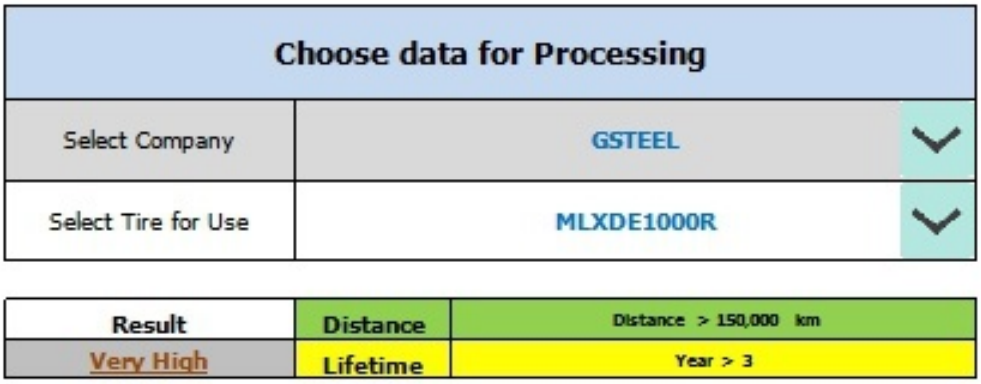

Figure 4.1 Example for application from human expert**.**

Tire segmentation analysis, the advantage for defining a strategy, Choose tire reasonable and activities as well as the products and suitable services for company. For example, user can select tire for company at stock tire as: worthiness use high or very high from company to use. In addition, it also provides an opportunity to keep an existing customer, establishes a good management relationship, extend and reduces the cost. Moreover, the organization would take the advantage over the competitors by knowledge of the target company patterns.

In this chapter, we discuss the experimental results, analysis, and knowledge of deployment for organizations. In the next chapter, the conclusion and future works for research are also given.

CHAPTER V
CONCLUSION

5.1 Conclusion and Discussion

This research presents the prediction model of the truck tires usage worthiness. Two proposed dimensions are the distance and lifetime of tires compared with two prediction methods: The Artificial Neural Network and the Linear Regression. This research also compared in the dimension of three data-transformation schemes. The best results for the distance and lifetime dimensions, are 99.63% and 99.54% accuracy respectively. These two results have been then integrated and got the worthiness prediction model reply to the experts, opinion. This new model has comparing with the expert system to get the final decision model. This research is beneficial to the user who is able to use the truck tires worthily in their company. This data will assist the user, especially in managing level, to arrange the schedule for maintenance. The company can use this data to determine their strategy to achieve the maximum benefit.

Specific to technical viewpoints, the collected have been divided into two parts: a distance and lifetime of tires. The final rule has created to determine the worth in usage. The technology is transfer from the ANN method and Linear Regression into a model. The results will be based on the characteristics and condition of the tires which concern to the mileage, and the duration. The worthiness is divided into four ordinal values, which we got a final rule in worthiness. Part of the research is to study the literature reviews also analyze the physical to determine the range of the distance use, actually in our analysis the data is from the actual use, but most of the research of the tire usage are related to the plane. The difference is the truck tires are using a longer distance. The data is obtained from human expert analysis and the results from the model. The factor is difference from the outcome of the trial, because of the distances. Even the lifetime of tires is secondary, but it has to integrate together to get

the final rule in worth of selecting tires. In business, the data in physical are unable to confirm with the actual usage.

5.2 Future works

According to the possible future work, this research may be extended based on the behavior to the truck driver or another device. We may be able to keep the data with the supplement to this research which will provide more accuracy. Additionally, since the data is develops as structural format, which the information provided may be uncompleted, they should be stored in the geo-graphical position which able to remove for analysis in any points to change the truck tire. In terms of the prices restrictions the truck tires are not in a variable normal store. It will be sold the vender contract. From the results, it can develop to another such as saving fuel, suspension systems, engine, etc. Also concerning to the monetary value by chooses the proper equipment to the right and appropriate purpose. This research should be brought for the data from the real usage which able to the tire producing for reasonable price and quality.

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APPENDICES

APPENDIX A
BIOLOGICAL NEURAL NETWORK

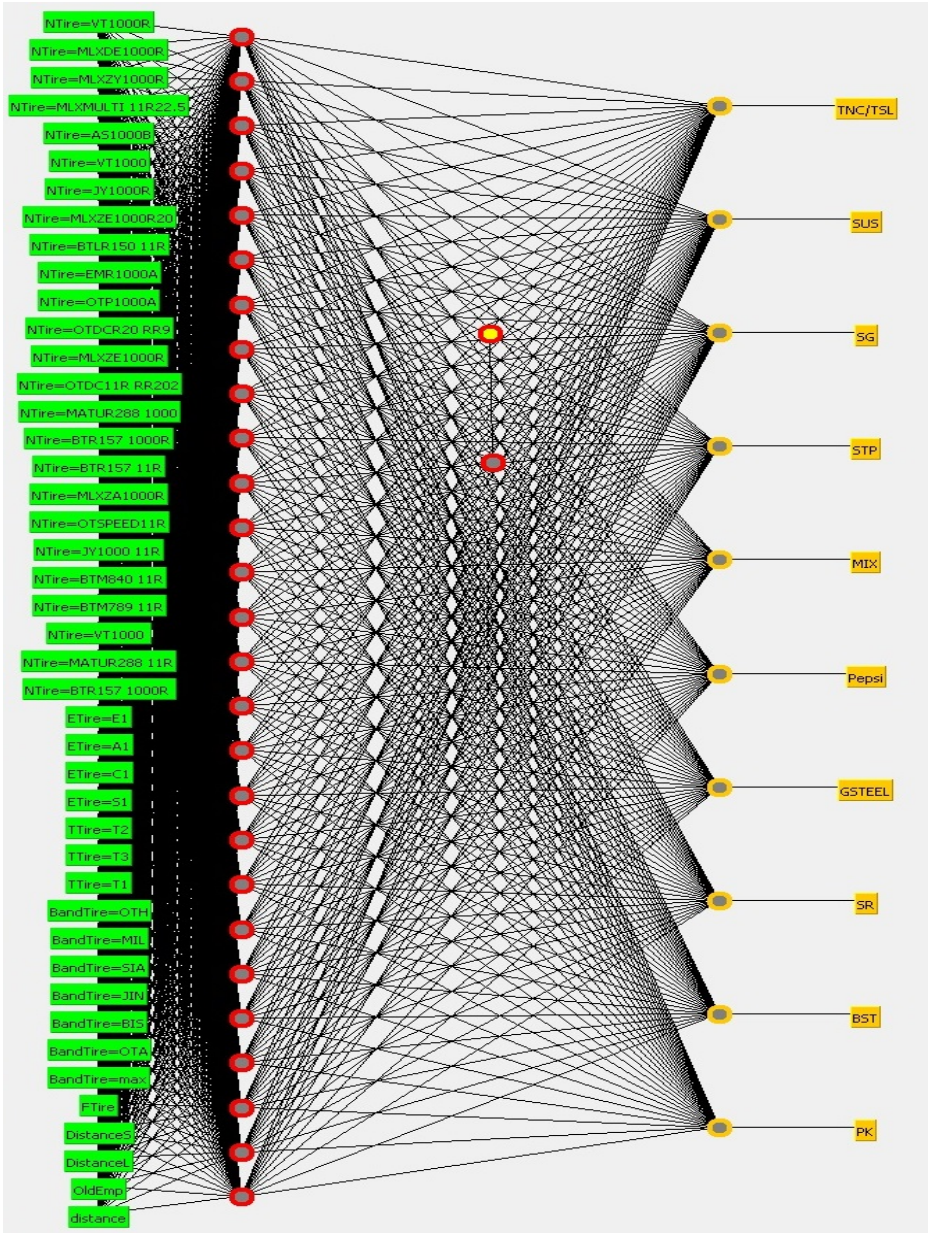

Figure A.1 Approximate functions from distance data

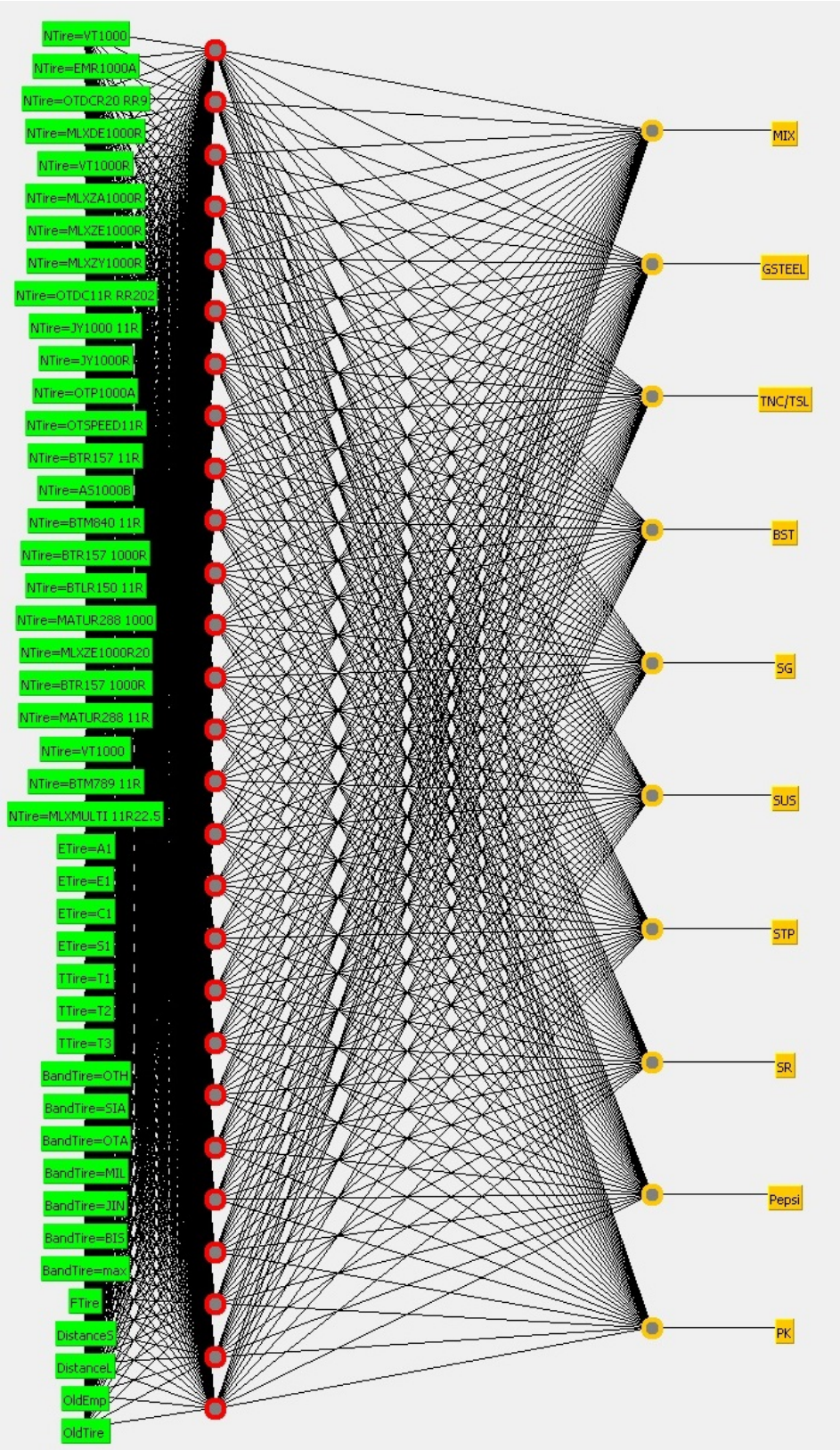

Figure A.2 Approximate functions from lifetime of tire data

APPENDIX B

TECHNICAL PAPER OF 2015 INTERNATIONAL CONFERENCE ON INFORMATION TECHNOLOGY

The 2nd Management Innvation Technology International Conference (MITiCON2015)

A Truck Tires Usage Worthiness Prediction Model

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Abstract— **Nowadays, Transportation cost is one of the significant parts in the Business operation. This method will be able to reduce the expenses of the transportation especially the factors which consumed in this case it about the truck tires. This research proposes the prediction model for the worthiness of the truck tires into dimension of distance and last long. This research uses the technology of data mining, The Artificial Neural Network model and the Liner Regression Model as the selected classification algorithm. Acquired accuracies are 99.63% and 99.54% respectively for distance and lifetime to determine the worth. The integrated strategy will lead how to use of truck tire to reduce the cost.**

I. Introduction

Transportation has been implemented in all businesses. The variable cost of transportation has effected and related to all the organization. The manufacturers have improved their own product to be in high quality and last long in distance. So the business owners will achieve maximum worth from the distance by using the truck tires in last long and get more profit. However, there is also a problem occurred as the user has no any instructions how to use and maintain the truck tire properly. Thus, this research is the alternative of tires selection and usage which will be beneficial to the user who concerned about the truck tires usage worthiness in their business.

This paper proposes a prediction tool separated into two models. The model predicts about the worthiness of the tires with the two perspectives, the distance and the duration of using tires. This model is developed by the data mining method truck tires data by using the distance and lifetime since it has taken off. To determine this process, it will be a prediction worthwhile and lower cost in the transportation business.

This paper is organized as follows: in section 2 and 3, we describe an overview of the related theories and researches. Section 4 presents the proposed procedure and steps of the research process. Section 5 is the description of the analytically experimental results. Finally, the conclusion of the paper is described.

II. RELATED THEORY

A. Factors that affect to the tires

Tires are the most important part that makes the automobile move. Since they are the only parts of mobile which touch the road [1], they would be wore and torn easily. The related factors which are described how to use and maintain the truck tires to make it long-life and safety in use as follows:

- Tire Pressure : This cause of burning tire and the structure of rubber dissociated from each other which will lead to the swollen and burst of the cuticles tires. It could be the result which make the sidewall tires tear or broken, and also the fuel supplies well in additional.
- Payload: Conveyance overloaded in a twisting area will make the tires heat while touching the road so often. The tires would not be last long and wear easily.
- Speed: While the truck is running in high speed, there are a friction and heat. Which it's concerned to the tire age to be drop down and affect to the wear resistance.
- Braking and Starting: The inertia of the running truck on the road is in the higher speed. So when the driver started to brake, the inertia has pushing until the wheels stop spinning. The wheels are crushing in the surface of road and the tire is wearing.
- State of Truck: The suspension and the wheels have a dramatic effect to the tire wear quickly. If the specification of the car and wheels are incorrect, it will cause of the friction and crushing to the surface tire.
- State of Road: Driving on the smooth surface road will protect the tires to be last long than driving on the rough road.
- Weather: Tires are the main ingredient from natural rubber. It is resistant to the high temperature than the synthetic resin. It will affect to wear quicker if the heat up.

B. Life of tires

Usually, the life of the tires stated since it have been deployed [2]. After the tires fitted with the wheel to the vehicle and started to run application program. These tires will be warranty by the manufacturer in each condition. The tires will be last long, depending on the user active which recommended to use the correct tires.

C. The Multi Layer Perceptron Model

The Multi Layer Perceptron algorithm (MLP) is a type of the Artificial Neural Network [3]. The Artificial Neural Network has many layers (a single layer called perceptron). The MLP is a classification algorithm which could learn linearly separable patterns. Single layer perceptron has artificial neurons or nerve cell which can input values sent to output values by a set of weight (see Fig. 1). Therefore, it is a basic feed forward network. MLP can be applied with activation function. In the MLP learning the hidden node activation often have to create a route to the simulation [4].

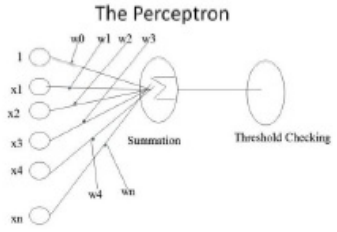

Fig. 1. Driagram Work flow MLP Model

D. Liner Regression Models

Straight-line regression analysis involves a response variable [5], y, and a single predictor variable, x. It is the simplest form of regression, and models y as a linear function of x. That is,

$$y = w_0 + w_1 x$$

This coefficient can be solves by the method of least square, which estimates the best-fitting straight line as the one that minimizes the error between the actual data and the estimate of the line (see Fig. 2). Let D be a training set consisting of values of predictor variable, x, for some population and their associated values for response variable, y. The training set contains D_j data points of the form(x_1, y_1), (x_2, y_2), …, (x_jD_j, y_jD_j). The regression coefficients can be estimated by using this method with the equations as follows:

$$y = w_0 + w_1 x_1 + w_2 x_2 + \ldots + w_n x_n$$

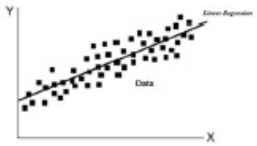

Fig. 2. Data distribution in Linear Regression Model

III. RELATED RESEARCHES

There are many different approaches to the problem of tire usage worthiness have been proposed. The data used for this case study are all gathered from operating distance and life tires from the actual use of a logistic company. In this study, several truck tires researches are mentioned.

The first paper is "Modeling Failure Rate for Boeing 737 Tires", proposed by Al-Garni, Jamal, Ahmad, Al-Garni, and Tozan [5]. This paper presents an application of The Artificial Neural Network (ANN) technique for conducting the reliability analysis of Boeing 737 tires. For this purpose ANN model using back-propagation algorithm feeds forward while learning. The rules were developed in a certain narrow context. The results are that the ANN can predict the failure rate better than the Weibull Regression. A comparative study shows that the three input ANN model performs much better with lesser percentage error from the actual data than the two and one input models, and six intermediate neurons give much reasonable accuracy than lesser number of intermediate neurons as also verified by visual inspection. In the present study, both the flying time and the number of landings are used as indicators of operational life of the tires. Different is using variables in the distance used truck tires and life, tire to use for research. The variables used to determine worth. There is extensive research documenting its safety profile.

Ahmed Z. Al-Garni et al.[6] proposes model for predicting the failure rate of De Havilland Dash-8 airplane tires. The inputs to the Neural Network are independent variables and the output is the failure rate of the tires . Six years of data are used for model building and validation. The average percentage difference of the failure rate with that of the actual data is found to be 19.84%, 8.56% and 5.66% for neural networks having one, two and three inputs, respectively. Moreover, with informal visual Applications of us focused improved operating range rather than live there. It is worthwhile to use standard to reduce accidents involving truck tires.

Factors wear of tires usage the distances, it is percussion of the tires on road. Jadranko Matusko et al. [7] proposed a tires/road friction force estimation. The main purpose of the simulation experiment was validation of the estimator robustness to changes of the friction model parameters. Four parameters of the friction model were changed. This research indicates the standard in the engineering design wear of the

tires for use. Production used as a benchmark in automotive design. Entrepreneurs can choose tires for worthiness.

A research study has model of the tire manufacturer's guarantee life, tire at age 4 years. Krivtsov [8] proposes the Regression Approach to tire reliability analysis. The paper considers how empirical analysis of the root causes you some type of tire failure. Tire life can get information from laboratory tests that have been developed to repeat the failures the field. A number of parameters related to tire geometry and physical properties. This research used the weight of the tires and tire temperatures to determine the life. The result indicates the quality of the tires that has good quality as a result. Their life is a variable that used, it is worth the distance. That is the choice of tires to the maximum worth of the distance.

IV. METHODOLOGY

In this paper, we apply data mining techniques to database of trucks tires usage worthiness. The steps of the research process are shown in Fig. 3.

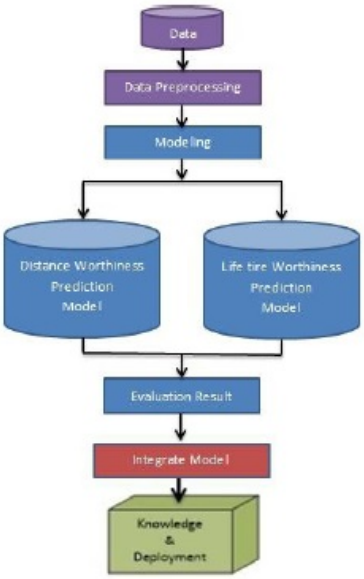

Fig. 3. Overall Methodology

A. Data

This research used database from use tires data for the last 1 year (A.D. 2012-2013). The database contains for data acquired from the data of the logistics company on the database. The subject of maintenance contains the replacement of truck tires, problems of the quality of tires, and tire-related accidents. The targeted attributes are the distance of truck tires and life tires as variables data in the research.

B. Data Preprocessing

This important step is to select a set of related data to be used in the case of data mining and data [9]. Data preprocessing aims to eliminate irrelevant data in some methods such as data integration, data transformation, and data reduction show in Table I. The original data format is Numeric. The preprocessed data is transformed to Nominal and Ordinal. This will help to optimize the impact on precision and accuracy in subsequent stages. From this stage, we have two factors to be taken into the model, including the distance and duration of use (see Fig. 4).

Data Section	Attribute	Data Criteria	Detail
Distance of Trucks :	*DistanceU*	Numerical Km.	Distance Use Start to End
	CompanyU	10 Type	Company Of Use Tires
	UseL	160 - 841 Km.	Long Distance Use Tire
	UseS	58 - 159 Km.	Short Distance Use Tire
Life of Tire :	*NTire*	24 Type	Version Of Type from Band Tires
	TTire	T1,T2 and T3	Characteristics of Tires
	FTire	F1 and F2	Tires tread pattern
	BTire	7 Type	Band Of Use Tires
	ATire	Day	Day Of Use
	ETire	A,C,E1	Reason for Change

Fig. 4. Data Dictionary Distance and Life Tire

TABLE I DATA BEFORE PREPROCESSING IN NUMERICAL TYPE

NTire	ETire	CompanyU	- - - -	ATire	DistanceU
EMR1000A	E1	GSTEEL	⋮	1895	115375
MLXDE1000R	E1	GSTEEL	⋮	1456	212010
VT1000R	A1	SG	⋮	1266	244805
MLXDE1000R	E1	GSTEEL	⋮	1266	244805
VT1000	E1	GSTEEL	⋮	1379	111550
VT1000	A1	GSTEEL	⋮	1360	48869
MLXZE1000R	E1	GSTEEL	⋮	1327	249403
VT1000R	A1	TNC/TSL	⋮	1327	249403
MLXZE1000R	E1	BST	⋮	1400	224090
EMR1000A	E1	TNC/TSL	⋮	1400	115375
⋮	⋮	⋮	⋮	⋮	⋮

C. Modeling

In this process, the MLP and Linear Regression are experimented and compared their accuracy and root relative square error.

D. Evaluation

In our model, we used 10-fold cross validation technique [10], dataset is divided into 10 subsets and the method is

repeated 10 times. In each time, one of those 10 subsets is used as the test set and the other subsets are put together to form a training set. On the other hands, the percentage splitting method is to split up into two sub-datasets for training set and testing set.

E. Integration

As described in the previous section, we will study the following steps of the method in the preceding section. Take the best results, comes from the evaluation expert Systems in integrating data.

F. Knowledge & Deployment

After that we have the results evaluated by the appearance of distance that the life of the tires. It should allow of find the cause of the tire problem. We will make the tire choice for the more worthwhile.

V. EXPERIMENTAL RESULT

A. Data Mining Result

The model is result by three methods in two Model Building, as shown in Table II.

TABLE II. MODEL BUILDING FROM DISTANCE AND LIFE TIRES

Data	Method	Model Building	
		Regression	**Neural Network**
Distance	Numerical (Root relative squared error)	74.30%	77.42% (hidden node 27)
	Nominal (Accuracy)	54.08%	65.60% (hidden node 31)
	Ordinal (Accuracy)	99.31%	99.63% (hidden node 36)
Life of Tires	Numerical (Root relative squared error)	92.97%	109.90% (hidden node 27)
	Nominal (Accuracy)	42.75%	43.17% (hidden node 31)
	Ordinal (Accuracy)	99.49%	99.54% (hidden node 36)

Firstly, the 10-fold cross validation method is applied for the evaluation on a dataset (2,189 instances). The accuracy of Distance results is 99.63% (Hidden Node 36) for data type Ordinal, 65.60% (Hidden Node 31) for data type Nominal and root relative squared error 77.42%(Hidden Node 27) for type Numeric from MLP. Then model building from Linear Regression the accuracy results get value just less. The work of two Models is accuracy in slightly different values, but the time to process the Linear Regression is faster.

For life tires use as method distance, the accuracy of Life tire results is 99.54% (Hidden Node 36) for data type Ordinal, 99.49% (Hidden Node 31) for data type Nominal and root relative squared error 109.90% (Hidden Node 27) for type Numeric from MLP. Additionally, the extended model building provides more practical worthiness segmentation rules which are advantage in the final phase, the knowledge deployment.

B. Integrated Result

After creating rules for distance and life tire segment, Tire Data will be able to see the difference in various groups of worthiness according applications of the distance by different units. Can able to choose the format of tire to use with applications worth. (See Table III.)

TABLE III. EXPERT SYSTEM TIRE WORTHINESS

Life Tire	**Distance**		
	Distance < 100,000km	*100,000km < Distance < 150,000 km*	*Distance >= 150,000km*
year < 1	Low	Medium	High
1<year<2	Low	Medium	High
2<year<3	Medium	High	Very High
Year > 3	Medium	High	Very High

The experimental results show that, in both evaluation methods, the proposed extended model is a little superior to the traditional approach, in term of accuracy. Additionally, the extended model building provides more practical customer segmentation rules which are advantage in the final phase, the knowledge deployment.

VI. CONCLUSION

This research proposes an extension of modeling prediction tire usage worthiness. The bring database used truck distance of tire and duration of truck tires (start-end) in 1 year. The value in use is worth distance and worth over time. The extension indicates the worthiness by which that has distance of used primarily before. To determine the worth of distance use with the worth of period that began tires. That is use of The Artificial neural network techniques in the Model. Then the results of the test are compared with the Model Linear regression, Distance (99.63%) and Life tires (99.54%) from the Ordinal data of the model MLP that will best accuracy. Correctly classified instances of testing are slightly different. Correctly classified instances of the results of the two models are the relationships that affect each. The results are us being the second part of the Integrated together. By creating a rule to say that is worth of this Model also different. The expert system is construction from result of two models by integrated to assess the results of the worthiness. The rule gets final Model Worthiness. That will make the tire choice for the more worthwhile. The data were analyzed to determine the Company's strategy to allocate funds for the business. This also helps to arrange their schedule to maintenance to achieve maximum benefit.

Future work is on the behavior of the driver of the truck or on other devices. Affect the active may be able to cause problems for the tires not worth it. We are able keep data to be supplemented this research provides more accuracy.

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