OPTIMIZING AUTO-REPAIR PRACTICE THROUGH MECHANIC VILLAGE AKURE METROPOLIS AS A CASE STUDY

BY

AKINYEMI, ADEMOLA ABIODUN
(MEE/96/8530)

A THESIS SUBMITTED TO THE DEPARTMENT OF MECHANICAL ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY, THE FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ENGINEERING (M. ENG) DEGREE IN MECHANICAL ENGINEERING (BUILDING SERVICES OPTION)

SEPTEMBER, 2006

DEDICATION

This project is dedicated to God Almighty, the author and finisher of my faith, and my wife, Mrs. Akinyemi O. O.

CERTIFICATION

We certify that this project was carried out by Akinyemi, Ademola in the Department of Mechanical Engineering, School of Engineering and Engineering Technology, Federal University of Technology, Akure, in partial fulfillment of the requirement for the award of Master of Engineering in Mechanical Engineering Degree(Building Services Option).

Engr. Dr. O. P. Fapetu
Project Supervisor/Head of Dept.

ACKNOWLEDGEMENT

My profound gratitude goes to the almighty God for making this project work a success

I acknowledge the moral support of all members of staff of Mechanical Engineering Department, Federal University of Technology, Akure, towards the successful completion of this project. My unreserved appreciation goes to my supervisor Engr. Dr. O. P. Fapetu for his efficient supervision of the project and for the wealth of experience he imparted onto me in the past, during the course of this project and for those I am gaining at present and those I am hoping to gain in the future. Once again I say thank you sir. Also I appreciate the fatherly advice of Prof. A.A. Aderoba throughout the period of this research work. Without adequate supervision project execution fails, but in the multitude of supervisions they are executed, I want to deeply appreciate the joint effort of my co-supervisor Engr. Prof. C. O. Adegoke for his rear touch of academic experience contributed towards making this project a success, God bless you sir.

I wish to express my sincere gratitude to my wife and children Olumide, Ayomide and Olamide for thier support in one way or the other throughout the period of this project. I thank you all.

I also appreciate the contribution of Mr.T.I. Ogedengbe, Mr. O.A.Kuti and Mr. S. P. Ayodeji towards the successful completion of this Project.

Finally I thank God almighty for his mercy and favor over me and my entire family throughout the duration of the project.

A. A. Akinyemi,,
2006

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This study investigates the problems facing automobile technicians with a view to optimising auto repair work. The data for the study were collected using questionnaire and interview techniques. One hundred and twenty(120) automobile technicians, forty-two (42)spare part dealers, and eighty(80) car owners were contained in the analyzed sample. The result of the analysis revealed the various problems facing automobile technicians in Akure which include inadequate tools with 78% of workshops interviewed not having adequate tools while 22% had fairly adequate tools and problems of low capital base with 75% Auto Technician interviewed having a working capital of less than N100,000 .00, 17% are operating between N101,000.00-N250,000.00,while 8% between N251,000.00 –N1000,000.00 above. Also included are the problems of bad location with 70% of the respondents acquirrng their land through rentage, 19% through lease while 3% through outright purchase and problem of poor educational background with only 6% having OND which represents the highest educational qualification of all the respondents,8% had City and Guilds Certificate 19% primary school, 11% had school certificate while 56% are without anyformal education(Apprentiship). Along with these problems is the lack of necessary social amenities in separate workshops. Encouragement of the development of mechanic village, which was observed from the data collected as one system that can help in solving most of the problems, was formulated as an hypothesis, analysed and tested. The hypothesis testing reveals that the establishment of mechanic village to assist auto repair activities is preferred by the respondents.

However, in view of the non-professional ways that some areas that adopted this policy of developing Mechanic Villages in the past had handled it, this study went ahead and developed standardized models for executing the development of such

villages so that optimum performance could be obtained. The developed models were later validated and found to be reliable and deper.dable. Hence, the establishment of standardised mechanic village using the working models developed in the study was proposed and suggested as a way of solving the auto technicians problems thereby optimising auto repairs.

CHAPTER 1

1.0 INTRODUCTION

1.1 BACKGROUND TO STUDY

The use of automobile vehicles on our road plays a key role in road transportation system. In Nigeria where land transport is larger compared to water transportation, the use of automobile vehicles either diesel or petrol driven is predominant. It is evident that the use of any mechanically operated engine or system requires proper maintenance to produce the required efficiency and durability.

The performance and maintenance of vehicles have advanced into sophisticated level. Unlike the old mechanically operated vehicle systems the modern vehicles are being operated and controlled by electric and electronic sensors and computers.

The modern trend of mechanical service therefore requires the use of more complex and highly technological and special diagnostic equipment to analyze vehicle faults for repair and service.

As vehicle technology and maintenance are advancing, the problems facing Automobile technician in the course of discharging their duties have adversely affected the transportation system hence affecting all the other systems in the country. The problems coupled with fuel scarcity have constituted a lot of fear, instability and setback in the country. Some of the results of the auto technician problems include: fear of insecurity among the people when plying the highway, unpredictable breakdown of vehicles on the highways when traveling, leaving passengers to the mercy of armed robbers, failure of vehicle parts like brakes resulting in accidents and loss of lives, delay

and failure of important appointment, molestation and maltreatment of car owners and heavy debts incurred by many car owners on maintenance.

A system with an optimum performance can be generated if all the problems highlighted earlier are tackled (Lindley, et.al, 1977 and Jarett, 1977). This will go along way in alleviating the problems being encountered by the Automobile technician in our society.

1.2 STATEMENT OF PROBLEM

The high level of usage of vehicles for both private and commercial activities coupled with the inflow of second hand vehicles popularly called "Tokunbo" brought about the need for very efficient and effective maintenance.

Often times, the garages where the maintenance activities are carried out are of low capital base and are makeshift establishments either located on slippery terrains, under tree sheds, canopy made of banana or palm fronds. No effective maintenance can take place in such environment.

Similarly a close look at the equipment used reveals the level of poverty of these mechanics. In most places, service pit are not available and where it is available there are no reinforcement at the sides to hold loose sands in place. No accuracy of either balancing or alignment could be obtained. New vehicles are the result of technological development, which calls for illiterate hands to handle.

With all these facts, there is the need for a thorough analysis of the existing practice and a synthesis of a comprehensive and management oriented practice to put the maintenance culture as what it should be. It is against all these facts that this research is being undertaking.

1.3 GENERAL OBJECTIVE OF THE STUDY

The broad objective of the research is to identify the problems facing Automobile technicians, so as to involve a system which will make them perform optimally.

1.3.1 Specific Objectives of the Study

The specific objectives are to:

1a. Evaluate the problems facing Automobile technicians especially in the developing countries like Nigeria using Akure as a case study.

1b. To develop models that are reliable and which would ensure improved performance of Automobile technicians.

1.4 METHODOLOGY

Extensive literature survey was carried out on the research work through consultation of necessary textbooks. The data for the study were collected using questionnaire and interview techniques. Questionnaires were designed and administered to Automobile technicians, spare parts vendors and car owners in Akure metropolis. One hundred and twenty, randomly selected, automobile technicians, forty-two spare part dealers and eighty car owners were contained in the analysed sample. The questions on the questionnaire were structured to match accurately, the requirement of the study.

Data were later extracted having collated the administered questionnaires. Analysis was carried out on the extracted data using statistical tools such as pie chart for percentile analysis and the five-point Likert method of summated rating (Kothari, 1995) which was ascertained to have a reliability of 0.95. The study was able to infer the problems facing Automobile technicians from the analysed data and proposed necessary

solution. Also models were formulated for the standardization of the proposed solution so as to facilitate the optimum performance of the proposed system.

1.5 EXPECTED CONTRIBUTION TO KNOWLEDGE

1.5.1 Relevance to the Field

The successful execution of this research will assist Automobile engineers, industrial engineers and management personnel to know the various problems being encountered by automobile technicians especially in developing countries.

It is ascertained that the result generated will be used to analyze and develop an optimum system, which is expected to improve the performance of automobile technicians.

1.5.2 Relevance to National Development

It is envisaged that the result from this research will go a long way to alleviate the problems associated with auto repair practice in Nigeria.

CHAPTER 2

2.0 LITERATURE SURVEY

2.1 HISTORICAL DEVELOPMENT OF THE MOTOR VEHICLE INDUSTRY

The story of motor vehicle can be dated to 1860, when Lenoir invented the first internal combustion engine (Encarta Encyclopedia 2003) though this vehicle was not at first used for vehicle propulsion. The fuel used in the early engine was coal or producer gas, and the new form of power brought about great changes in manufacturing methods in many industries. Until this time, that the small-scale manufacturer had been at a great disadvantage in at least one respect, for the installation of steam power plant was frequently too expensive for him, while the running costs of such a plant were almost certainly prohibitive. Since no other form of mechanical power was at that time avail able he had to do without mechanical power unless he could hire a plant. The new gas engine, however, was very well suited for use in small factories and workshops, and many manufacturers installed the new form of power during the last two decades of the nineteenth century.

At a slightly late date came the next step- the propulsion of a road vehicle by the new engine. It is true that road vehicles had earlier been produced which were driven by steam engines, but the Red flag Acts of 1831 and the development of the railways had discouraged experiments. It was in 1863 that Lenoir invented a road vehicle which was driven by a gas engine, the coal gas being ignited by an electric spark, but the problem of fuel supply was a very difficult one; the carrying of sufficient coal gas for any but the shortest journey was not easily managed. The problem was finally solved by the adoption of a new form of fuel which is gasoline i.e. petrol, a fuel which releases great

energy per unit weight. Markus used petrol as fuel for a vehicle he produced in Austria in 1865, while a great advance was made by Otto in 1876 (Encarta Encyclopedia, 2003) by the compressing of the fuel immediately before ignition, this considerably increase the explosive force in the cylinder and performance was considerably improved. The production of motor vehicles was well advanced by the 1890s as a result of the subsequent invention of such pioneers as Carl Benz, Gottlieb Daimler and Panhard.

Subsequent advances in the manufacturing of motor vehicles were associated with development in related industries. For example, the idea of the pneumatic tyre went back to 1845 though at the time of the initial discovery, there was no obvious application for it, but when Dunlop took out his patent in 1888 (Encarta Encyclopedia, 2003), cycling was fast becoming an important and popular means of transport for business and pleasure. Another patent taken out afterwards by Clincher made it possible to fit pneumatic tyre to motor vehicles. Significant improvements in the metal – working trades towards the end of last century and early in this made possible further advances in the motor- vehicle industry.

Since the first internal combustion engine (like the first steam engines) was designed for stationary use as power plants factories or workshop, little thought was given to their overall weight. Engines were accordingly of robust construction, but this feature, which was a virtue for the stationary engine, proved a serious handicap to the motor vehicle engine which had to be carried along by the very vehicle which is powered. Lightness in weight became a very desirable feature under the condition and this requirement stimulated research into the possibility of producing forms of metal which

are light in weight in proportion to their strength. The production of alloyed steels was therefore initiated with far-reaching effects in other countries.

Other industries, which have been stimulated by the development of the motorcar, include the electrical industry and the manufacture of petrol and lubricants. The manufacture of the modern car needs a wide variety of raw materials and component parts (e.g. tyres, upholstery, safety belts, silencers, windscreen, washers, spark plugs and other electrical equipment) and this fact has marked effect upon the structure and location of the industry.

2.2 MAINTENANCE

Maintenance is the key to achieving an optimum performance in machineries which include motor vehicles. Motor vehicles and equipment costing millions of Naira will surely fail if adequate maintenance procedures are not followed. (Adeniji and Inegbenebor, 2002)

According to Seely (1972). Maintenance can be defined as the work undertaken in order to keep or restore every facility of the vehicle to an acceptable standard.

Harold et. al. (1984) affirmed that maintenance is concerned with the day-to day problem of keeping a physical plant e.g. vehicle in good operating condition. Dhillon (1980) in his own view defined maintenance as a work-undertaken in order to keep or restore every facility to an acceptable standard. Maintenance helps in accessing potential problems on machineries and equipment, which could lead to breakdown, and if breakdown occurs, the system is restored to condition of operational effectiveness all at a minimum cost (Okemiri, 2000)

Maintenance is also supposed to respond to changing circumstances. This includes a rapid growing awareness of connection between maintenance and increasing pressure to achieve system availability at the same time (Moubray, 1991). Desirable performance can only be achieved on our vehicles through effective maintenance practice by our roadside automobile mechanics in a more conducive environment.

The goal of effective maintenance is primarily to ensure the availability of vehicles and its equipment at the optimal level and to obtain maximum return on usage. Due to complicated nature, it is highly desirable but feasible to produce cars that are maintenance free. However, there is no gainsaying the fact that all elements used in the construction of motor vehicles deteriorate. The rate at which this occurs depends on the materials, methods of construction, environmental conditions and level at which the vehicle is maintained.

2.2.1 Types of Maintenance

According to Lindley et.al (1977), there are four major types of maintenance; these are:

- Corrective Maintenance
- Predictive Maintenance
- Repairs Maintenance
- Preventive Maintenance

2.2.1.1 Corrective Maintenance

Corrective or breakdown maintenance occurs when equipment fails and then must be repaired on an emergency or priority basis. Corrective Maintenance is the fix-it-variety, this is where maintenance becomes a repair work. (Adejuyigbe, 2002). This

maintenance includes such improvement as minor changes in design and substitution of more suitable component of improved material of construction to eliminate a problem. If the problem cannot be eliminated economically, it may be possible to reduce the frequency of its occurrence.

2.2.1.2 Predictive Maintenance

Predictive maintenance is a relatively new term now coming into general use. Recognizing that a change in physical condition is the principal reason for maintenance, it is logical to consider the use of sensing, measuring or monitoring devices to determine significant changes. This technique can minimize the need for disassembly and inspection of internal parts. Through periodic measurement or monitoring, it is possible to identify conditions that require correction before a major problem develops. Predictive maintenance takes advantage that commercial equipment is available such as portable vibration analyser, amplitude meters, vibration amplitude and axial- displacement monitors, ultrasonic equipment for wall thickness measurement and other non destructive testing or measuring devices, optical tooling, contracting displacement sensors for monitoring alignment etc. With such equipment, conditions can be measured and recorded periodically or when justified continuously monitored with alarms or cutoff set at pre-established levels.

According to Harold et.al (1984) a well conceived preventive maintenance program should contain the following features:

1. Proper identification of all items to be included in the program.
2. Adequate records covering: volume of work, cost, etc.
3. Inspections on a definite schedule- with standing order on specific assignments.

4. Use of checklists by inspectors.

5. An inspection frequently schedule- may vary from as often as once six months to as little as once a year.

6. Well qualified inspectors- have craftmen, familiar with items being inspected and capable of making simple repairs at time trouble is observed.

7. Use of repair budgets for major items of equipment.

8. Administrative procedures that provide necessary fulfillment and follow-up on program.

2.2.1.3 Repair Maintenance

Repair maintenance is simply carrying out maintenance as the need develops. This elementary approach has sometimes been replaced by periodic overhauls and other preventive practices. This method could be the most logical approach to maintaining "non critical" equipment- individual units or parts of a production system.

2.2.1.4 Preventive Maintenance

Preventive maintenance is undertaken before the need develops to minimize the possibility of unanticipated production interruptions or major breakdowns. According to Harold et.al (1984), it usually involves the use of sensitive instruments e.g. vibration analysers, amplitude meters, audio gauges, optical tooling, pressure, temperature and resistant gauges to predict trouble. Conditions can be measured periodically or on continuous basis, and this enables the maintenance personnel to establish the imminent of need for overhaul. While this seems a sound idea, it may be found that when such planned preventive maintenance programme are developed and following religiously, the frequency and extent of overhauling or reconditioning equipment may not be justified, particularly if the down time required to perform the work result in loss of production.

Rather it is better to consider preventive maintenance only when corrective maintenance cannot be justified, predictive maintenance cannot be applied or repairs maintenance effect cannot be tolerated. Fig 2.1 shows the flow chart for maintenance operation procedures.

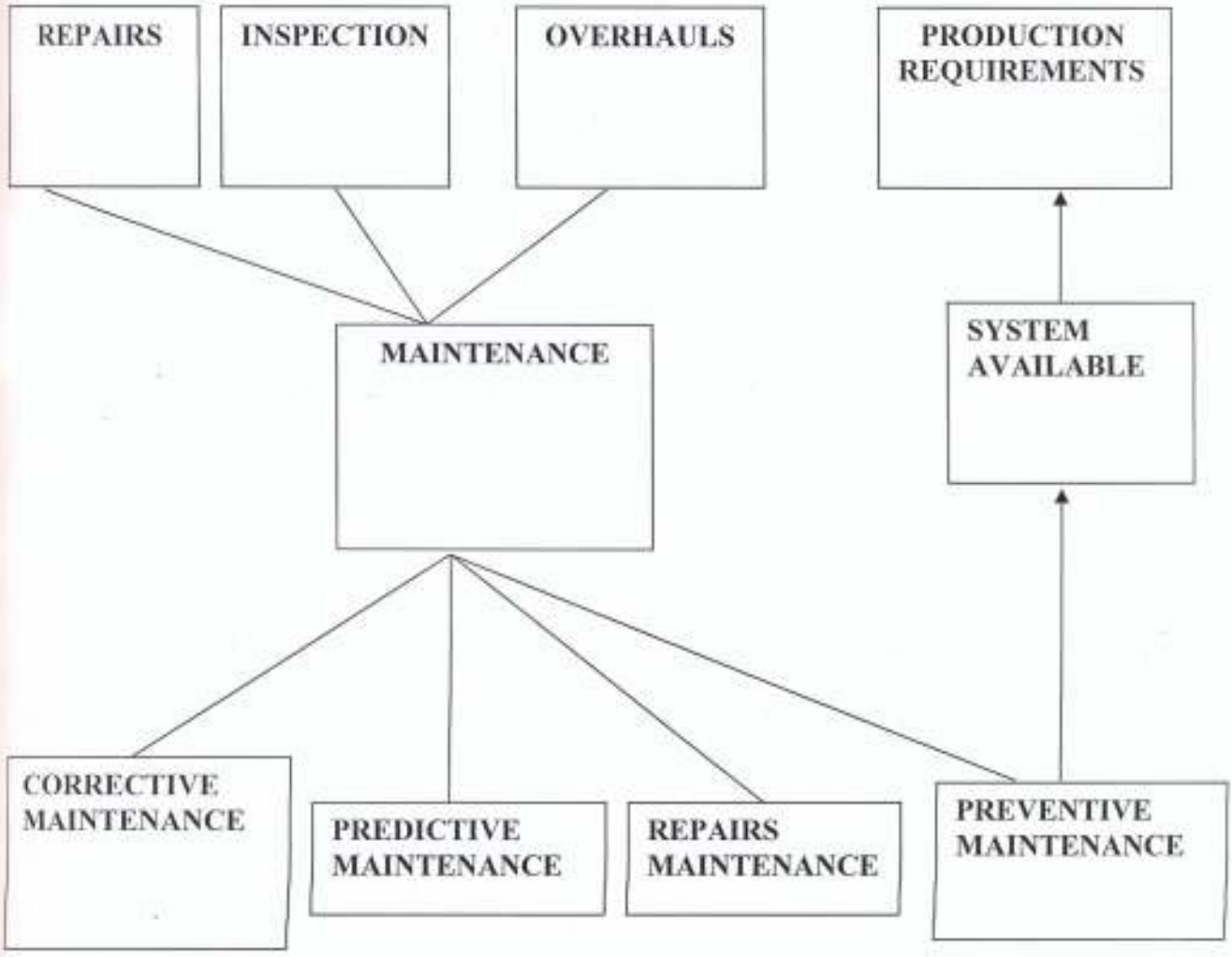


Fig 2.1: Flow chart for maintenance Operating procedure. **Source: Lindley et.al (1977)**

2.2.1.5 Lubrication in the Maintenance of Automobile

Lubrication of all moving parts, other than nylon, rubber bushed or pre- lubricated components, is essential to reduce friction and wear and to prevent seizure.(Dolan,1978). Similarly lubrication is very important in automobile maintenance as vehicle consists of engine, transmission system, final drive and chassis which all function in relation to the principles of lubrications and since the parts will surely wear off due to usage and handling. Periodic maintenance program has been designed by manufacturer for lubrication therefore there is a need for deep understanding of the lubrication principle by the mechanics and car owners.

2.2.2 Essential Testing and Maintenance Equipment for Vehicles Expected to be available in Mechanics workshops.

It is unfortunate that majority Automobile technicians do not have vital equipment in their workshop and this is one of the factors that accounted for the problems being encountered by them. Terry, (1998) reported that the diagnosis of automobile problems has become more of a science than ever before in history and the equipment required to do a thorough analysis of a problem is out of reach of most shops even in civilized countries. As a result there are a lot of shops out there that ignore the diagnosis phase of the problem solving process and just start throwing parts at a problem in hopes of getting lucky, either by some past experience or by just dumb luck. The result is a population of car owners which are afraid to take their cars to a shop knowing fully well that they may have to take a mortgage out on their house to fix the family buggy and then come away from the situation driving a car with all new parts in it and still exhibiting the same symptoms that it did in the first place! While Auto Diagnostic Equipment Homepage listed various types of automobile diagnostic equipment through link Terry, (1998)

explained that even though investing in such equipment is heavy, the result is an excellent record of solving problems that no one else has been able to solve and a reputation of customer satisfaction. According to Auto Tips (2001), even though computers in cars have become more sophisticated, and can help isolate problems, they can't diagnose everything. A little help from the customer can aid an experienced technician track down a problem and keep repair time and costs down. It can also help the technician check to be sure the problem is corrected under the conditions in which you observe it. This does not mean you should try to diagnose the problem for the technician, just give the best explanation of what you are observing and how this is different than you expect. Lindley et al. (1977) gave exhaustive lists of tools and equipments that a motor mechanic must possess for effective and standard maintenance service. These are summarized as follows:

- Mechanic Equipment

These include: tachometer, vacuum gauge, timing belt, belt- tension gauge, distilled water container, pressure tester for radiator and radiator cap, suction pump for drawing oil out of filter housings, compression tester, feeler gauge, voltmeter, hydraulic jack, jack lifting adapter, battery hydrometer, air compressor, greasing equipment, air hose extension, quad gauge for checking power steering, transmission and hydraulic systems pressure and Brake pressure bleeder.

- Mechanic hand tools

These include: Toolbox, Wrenches (Combination of open end and box 9.38mm to 31.25mm), ignition kits, tappet wrenches, 12.5mm drive- socket set with handles, ratchet, extensions, pliers, screw drivers (standard and offset), set of allen keys, pipe wrenches.

pry bar, chisels, drift punches, center punches, hammers, hacksaw, continuity light and tin snips

2.3 THE HISTORY OF ROAD TRANSPORT IN NIGERIA

Transportation, either by air, rail, ship or motor vehicles, plays an important role in our modern life (Bob, 1997). Edundare (1973) gave a brief history of road transport in Nigeria. They affirmed that after the Second World War, a considerable programme of road construction was undertaken in Nigeria. These programmes were under the Colonial Development and Welfare Scheme and the Nigerian Economic Development Schemes. The first road was built in 1945 from Lagos to Ikorodu, joining the road to Shagamu, Ijebu-Ode and Ibadan. Other roads were built linking the North, East and South of Nigeria together. The major transport system continued to compete effectively with the railways, encouraged by the expansion of the economy, particularly the increasing volume of exports and imports and the construction of better roads. Between 1946 and 1954, there was motor-transport "mania" in the southern half of the country; because of the great boom in the export trade, which began after the Second World War and lasted until 1954, an increasing number of people bought lorries and operated transport services.

In addition to the purely commercial road transport system, the Nigeria Railway Corporation operated a motor feeder service and passenger service in the North. The most important which emanated from the road transport was that of motor repairing (i.e. mechanic). Originally, the few Nigerians who began to provide this service obtained their training and experience while in the service of either the government (e.g. Public Works Department) or Commercial firms like U.A.C Motors. They in turn trained a number of

apprentices to handle simple mechanical faults in vehicles. These apprentices are those that latter started to work and trained other people that lacked former education. These are the people we refer to as Automobile technicians.

CHAPTER 3

3.0 MATERIALS AND METHODS

3.1 DATA COLLECTION

In this study, questionnaires were designed and administered to Automobile technician, spare parts vendors and car owner in Akure metropolis. The questionnaires were designed to request for answer to questions that bother on the problems that Automobile technicians might face after considering the salient characteristic of the job. Hence, the questions on the questionnaire were structure to match accurately, the requirement of the study.

The data for this analysis covered responses from 120 owners of Automobile technician workshops, 42 spare part dealers and 80 car owners all in Akure in the southwestern zone of Nigeria. The data were collected using questionnaire and interview techniques. The questionnaire consists of questions that are able to identify, after analysis, the various problems facing Automobile technician in Akure so that necessary solution can be proposed. The data as collected from Automobile technician, spare part dealers and car owner were extracted and tabulated in Table 3.1, 3.2 and 3.3 respectively. Table 3.1 and 3.2 were analysed by plotting them on pie chart to reflect the percentile analysis of some of the components of the questions in the questionnaire. These are as shown in Fig. 4.1 through Fig. 4.12. In other to maintain a level plain ground for our analysis, the Automobile technician and spare part dealers' interview were selected to spread over almost all specialisations with respect to the car they repair and the car part they sell. Also the car owner interviewed ranges from those using Toyota, Nissan, Honda, Audi, Volkswagen, and so on so that our analysis is not bias to type of car. Table

3.3 present data on the satisfaction of customers i.e. car owner as regard the work done for them by their mechanics. The respondents' responses to this question were graded as very high, high, moderate, low, very low with the corresponding rating score of 5,4,3,2,1, respectively and these were analysed using mean score (average). Average rating was obtained by dividing the total point scored by the total number of respondents so that the average rating can then be interpreted as; values between 4.01 to 5.00 was "highly satisfactory", values between 3.01 to 4.00 "satisfactory", values between 2.01 to 3.00 "moderate/acceptable", value between 1.01 to 2.00 "poor job/not satisfactory", and values between 0.01 to 1.00 "very poor job".

Table 3.1: Data extract from questionnaires prepared for Automobile technicians and administered

Questions in the questionnaire	Number of respondents that satisfy the conditions in the question
Year of Practice:	
1-5	6
6-10	50
11-15	46
Above 15 yrs	18
Educational level:	
Apprenticeship	67
School Certificates	13
Primary School	23
City and Guilds	10
OND	7
HND	-
Specialization - in petrol engine	110
- in diesel engine	10

Automobile workshop that has standardized tool and engine trouble shooting equipment	26
Automobile workshop without standardized tool and engine trouble shooting equipment	94
Workshops - with pit	77
- without pit	43
Minimum set up cost:	
25,000 - 50,000	37
51,000 – 100,000	54
101,000 – 250,000	20
Above 250,000	9
Method of land acquisition:	
Rent	93
Lease	23
Purchase	4
Relationship with landlord (rent or lease):	
Cordial	37
Not cordial	17
Satisfac tory	66
Distance of mechanics' workshop to the nearest spare part shop:	
1 – 2km	58
2 – 4km	34
4 – 6km	13
6 – 8km	8
Above 8km	7
Respondents that shared workshop with Panel beater, Auto Electrician & Painter:	
- All the three	80
- Any two	23
- Any one	13
- None	4
Auto technicians that prefer to be left alone in their scattered location	21
Auto technicians that prefer to be organized and located in selected optimum location	93

Table 3.2: Data extract from questionnaires prepared for spare part dealers and administered

Questions in the questionnaire	Percentage of respondents that satisfy the conditions in the question
Years of Experience:	
1-5	5
6-10	23
11-15	10
Above 15	4
Do you have all the motor part required by your Automobile customers in stock	4
Dealers that do not have adequate good in stock for customer	38
As a Spare part dealer do i normally help to fix parts for car owners	34
As a Spare part dealer do i not normally help to fix parts for car owners	8
Type of Spare parts usually sold:	
Brand New	8
Both new and second hand	24
Second hand	9

Table 3.3: Data extract from questionnaires prepared for car owners and administered

Questions in the questionnaire	Percentage of respondent that satisfy the conditions in the question
Private	44
Commercial and others	36
Preferred Part for maintenance:	
Brand new	46
Second hand	34

Customer's Satisfaction		
Level of satisfaction	**Number of respondents**	**Total score:**
5	9	45
4	48	192
3	23	46
2	-	
1	-	
		283
Average rating for customers' satisfaction is		$\frac{283}{80}$ =3.54

3.2 HYPOTHESIS FORMULATION, ANALYSIS AND TESTING

Generally, it is obvious from the data collected that automobile service and repair workshop were sited indiscriminately within our communities, which may constitute nuisance to our various communities and serve as a major restriction in curbing the problem of pollution of the environment. Also most of these workshops are without proper environmental and safety facilities.

A hypothesis was set up based on the question as to whether or not Automobile technicians would like to be organized together with their colleagues doing similar jobs in a center to form a mechanic village as it was been suggested in some other States of the Federation, in the past.

The null hypothesis h_o is that

Roadside mechanic prefers to be left alone in their scattered location.

Hence, the alternative hypothesis h_1 is

Roadside mechanic prefers to be organized and located in selected optimum locations.

Customer's Satisfaction		
Level of satisfaction	**Number of respondents**	**Total score:**
5	9	45
4	48	192
3	23	46
2	-	
1	-	
		283
Average rating for customers' satisfaction is		$\frac{283}{80}$ =3.54

3.2 HYPOTHESIS FORMULATION, ANALYSIS AND TESTING

Generally, it is obvious from the data collected that automobile service and repair workshop were sited indiscriminately within our communities, which may constitute nuisance to our various communities and serve as a major restriction in curbing the problem of pollution of the environment. Also most of these workshops are without proper environmental and safety facilities.

A hypothesis was set up based on the question as to whether or not Automobile technicians would like to be organized together with their colleagues doing similar jobs in a center to form a mechanic village as it was been suggested in some other States of the Federation, in the past.

The null hypothesis h_0 is that

Roadside mechanic prefers to be left alone in their scattered location.

Hence, the alternative hypothesis h_1 is

Roadside mechanic prefers to be organized and located in selected optimum locations.

The critical value for this hypothesis analysis was set at a significant level of $\alpha = 0.05$ such that

$$P(Z_{x-x} \geq Z_{\alpha} / h_o) = 0.05$$

Total area under the standard normal curve is 1, so if $P(Z_{x-x} \geq Z_{\alpha} / h) = 0.05$, then

$P(Z_{x-x} \leq Z_{\alpha}) = 1 - 0.05 = 0.95$, therefore the critical value is the value for which

$P(Z) = 0.95$

From Table 3.4 in Appendix I, $P(1.64) = 0.95$

$$Z_{x/x} = \frac{\frac{x}{120} - 0.5}{\sqrt{\frac{(0.5)(0.5)}{120}}}$$

Hence,

$$1.64 = \frac{\frac{x}{120} - 0.5}{\sqrt{\frac{(0.5)(0.5)}{120}}}$$

$$\frac{x}{120} = 0.575$$

Therefore, $x = 69$

This implies that the null hypothesis h_o should be rejected if x (that is the number of respondent that oppose the null hypothesis) is greater that or equal to 69.

Written mathematically as

If $x \geq 69$ reject h_o

But table 3.1 shows that $x = 93$, therefore we have to reject the null hypothesis and aspect the alternate that the establishment of a mechanic village is preferred.

3.3. MODEL DEVELOPMENT FOR THE PROPOSED MECHANIC VILLAGE (AUTOMOBILE RECONDITIONING CENTRE)

There is no gainsaying the fact that automobile reconditioning centres had been introduced in some States of the Federation early in the form of mechanic villages. However, such centres as were established then lack the basic impetus for survival as there were no working equations modelled for them.

A model can be described as an abstract of reality which presents and simplifies a complete version of a real object but lacks the reality that makes the real object function. Malas and Seetharaman (1992) and Levin (1989), reported that the process of converting the verbal description and numerical data into mathematical expressions, which will capture the relevant relationships, goals, and restrictions of any particular system, is known as modelling/model building and the resulting mathematical description is called a model.

According to Edward and Hamson, (1993) model is a skilled and perfection acquired from experience. A modeller need not to consider already derived sophisticated equations but should pay great attention to basic and simple existing facts towards derivation of his/her model.

Some of the importance skills involved in mathematical modelling are: -

1. Making an exhaustive list of factors by identifying variables, parameters and constraints of the system to be modelled, some of which can be linked together in groups.

2. Thinking carefully about your assumption and trying to make a complete and accurate list. Assumption is important to make progress with our model building other wise model development may be a limitation on his own.

3. Trying to identify variable that affect each other and how the relationships can be represented mathematically.

4. Care is needed when translating verbal statement into mathematical equations. The verbal statements are often vague so that there are a number of mathematical options. We should choose simple forms in preference to complicated ones.

5. Comparing the relative sizes of the terms appearing in your equation. This can lead to simplifications without loss of accuracy and also helps to pinpoint areas where more details are required.

6. Reducing the number of parameters to the minimum if you can. This ultimately decreases the amount of computation required.

Groover (1992) clarified that one of the first steps in the study and analysis of a physical process (including most industrial processes/systems) is to develop mathematical models to represent the process or system. This, however, must have geared various researchers such as Aderoba et al (2003); Offiong (2002); Charles-Owaba and Popoola (2002), to mention a few, towards model development in various areas of the engineering field. It is worthwhile to report that such models have been found to give a very good representation of the various stochastic and deterministic conditions of the process/system been modelled.

Modelling was considered in this study in other to assist the result of the hypothesis that was tested above, using part of the data collected from our field survey,

and bearing in mind that there are no existing working model for such automobile reconditioning centre that was preferred by the mechanics as authenticated by the inference of the hypothesis testing.

This aspect of the study is intended to develop reasonable working equation (after due consideration of salient and important characteristic and constraints of the system) which will serve as a standardized working equation for the establishment of such centre based on the proposed layout and bring about functionability and reliability of the system.This study employ the use of deterministic model in which the behaviour of a system is known and con be determined.The models employ suitable heuristics to simplify the rather cumbersome analytical techniques. This was done in the following sections of the work in this chapter.

3.3.1 Model for determination of workshop location

The factors involved in formulating such location model include,

a) Location of spare part shop:

This includes:

(i) Distance, d_{ij}, between the available spare part markets j, and the intended automotive reconditioning centre location, I, of the workshop.

(ii) Number of shops selling spare parts, N_j., in these different spare part markets, J_1, J_2, etc.

Factor (i) provides for the ease with which an automobile technician can get to a place to purchase spare part to work for their customer when the need arises while factor (ii) provide for probability of getting the required part at an appropriate price in a particular spare part market.

b) **Accessibility of the intended location of the workshop by customer, K.**

Our objective therefore is to formulate a model relating L_i (the location index for a mechanic workshop with d_{ij} and N_j, where K is the constant of proportionality. Alternatively, we could have defined L_i in terms of the amount of money spent on transportation and cost of availability of spare parts.

Assumptions for the model:

(1) L_i is directly proportional to N_j

(2) L_i is inversely proportional to d_{ij} i.e. L_i increases as d_{ij} decreases.

The mathematical consequence of assumption (1) is that

$$L_i \propto N_j$$

The mathematical consequence of assumption 2 may be difficult to infer for the evolving equations will become cumbersome, however, some possibilities are as follows

(a) $L_i \propto -d_{ij}$

(b) $L_i \propto \frac{1}{d_{ij}}$

(c) $L_i \propto \frac{1}{d_{ij}^2}$

(d) $L_i \propto \frac{1}{d_{ij,\mu}}$ where μ is a parameter that is dependent on the degree or smoothness of the road surface.

Models such as this have been developed and used successfully (Edward and Hamson, 1993). Generally, it is found that the effect of distance is quite pronounced and that L_i decreases with d_{ij} more sharply than both the linear model (a) and the inverse model (b). The inverse square model (c), Seems to be about right and by analogy with the

inverse square law of Newton's mechanics this is often known as the gravity model. In this study we shall use the inverse square model (c)

Therefore, a combination of assumption 1 and 2 gives

$$L_i \alpha \frac{N_j}{d_{ij}^2}$$

Which gives $L_i = \frac{KN_j}{d_{ij}^2}$ where K is the constant of proportionality.

The most practical way to proceed with the model is to calculate the quantity

N_j / d_{ij}^2. For all i and j

And to find the sum (SL_i)

$$SL_i = K \sum_{j=1}^{j=j_{max}} \frac{N_j}{d_{ij}^2} \quad \text{.....(3.1)}$$

Hence equation (3.1) gives the model equation for locating such automobile technicians village. The location that has the highest location index sum SLi of all the locations considered should be selected for the location and establishment of the automobile-reconditioning center. The constant K values which is intended to reflect the accessibility i.e. the ease with which a customer will want to visit a given center location in order to fix a fault, K_1, K_2, K_3..... K_1 may be used to account for flexibility in the model. We could use different K values for the different zone proposed for location of the center to reflect the accessibility of such center.

3.3.2 Model for determining the size of the village

The proposed layout and the extracted layout of a workshop in the village are as shown in Appendix II & III . This takes into consideration easy assess into the various

workshops by the vehicles, ease of evacuation of people and vehicles, quick assess to tools, and proper ventilation and illumination to improve the efficiency of the workers.

To develop a model for determining the size of the village the following factors were considered.

1) The maximum length, A_L, of the type of vehicle to be repaired in the sector.
2) The maximum width, A_w, of the type of vehicle to be repaired in the sector.
3) The width C_w and length C_L of the corridor for passage of people.
4) The width R_w of the reception room.
5) Office width, O_w and stores width S_w.
6) X_w = Other considered allowance for future development along the workshop width.
7) X_L = Other considered allowance for future development along the workshop length.

Assumption

- A mechanic village must consist of a reception, one each of mechanic, panel beater, painter and auto technician workshop and other necessary amenities as evidence from the proposed layout in appendix II, but a central reception is considered in our layout for customer waiting room and relaxation spot.
- All workshops in a particular mechanic village must have the same dimension including the offices and stores.
- Office width is equal to the store width. This assumption can be corroborated with the layout structure.

- 228.6mm/450mm blocks were assumed to be used for the construction/block works in the village.
- All dimensions were considered in millimeters for uniformity, hence all other dimensions should be analyzed in millimeter.

From the data recovered during the assessment process, this study was able to arrive at the following dimensional relationship between the size of the automobile to be repair and the size of the workshop in which the repair is to be carried out as follows.

Workshop width, $W_w = 2.51A_w$

Workshop length, $W_l = 2.36A_l$

Where A_w and A_l are automobile/vehicle width and length respectively.

From the layout diagram and implementing the assumption for the model, it is obvious that the size of the land can be modelled as below.

Let, the total width of a workshop including office and store = W_{wt} and

The total length of a workshop including office and store = W_{lt}

Then

$W_{wt} = W_w + S_w + 450 = 2.51A_w + S_w + 450$

$W_{lt} = W_l = 2.36A_l$

If the length and breadth/width of the proposed village is designated as V_l and V_w respectively.

V_l = (The sum of the total width of a workshop including office and store for the number of workshop intended for the village) + R_w + $2b_g$ + 1200 (for gutter allowance) + 900 (for gutter blocks size) + X_{w1} + X_{w2}

Written mathematically as

$$V_L = \sum_{i=1}^{i=n} (2.51A_{wi} + S_{wi} + 450_i) + R_w + 2b_g + 1200 + 900 + X_{w1} + X_{w2}$$

$$V_L = \sum_{i=1}^{i=n} (2.51A_{wi} + S_{wi} + 450)n + R_w + 2b_g + 2100 + X_{w1} + X_w \quad \ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

Where b_g is the gutter width and n is the number of workshops to be included in the village.

Similarly,

V_w = (The total length of a workshop including office and store) + C_w + $2b_g$ + 900 (for gutter blocks size) + r + 1200 (for gutter allowance) + X_L

Where r is the standard road width. The standard road width r is 40feets.

$\therefore r = 40ft = 12000mm$

$\therefore V_w = 2.36A_L + C_w + 2b_g + 900 + 12000 + 1200 + X_L$

$= 2.36A_L + C_w + 2b_g + 900 + 12000 + 1200 + X_L$

Hence, $V_w = 2.36A_L + C_w + 2b_g + 14100 + X_L$ ---------- (3.3)

3.3.3 Model for Easy Evacuation of the Village (Number of Entrance/Exit)

From time to time, any organization occupying a large building will want to practice an evacuation procedure in case of an emergency. Such an evacuation may be required for a variety of reasons. Therefore we may want to have some ideas of how long it will take for the building to be emptied. This will then enable us to decide whether the numbers of exit routes are sufficient to cope when the building is full capacity or not.

Assumption

The corridor is wide enough for only one column of people to file along through the exit door in safety.

Procedure:

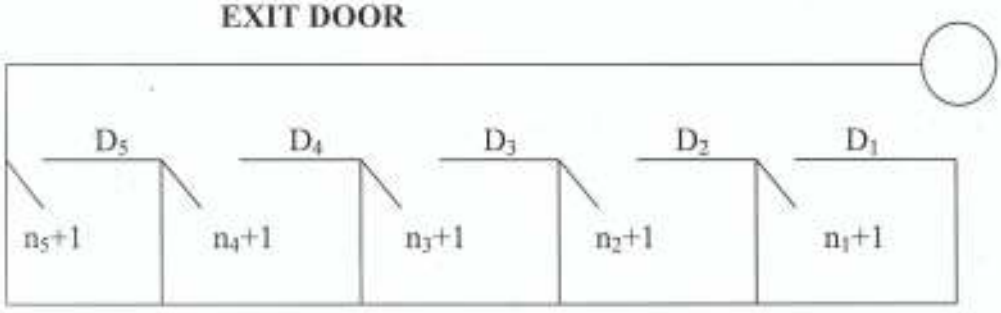
We first consider an orderly departure from a single room. Lists of the relevant variables that will help to clarify the situation are:

Let $n_i + 1$, denotes the number of people in the room

d (m), be the average spacing between each person

v (m/s), be the average constant speed everyone walks

Fig. 3.1: DIAGRAM SHOWING A WORKING DISTANCE THROUGH EXIT DOOR



Consider room 1, the reception

Lengths of chain of people filling out of the room

$= n_1 d$., (This assumes that the first person starts at the Di)

Time needed for every one to leave, t_o.

$$= \frac{n_1 d}{v} \qquad \text{---------- (3.4)}$$

Let t_o = Initial short delay while the first person reaches the door

The total room emptying time for the first room i.e. reception is,

$$T_{11} = t_o + \frac{n_1 d}{v} \qquad \text{---------- (3.5)}$$

From the diagram, as at the door of the first room there is still a distance D_1 to walk to the exit door, an additional time of $\frac{D_1}{v}$ is needed for this. Thus, the final total time for the first room to be completely evacuated, T_{fi}

$$T_{F1} = \frac{D_1}{v} + \frac{n_1 d}{v} + t_o \qquad \text{---------- (3.6)}$$

But that is after considering the first room (i.e. reception). If reference is made to the second room (i.e. the auto technician workshop ATW), which is a different size from the reception and contain different no of people. It is likely that t_o, v and d are the same.

$$\therefore T_{f2} = \frac{n_2 d}{v} + t_o \qquad \text{----------(3.7)}$$

Also since corridor length that the people from this workshop have to walk along before getting to the exit is $(D_1 + D_2)$ m.

$$T_{f2} = \frac{D_1 + D_2}{v} + \frac{n_2 d}{v} + t_o$$

This equation holds if the corridor is wide enough so that no delay takes place during the evaluation. In a similar way, it can be deduced that

For the mechanical workshop

$$T_{f3} = \frac{D_1 + D_2 + D_3}{v} + \frac{n_3 d}{v} + t_o$$

For panel beater workshop, the 4th room

$$T_{f4} = \frac{D_1 + D_2 + D_3 + D_4}{v} + \frac{n_4 d}{v} + t_o$$

For spray painter workshop, the 5th room

$$T_{f5} = \frac{D_1 + D_2 + D_3 + D_4 + D_5}{v} + \frac{n_5 d}{v} + t_o$$

:- Generally speaking the time for evacuating the j^{th} room modeled as in equation (3.8)

$$T_{ij} = \sum_{j=1}^{w} \frac{D_j}{v} + \frac{n_j}{v} + t_w \qquad \text{----------(3.8)}$$

So that the total evacuation time of the village will be

$$T = \sum_{j=1}^{w} T_{ij} \qquad \text{----------(3.9)}$$

Where m is the total number of workshops in the village. The implication of this model is that the evacuation time of a given village established with this model can now be calculated and compared with the expected evacuation time to determine whether the number of exits for people should be one or more.

3.3.4 Modeling of the Village for Proper Drainage

Also, it is our observation that there should be proper drainage; therefore this study decided to provide hints to modeling for the drainage system standing as a guide to other further interested researchers on this aspect with a view to propose adequate parameters of expected drain.

The critical question will be whether the gutter can hold all the rainwater without overflow? This means that we are interested in the height, h, of water in the gutter at a particular time which should not be greater than the total height, h_g, of the gutter itself.

Model development

If we apply the principle of "rate of flow" to the system

Volume rate of change in water in the gutter = inflow rate from rain - outflow rate down the drain pipe.

$$V'(t) = Q_i - Q_o \qquad \text{----------(3.10)}$$

Note that Q_i and Q_o are volume flow rates.

This model however assumes that.

1) All the rainwater falling on the roof will enter the gutter.
2) Rainwater falling directly into the gutter can be neglected (very small).
3) There are no unforeseen blockages in the systems due to debris.
4) Rain falls straight down onto the roof.
5) Rain does not splash away on hitting the roof.

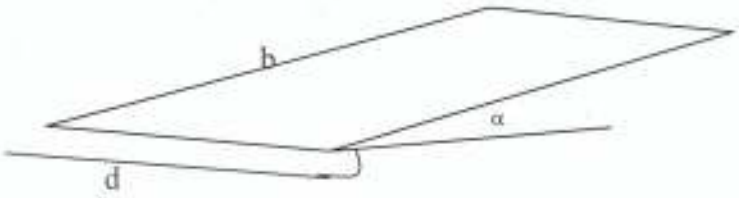


Fig. 3.2.: Roof of a typical mechanic village

From Fig. 3.2 it is obvious that the area of the root is bd.

: Area on which rainfalls = bd Cos α

: Volume rate of rainfall on the roof = r (t) bd Cos α where r is a linear variable in (m/s).

This is because the inclination of the roof will affect the flow rate into the gutter. The steeper the roof, the faster will be the component of the rain velocity down the roof.

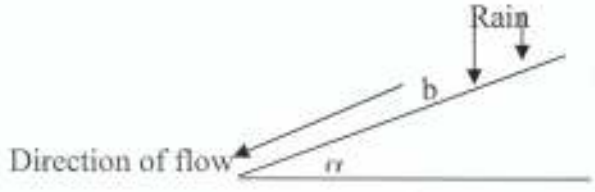


Fig. 3.3.: Component of rain velocity down the roof

A simplification of what actually happens as rain is falling on top of water that is already flowing down into the gutter can be obtained from Fig. 3.3. as;

$Q_i = r$ (t) bdSinαCosα.

Volume of water lying in the gutter at any moment

= Gutter cross-sectional area (base) x length, (d) of gutter.

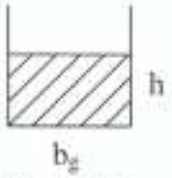


Fig. 3.4.: A cross-section of the Gutter

From the diagram, Base area of the gutter $= b_g \times d$.

Maximum volume of water in the gutter at any time is

$V(t) = b_g \times d \times h$

But what is required is the rate of change of V(t).

If we assume that the outflow from the gutter is through a vertical drain pipe, and apply Torricelli's law of energy conservation, which says that the potential energy lost over the height h is balanced by the pipe kinetic energy gained on exit down the drain pipe. Thus, the exit velocity is $\sqrt{2gh}$.

Let A_g = cross-sectional area of the drain pipe

$\therefore Q_o = A_g\sqrt{2gh}$.

To find the volume rate of change of water in the gutter

$$V'(t) = \left(dV/dh\right)\left(dh/dt\right)$$

$$= b_g \times d \left(\frac{dh}{dt}\right)$$

Returning to the main flow equation and substituting for the flow rates gives the differential equation in equation 3.5 below

$$b_g \times d \quad \left(\frac{dh}{dt}\right) = r\,(t)\, bd\mathrm{Sin}\alpha\mathrm{Cos}\alpha - A_g\sqrt{2gh}$$

$$\therefore \left(\frac{dh}{dt}\right) = \frac{r(t)\, bd\mathrm{Sin}\alpha\mathrm{Cos}\alpha - A_g\sqrt{2gh}}{b_g d}$$

$$h'(t) = \frac{r(t)\, bd\mathrm{Sin}\alpha\mathrm{Cos}\alpha - A_g\sqrt{2gh}}{b_g d} \qquad \text{----------(3.5)}$$

Where h'(t) = height of water in the gutter at a particular time, r(t) is the rate of rainfall, b is the slant height of the roof; d is the length of the roof, α is the roof's angle of inclination. A_g is cross-sectional area of the drain pipe, b_g is the breadth of the gutter and h is the height of the gutter.

Given that we have the necessary data for the b, d,α, A_g and b_g, solving the differential equation (equation 3.5) will give us h(t), the height of the water in the gutter at any time. Hence if we know the rainfall rate r(t), then the depth h can be determined.

CHAPTER 4

4.0 RESULTS AND DISCUSSION

4.1 RESULT OF ANALYSIS OF THE DATA COLLECTED

Fig. 4.1 shows that 53 percent of the respondents have more than 10 years experience while 42 percent have between 6-10 years experience and only 5 percent have between 1-5years automotive maintenance experience. An overview of this figure shows that the respondents are experienced enough to give useful information for the study. However, Fig. 4.2 indicates that most of the respondents do not have good education therefore care was taken in conducting this assessment via personal follow up and a not too open method of asking question.

Fig.4.3 shows that 78 percent of the respondents acquired the land they are using for their workshop through rent, 19 through lease while only 3 percent of the respondents actually purchased the land they are using. This, as the study reveals, is due to the fact that lands are not available for sale in strategic areas where location of workshops can be lucrative and the few ones that are available are very expensive which make it difficult for auto mechanics to acquire. However, the major problem with landed facilities for this group of people was revealed by Fig. 4.4, which implies that only 31 percent of the respondents that either rented or leased land have cordial relationship with their landowner. These constitute a great problem to Automobile technicians. However the government or wealthy individuals can come to their rescue through the establishment of mechanic villages.

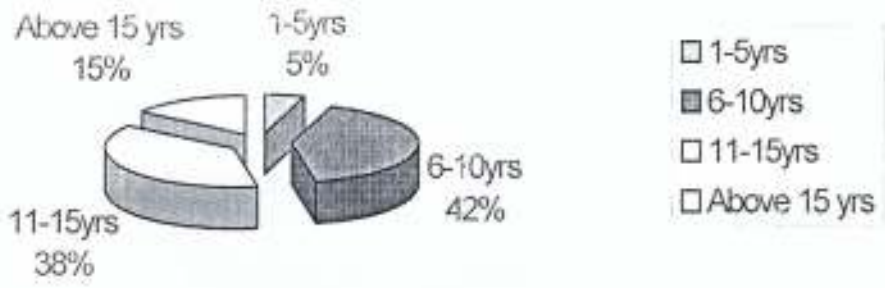


Fig 4.1: Distribution of Auto mechanics consulted, for this study, in Akure in term of year of experience

Fig 4.2: Distribution of auto-mechanics in akure according to their education level

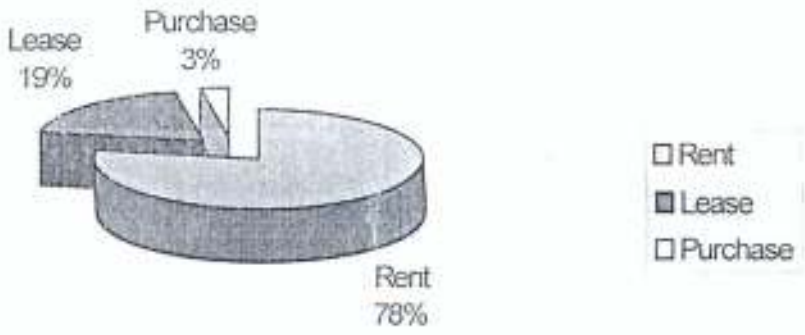


Fig. 4.3: Distribution according to method of acquisition of land by auto-mechanics in Akure

Fig. 4.4: Auto mechanics distribution in Akure with reference to their relationship with their landowner

Fig. 4.5, 4.6 and 4.7 reflects, in picture, the result of our questionnaire administration as regard other important requirements necessary in mechanic workshop such as the availability of repair pit, standard tools and repair/troubleshooting equipment and the nearness of the workshop to spare part stores/markets respectively. Fig. 4.5 reveals that 64 percent of the respondents have repair pit in their workshop while Fig. 4.6 shows that only 22 percent of the respondents have almost all (precisely 90 percent) the tools and equipment required. This mean that most of the workshop of the Automobile technician do not have all facilities necessary to facilitate their work and this was believed to be associated with the poor economy in the country. This is probably one of the reasons why 67 percent of the respondents are sharing landed facilities with panel beater, painter and auto technician as in Fig. 4.8. This Figure also reveals that it is preferable for these workmen with almost similar but technically different job to be together in each location. This according to these research findings draws more customers to the location, help facilitate their works and provide for a tendency to availability of almost all required facilities.

Fig. 4.7 also reveals that 48 percent of the respondents representing the largest group have their workshop situated within 2km of the nearest spare part stores/market as against other groups whose distance is farther.

Fig. 4.5: Position of Mechanics workshop in Akure according to availability of pit.

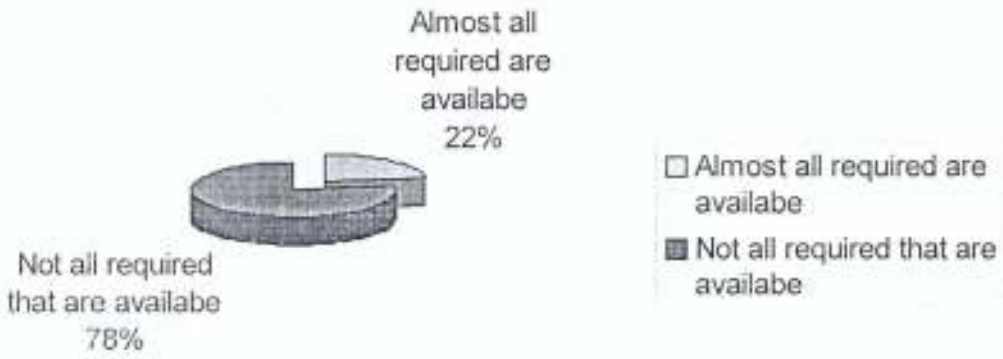


Fig. 4.6: Distribution of Mechanic workshop in Akure according to the availability of all necessary/required tools and equipments

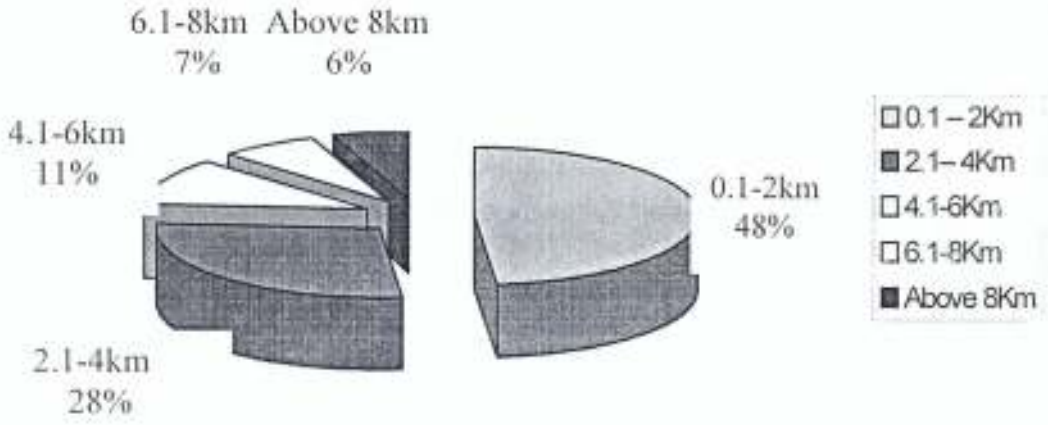


Fig. 4.7: Distribution of Mechanic workshop in Akure according to their distance to the nearest spare parts market

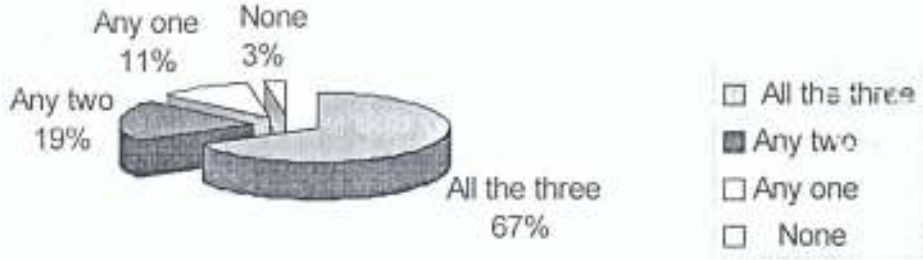


Fig. 4.8: Distribution of mechanic workshop as they share land usage with any of Panel beater, Auto technician & Painter in Akure.

Fig. 4.9 gives the distribution of the respondents consulted to give information on spare parts related to problems facing automobile technician. While 33 percent of the respondent has been selling part over 10 years ago, 54 percent of them have been selling it for a range of year between 6 and 10 years, which implies that the information collected should be reasonably accurate. According to Fig. 4.10 very few respondents (approximately 10 percent) have almost all (95 percent) of the parts required for purchase by their mechanics customer so that more spare part dealers/sellers are required very close to a mechanic workshop to guarantee part availability.

Fig. 4.11 revealed another problem facing automobile technicians where the majority of the part dealers (80 percent of the respondents to be precise) help their car owner customer to fix some of the part bought from them. This to a large extent always deprives the automobile technician of the necessary revenue/income. Even though, it can be said that the part dealers are doing this as a form of customer satisfaction, it is also important that the mechanics position should be considered and proper/necessary legislation enacted to assist them so that other people will not be doing their jobs for whatever reason.

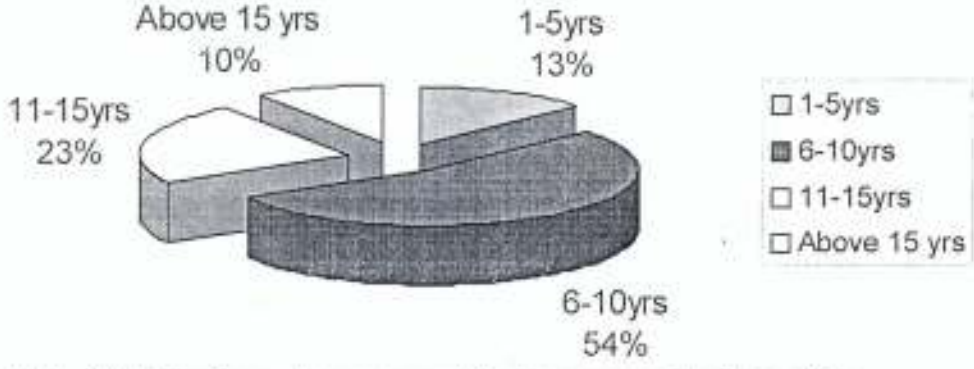


Fig. 4.9: Distribution of spare part dealers consulted, for this study, in Akure in term of year of practice

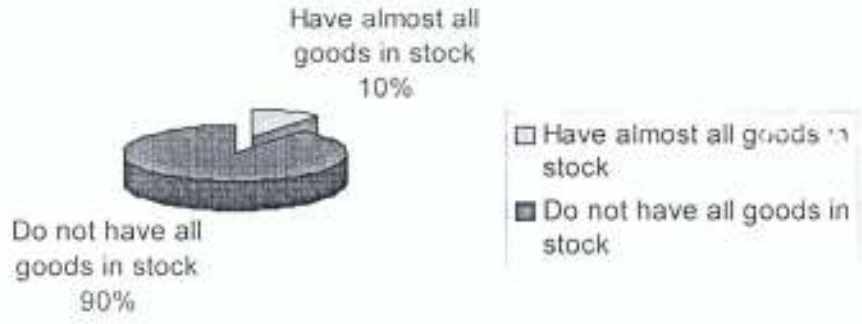


Fig. 4.10: Distribution of spare part dealers with respect to availability of goods in stock in Akure

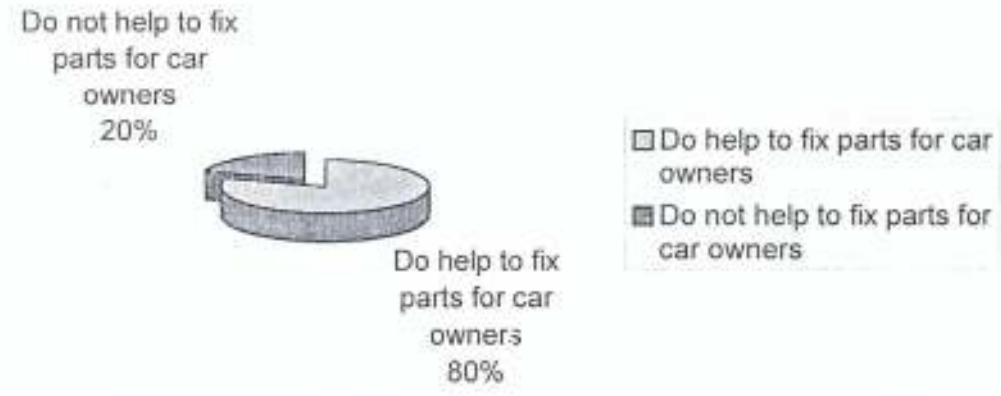


Fig. 4.11: Distribution of spare part dealers in Akure according to whether or not they help to fix parts for car owners

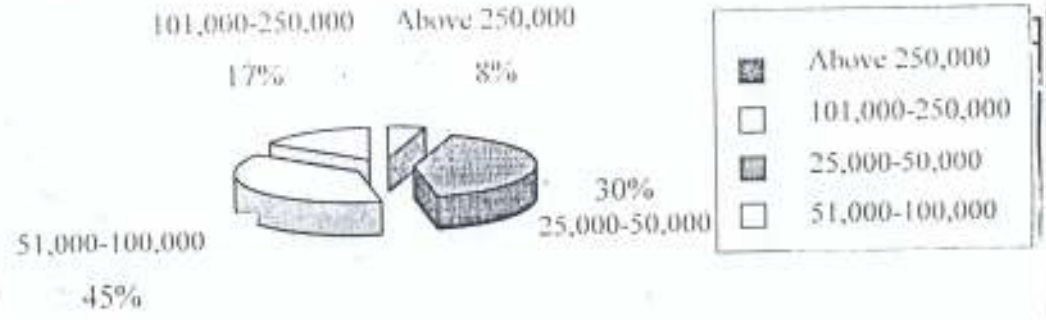


Fig 4.12: Distribution of Auto mechanics consulted, for this study, in Akure in term of minimum set-up cost

As the data in Table 3.3 turn out after analysis, the customer was found to be satisfied with the jobs done by automobile technicians with an average rating of 3.54. However some personal oral interviews conducted vis-à-vis questionnaire administration reveal that because of the low level of education, automobile technicians tend to advise car owners wrongly, which often is expected to affect the quality of their work. This

implies that the automobile technician can be very productive if there are moves/measures by government or wealthy individuals to ameliorate some of the problems facing them that have been identified by the analyses in this study. Some of these problems according to the analyses above are given in the next section

4.2 OBSERVED PROBLEMS FACING AUTOMOBILE TECHNICIAN

Most automobile technicians face a lot of problems in their every day practice. This calls for an immediate solution to achieving a standard workshop system with optimum performance. The problems being faced by the road side mechanics are vast but could best be summarized, according to this study, as follows:

4.2.1 Problem of inadequate tools

The use of inadequate tools in the execution of jobs in the workshop leads car owners into unnecessary danger. Most of these technicians use tools of low quality because they cannot afford the high quality ones that enhance proper fitting required by most screws and nut, which are vital in vehicle parts. Engines are removed manually instead of using crane or hydraulic lift. This was established in fig. 4.6 that show that a whooping 78% of the workshops interviewed do not have adequate tools while the remaining 22% that appear to have fairly adequate tools have such tools characterized with sub-standard attribute. The results are stress and consequent damage to auto parts.

4.2.2 Problem of Bad Location

Workshop location stands to be another major problem facing our auto mechanics. A well- located workshop allows for accessibility and visibility. It also allows for easy location and description. Fig 4.3 implies that 78% of the respondents acquired their land through rentage, 19% through lease and only 3% through outright

purchase while fig 4.4 shows that only 31% of the respondents have cordial relationship with their landlords. The government does not give adequate priority attention to allocation of land for auto-workshop establishment rather they allocate land in areas regarded as setback initially to estate areas, industrial areas and some others. These allocated areas are usually very small to accommodate all the required section for auto repairs. Road expansion leads to relocation of such workshop, which have negative effect on the new set up.

4.2.3 Poor Educational Background

According to fig.5.2 only 6% of the auto technicians interviewed were OND holders which represent the highest educational qualification of all the respondents. 8% had City and Guilds Certificates, 19% primary school, 11% school certificates and 56% apprenticeship. This has caused a major setback in that most of the Auto technicians are ignorant and not quite familiar with the advancing technological know-how of the trade. Some of the road mechanics can not read and write talk less of identifying the vehicle components and maintaining them properly according to instructions in manuals. This has accounted for one of the factors contributing immensely to vehicle accidents in developing countries.

According to Inyang (1991), bad mechanics contribute to accidents because vehicles not properly repaired and maintained are prone to accidents. In alleviating this problem, Inyang (1991), reported the efforts of the Inyang Ette Motors, Calabar, in ensuring that their Auto technicians usually undergo courses at PAN Kaduna and ANAMCO Enugu. In addition the mobile workshops of ANAMCO do visit Inyang Ette workshops from time to time teaching the mechanics the latest method in vehicle repairs.

4.2.4 Low Capital Base

There is no establishment set up without prior consideration of the financial constraints. Fig. 4.12 revealed that 75% of the auto technician interviewed has a working capital less than a N100,000.00, 17% are operating between N101,000.00 - N250,000.00, 8% are operating between N251,000.00 – N1,000,000.00 above. This implies that most auto technicians workshops are of low standard because of low capital base. Hence, many experienced auto-technicians end up as a Forman in workshop owing to problem of inadequate capital to get established. Many of the technicians established workshop that can best be describe as oil changing centres, their capital is so low that they can not afford to buy good spanners and other tools.

4.3 PROPOSED SOLUTION

Having identified some of the problems facing automobile technicians, the following propositions towards solving most of the problems are suggested:

- Automobile technicians should be educated via conduct of seminar, exhibitions and the likes for them and this can be done easily when they are together in selected locations;
- Government/wealthy individuals should embark on the development of mechanic villages (as one shown in appendix II) that should be let out to automobile technicians at a subsidized rate. However, government should enact law restraining any automobile technicians to have his/her workshop in a mechanic village. This will solve some of the problems they are facing on acquisition of land facility and other necessary facilities for their workshop.

- Such village should be planned to accommodate panel beater, painter and auto technician as our analysis had revealed that when this people are together it is better for their productivity and efficiency.
- Also, availability of spare parts and easy access to spare parts market should be taking into consideration when determining the location of such village.
- Such village it is believed will facilitates the provision of certain expensive facilities required for increase productivity that could be shared for use among the occupant of the village. This can be easily achieved as people within the same village can join together to procure expensive equipment and other facilities that are of mutual benefit to them.

4.4 MODEL APPLICATION/VALIDATION

The hypothesis that was formulated, analysed and tested in section 3.2 of the study confirmed that automobile technician would appreciate the establishment of a mechanic village which may serve as a form of solution to most of the problems facing them. Hence the study was conducted to embrace the development of model to serve as working equation that can be used to guide the establishment of such village. Two major salient characteristics of such village were modelled in section 3.3.1 to 3.3.2 with the other two additional section 3.3.3 to 3.3.4 serving as guide to further researchers on this study and the result are as given below

1. The locational model

$$SL_i = = k \sum_{j=1}^{j=j\,max} \frac{N_j}{d_{ij}^{\,2}}$$ *see section 3.3.1*

2. The size model

$$V_1 = \sum_{i=1}^{i=n} (2.51A_{wi} + S_{wi}) + 450n + R_w + 2b_g + 2100$$

$V_w = 2.36A1 + C_w + 2b_g + 14100$ *see section 3.3.2*

3. Evacuation/Number of entrance/exit model

$$Tfj = \sum_{i=1}^{n} \frac{D_i}{V} + \frac{n_i}{V} + t_o \qquad \textit{see section 3.3.3}$$

So that the total evacuation time of the village will be $T = \sum_{i=1}^{n1} T_{fi}$ for single exit

4. Drainage method

$$h^{\cdot}(t) = \frac{r(t)bdSin \propto Cos\alpha - A_g\sqrt{2gh}}{b_g d}$$ See section 3.3.4

This models were validated as shown below

4.4.1 The locational model: was applied for validation to two different locations selected from two ends of Akure township, as these locations are the places where spaces are available for the possibility of building the proposed village. Also four spare parts market were considered. One location is very close to Engineering Materials Development Institute. The shortest route from this location to Ilesha garage, Car street, Butcher and bypass spare part market were measured and found to be 3.9km, 5.2km, 9.3km and 3.5km respectively. The second location is close to Onyarugbulem market and its shortest route was found to be 4.5km, 3.6km, 1.5km and 4.8km from Ilesha garage, Car street, Butcher and bypass spare part market respectively. Also, the number of spare part selling shops in the four markets were found to be 500, 70, 30 and 36 respectively.

These data when fix in the developed model for Village location will give for EMDI location, E, the sum of location index $E(SL_i)$ as

$$E(SL_i) = K \sum_{j=1}^{j=j_{app}} \frac{N_j}{d_{ij}^2}$$

$$= \frac{420}{3.9^2} + \frac{70}{5.2^2} + \frac{30}{9.3^2} + \frac{36}{3.5^2}$$

$$= 33.5$$

For the Onyarugbulem location, O, the sum of location index $O(SL_i)$ as

$$O(SL_i) = K \sum_{j=1}^{j=j_{app}} \frac{N_j}{d_{ij}^2}$$

$$= \frac{420}{4.5^2} + \frac{70}{3.6^2} + \frac{30}{1.5^2} + \frac{36}{4.8^2}$$

$$= 41.04$$

This implies that the Onyarugbulem location have a better locational index compared with the other location, hence it should be used for the establishment of the village. It is important to mention here that if the available location are more than two, similar analysis should be carry out on the various locations and the locations with the highest unit of locational index should be chosen for the establishment of the village.

4.4.2 The Size Model: This is given by eqn. (2) and (3). For an average mechanic workshop that specializes in Datsun Nissan 2.0 repairs and long cars (Jeep), as obtained from our data collection, where A_w, A_L, S_w, C_w and R_w as shown in Appendix II & III are respectively 1600mm, 4200mm, 3000mm, 2000mm and 3600mm. The dimension of such a village that is expected to have 4 workshops can be determined as follows:

Village length

$$V_L = \sum_{i=1}^{i=n} (2.51 A_w + S_w + 450)n + R_w + 2b_g + 2100 + X_{w1} + X_{w2}$$

If the four workshops are to be repairing the same type of car say Datsun Nissan 2.0 in this case, then the formula reduces to

$V_L = (2.51 A_w + S_w + 450)n + R_w + 2_b + 2100 + X_{w1} + X_{w2}$

$= [(2.51 \times 1600) + 3000 + 450] \times 4 + 3600 + (2 \times 600) + 2100 + 6800 + 10000$

$= 44,764$ mm

Village width

$V_w = 2.36A_t + C_w\ 2b_g\ 14100 + X_t$

$= (2.36 \times 4200) + 2000 + (2 \times 600) \times 14100 + 16000$

$= 37,212$mm

Therefore

Village length, $V_L = 44,764$mm

Village width, $V_w = 37,212$mm

In reality, this size is obviously reasonable when compared to what is existing in standardized workshops in the country with a minimum workshop width of 4000mm and a minimum workshop length of 9900mm established by most standard service station workshops located in major marketers fuel stations in Nigeria.

The study into Optimizations of Auto repair practices using location and size model proffer solution to the set objectives of this research, however with further literature search two other models which were used by other investigators on evacuation and drainage models were presented in this study to compliment the effort of the size and location models.

CHAPTER 5

5.0 CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

5.1 CONCLUSION

The problems facing Automobile technicians have been investigated, and attempt has been made with success towards proffering solutions to the various problems identified. The study has been able to establish, through standardized statistical analysis after questionnaires administration, the numerous problems facing Automobile technicians. One of the solutions suggested was the establishment of mechanic village so that Automobile technicians and their colleagues can make use of the spirit of togetherness towards overcoming their various problems particularly in terms of finance and procurement of state of the art equipment which may be provided by the government or individual that is building the village or by the coming together of the mechanics in the village. The study suggests appropriate mathematical models for such mechanic village, which were developed in order to, standardise and facilitate the development of such village at the cheapest cost with high patronage. The models took into consideration the salient characteristics of a typical mechanic village such as nearness to spare parts, accessibility, the number of available shops in different spare part markets, the size of the village by considering maximum length and width of vehicle type to be repaired, reception width, office and store width. The models were applied to some selected locations and situations. There were other forms of problem identified from questionnaire analysis and necessary recommendations were suggested.

5.2 SUGGESTION FOR FURTHER WORK

Based on observation and experience, in the course of this study, it can be suggested from the point of view (as a guide in pointing out areas that could not be covered to other researcher) that,

1. Further work should be proposed on models for drainage, by identifying more variables, parameters and constraints of the system to be modelled for validation purpose. This will facilitate more dependable drainage system.
2. Model for evacuation is also suggested for further research work taking into consideration easy evacuation of vehicles in parking slots, people in the toilet & bathroom to aid a reliable system of optimum performance.

In addition this study is presenting the following as a form of suggestion that .Government or other relevant authority should try and exploit the possibility of using the models developed in this study in the development of mechanic village in the country with a view to alleviate the various problems facing the mechanics. Further to this

- Automobile technician should be educated, they should be taught how best to perform their duties easily using modern equipment.
- They should be advised on the procurement of standard troubleshooting equipment to facilitate fault detection. This they can do as a group in an established mechanic village.
- Car owners should be educated, by the Government or other relevant organizations, on what they should know about their faulty cars before taking it to the mechanics to assist the mechanic's decision on how to repair the fault.

REFERENCES

Adejuyigbe, S. B. (2002): Production Management (Design, Planning, Implementation and Control).

Adeniji, F.A. and Inegbenebor, A.O (2002): Impact of Maintenance on the Productivity of some Companies in the North-Eastern State of Nigeria. Journal of Industrial and System Studies. 1(1): 19-20

Adeoba, A. A., Kareem B. and Ogedengbe T. I. (2003): A Model for Progressive Inventory Management for Job-Shops. Nigerian Journal of Engineering Management. 4(1): 1-6.

AutoTips (2001): What your shop should know about your car. http://www.jonko.com/

Bob, Hewitt (1997): Vehicle Routing and Driver Scheduling. http://www.osiris.tuwien.ac.at/vehicle routing/

Charlse-Owaba, E. O. and Popoola O. P. (2002): A Model for selecting Electric Power system. Nigerian Journal of Engineering Management. 3(1): 19-25

Dhillon, B.S. (1980): Reliability and Maintainability Engineering in Engineering / Digest. pp 24.

Diagnostic Equipment Homepage: http://www.inet.net/auto/

Dolan, J. A. (1978): Motor Vehicle Technology and Practical Work Parts 1 and 2. pp468.

Edundare, R.O. (1973): An Economic History of Nigeria. Methuen & Co. Ltd. London. 1st Edition. pp 264.

Edward, D. and Hamson, M. (1993); Guide to Mathematical Modelling, Macmillan Mathematical Guides. The Macmillan Press Ltd., Hong Kong.

Encarta Encyclopedia Deluxe (2003): A software package Developed by Microsoft Inc.

Frank, H. and Althoen, S.C. (1994): Statistics: Concepts and Application. Cambridge University Press. The Pitt Building, Trumpington Street, Cambridge CB2 1RP

Groover, M. P. (1992): Automation, Production System and Computer-Integrated Manufacturing. Prentice Hall of India Private Ltd. New Delhi-110001. pp 808

Harold, T. A.; John, A.R and Oliver, S.H. (1984): Manufacturing Organization and Management. 4th Edition. Prentice-Hall Inc., Englewood Cliffs, N.J., U.S.A. pp 316-328.

Inyang, E.E (1991): Measure of Reducing Accidents and Improving productivity "The Private Sector Experience II" in Proceedings of the Training Workshop on "Accident Control and Safety Measures in Mass Transit Operations in Nigeria". Ibadan University Press, University of Ibadan, Ibadan Nigeria. pp 125-127.

Jarett, H. R. (1977): A Geography of Manufacturing. MacDonald and Evans Ltd. Plymouth. 2nd Edition.

Kothari, C. R. (1995): Research Methodology. Methods and Techniques, Second Edition, New Delhi, India.

Levin, I. R. (1989): Quantitative Approaches to Managements. McGraw-Hill Book Co. Singapore.

Lindley, R.; Higgin, P.E. and Morrow L.C. (1977): Maintenance Engineering Handbook. Mc-Graw Hill Book Company, U.S.A. 3rd Edition.

Malas, C. J. and Seetharaman V. (1992): Using Materials Behaviours Models of

Developing Process Control Strategies. The Journal of Minerals, Metals and Materials Society, USA. pp 8-12

Moubray, J. (1991): Reliability – Centred Maintenance, Burterworth-Heinemann Ltd Oxford, Britain. pp8-12

Offiong, O. (2002): Development of a Group Replacement Model for Low Cost Item in an Industry. Nigerian Journal of Industrial and System Studies. 1(3): 11-19

Okemiri, C. (2000): Maintenance Technology and Productivity. Journal on Productivity Improvement. National Productivity Centre. 19(1): 4-10

Seely, I (1972): Maintenance Practice of Vehicles. Edward Diton Ltd., U.K., pp 14

Terry, C. (1998): Bruckner Auto Repair Clinic: - Diagnostic Equipment. http://www.misterfixit.com/showcase.htm

APPENDIX I: CUMULATIVE PROBABILITIES FOR THE STANDARD NORMAL RANDOM VARIABLES

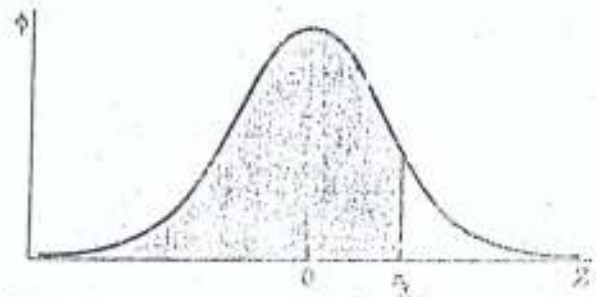
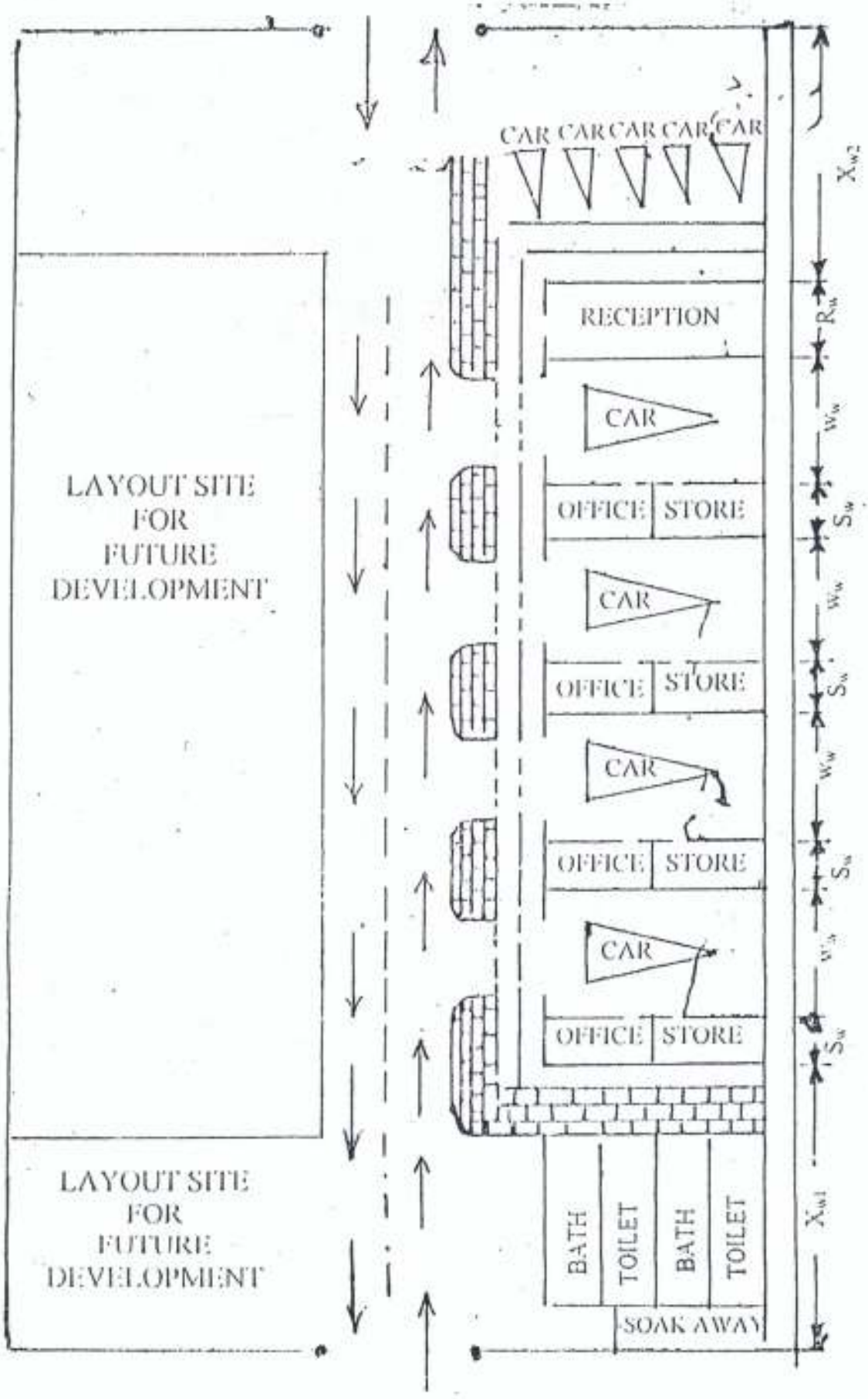


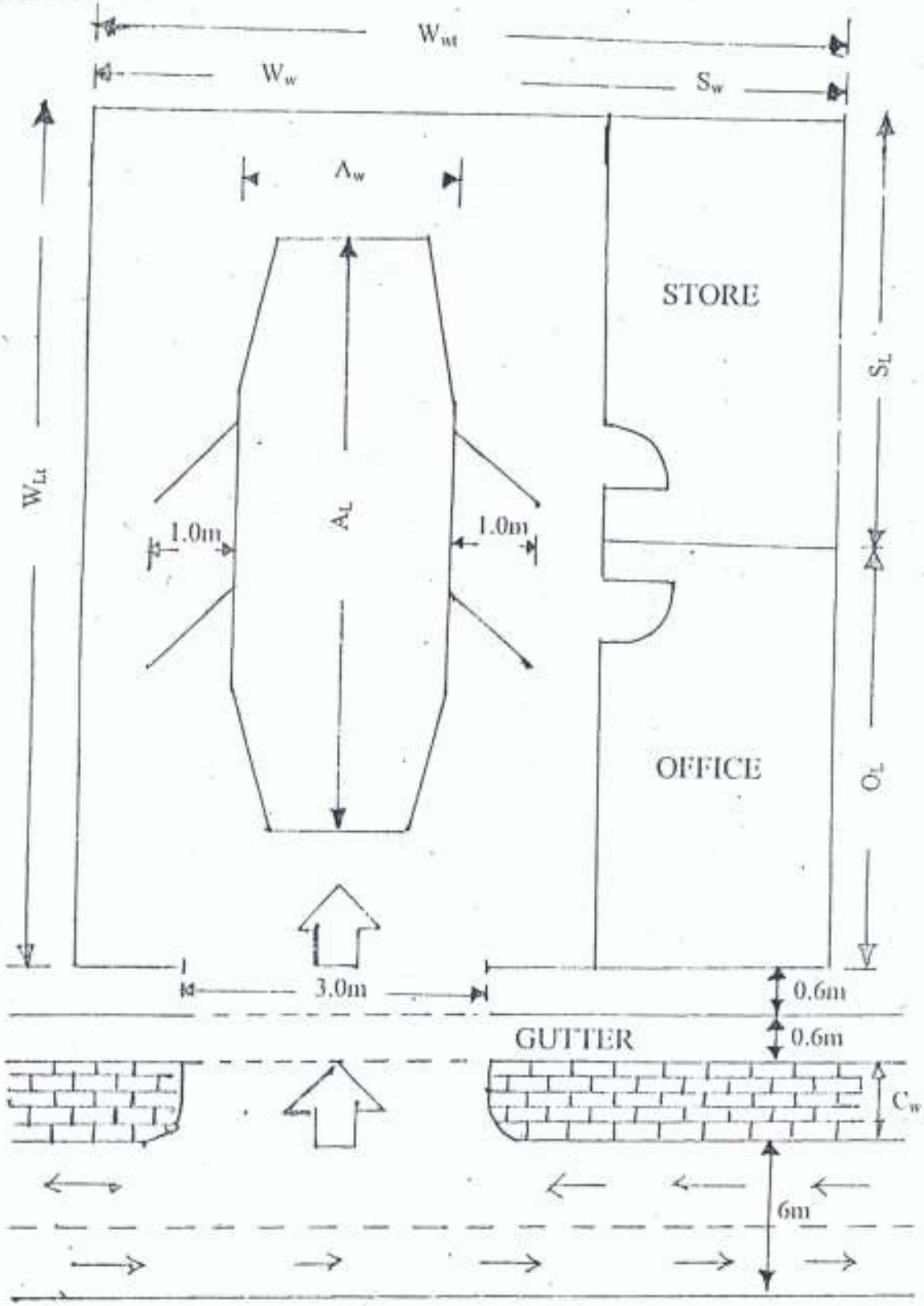
Table entry is shaded area, $\Pi(z_i)$.

z_i	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.0	$.^{3}1350$	$.^{3}1306$	$.^{3}1264$	$.^{3}1223$	$.^{3}1183$	$.^{3}1144$	$.^{3}1107$	$.^{3}1070$	$.^{3}1035$	$.^{3}1001$
−2.9	$.^{3}1866$	$.^{3}1807$	$.^{3}1750$	$.^{3}1695$	$.^{3}1641$	$.^{3}1589$	$.^{3}1538$	$.^{3}1489$	$.^{3}1441$	$.^{3}1395$
−2.8	$.^{3}2555$	$.^{3}2477$	$.^{3}2401$	$.^{3}2327$	$.^{3}2256$	$.^{3}2186$	$.^{3}2118$	$.^{3}2052$	$.^{3}1988$	$.^{3}1926$
−2.7	$.^{3}3467$	$.^{3}3364$	$.^{3}3264$	$.^{3}3167$	$.^{3}3072$	$.^{3}2980$	$.^{3}2890$	$.^{3}2803$	$.^{3}2718$	$.^{3}2635$
−2.6	$.^{3}4661$	$.^{3}4527$	$.^{3}4396$	$.^{3}4269$	$.^{3}4145$	$.^{3}4025$	$.^{3}3907$	$.^{3}3793$	$.^{3}3681$	$.^{3}3573$
−2.5	$.^{3}6210$	$.^{3}6037$	$.^{3}5868$	$.^{3}5703$	$.^{3}5543$	$.^{3}5386$	$.^{3}5234$	$.^{3}5085$	$.^{3}4940$	$.^{3}4799$
−2.4	$.^{3}8198$	$.^{3}7976$	$.^{3}7760$	$.^{3}7549$	$.^{3}7344$	$.^{3}7143$	$.^{3}6947$	$.^{3}6756$	$.^{3}6569$	$.^{3}6387$
−2.3	.01072	.01044	.01017	$.^{2}9903$	$.^{2}9642$	$.^{2}9387$	$.^{2}9137$	$.^{2}8894$	$.^{2}8656$	$.^{2}8424$
−2.2	.01390	.01355	.01321	.01287	.01255	.01222	.01191	.01160	.01130	.01101
−2.1	.01786	.01743	.01700	.01659	.01616	.01578	.01539	.01500	.01463	.01426
−2.0	.02275	.02222	.02169	.02118	.02066	.02018	.01970	.01923	.01876	.01831
−1.9	.02872	.02807	.02743	.02680	.02619	.02559	.02500	.02442	.02385	.02330
−1.8	.03593	.03515	.03438	.03362	.03288	.03216	.03144	.03074	.03005	.02938
−1.7	.04457	.04363	.04272	.04182	.04093	.04006	.03920	.03836	.03754	.03673
−1.6	.05480	.05370	.05262	.05155	.05050	.04947	.04846	.04746	.04648	.04551
−1.5	.06681	.06552	.06426	.06301	.06178	.06057	.05938	.05821	.05705	.05592
−1.4	.08076	.07927	.07780	.07636	.07493	.07353	.07215	.07078	.06944	.06811
−1.3	.09680	.09510	.09342	.09176	.09012	.08851	.08691	.08534	.08379	.08226
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.09853
−1.1	.1375	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−.7	.2420	.2389	.2358	.2327	.2297	.2266	.2236	.2206	.2177	.2148
−.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−.1	.4602	.4562	.4523	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7703	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8113
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8661
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	$.^{2}9897$	$.^{2}9838$	$.^{2}9863$	$.^{2}9888$	$.^{2}9911$	$.^{2}9934$	$.^{2}9956$
2.4	$.^{2}9918$	$.^{2}9938$	$.^{2}9940$	$.^{2}9951$	$.^{2}9963$	$.^{2}9973$	$.^{2}9981$	$.^{2}9989$	$.^{2}9996$	$.^{2}9998$
2.5	$.^{2}9379$	$.^{2}9883$	$.^{2}9412$	$.^{2}9297$	$.^{2}9457$	$.^{2}9614$	$.^{2}9766$	$.^{2}9915$	$.^{2}9060$	$.^{2}9201$
2.6	$.^{2}9339$	$.^{2}9473$	$.^{2}9604$	$.^{2}9731$	$.^{2}9855$	$.^{2}9975$	$.^{3}0091$	$.^{3}0203$	$.^{3}0311$	$.^{3}0417$
2.7	$.^{3}0533$	$.^{3}0636$	$.^{3}0736$	$.^{3}0833$	$.^{3}0928$	$.^{3}1020$	$.^{3}1110$	$.^{3}1197$	$.^{3}1282$	$.^{3}1365$
2.8	$.^{3}1445$	$.^{3}1523$	$.^{3}1599$	$.^{3}1673$	$.^{3}1744$	$.^{3}1814$	$.^{3}1882$	$.^{3}1948$	$.^{3}2012$	$.^{3}2074$
2.9	$.^{3}2134$	$.^{3}2193$	$.^{3}2250$	$.^{3}2305$	$.^{3}2359$	$.^{3}2411$	$.^{3}2462$	$.^{3}2511$	$.^{3}2559$	$.^{3}2605$
3.0	$.^{3}2650$	$.^{3}2694$	$.^{3}2736$	$.^{3}2777$	$.^{3}2817$	$.^{3}2856$	$.^{3}2893$	$.^{3}2930$	$.^{3}2965$	$.^{3}2999$

APPENDIX II: LAY OUT OF PROPOSED MECHANIC VILLAGE



APPENDIX III: LAY OUT OF TYPICAL WORKSHOP EXTRACTED FROM THE PROPOSED MECHANIC VILLAGE



APPENDIX IV: RESEARCH QUESTIONNAIRE I FOR AUTO TECHNICIAN

THE FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE
DEPARTMENT OF MECHANICAL ENGINEERING
RESEARCH QUESTIONNAIRE

TITLE OF RESEARCH STUDY: PROBLEMS FACING AUTOMOBILE MECHANICS IN NIGERIA, A SYSTEM APPROACH

IMPORTANT NOTE: This questionnaire has been prepared to assist in problem analysis and system formulation, with a view of solving to a large extent, the problems facing Automobile technicians in Nigeria. We wish to assure the respondents that all information supply in respect of this questionnaire shall be treated in confidence. It will be strictly considered for the purpose of problem analysis that will lead to suggestion of probable solution. Thank you for your anticipated cooperation.

PARTICULARS OF THE RESPONDENT

(i) Name of mechanic outfit.....

(ii) Name of respondent.....

(iii) Name of qualified staff in the outlet.....

(iv) How long has the respondent been practicing.....

(v) Level of education of the respondent (Tick as appropriate)

Apprenticeship ☐

- With primary school
- With secondary school

Technical College ☐

City and Guilds ☐

Polytechnic ☐

- OND
- HND

University ☐

Others if not of one of the above, specify.....

(vi) At what age did you start your career as a mechanic?.....

CUSTOMER RELATED QUESTIONS

i. How many customers do patronize you on regular basis.....

ii. How many of your regular customers do carry out preventive maintenance constantly.....

iii. How many of your regular customers do carry out breakdown maintenance .....

iv. What type of cars do you specialize on (Toyota/Nissan/etc)?.....

v. What type of engine do you specialize on (Tick as appropriate)

(a) Spark Ignition (Petrol Engine) ☐

(b) Compression Ignition (Diesel Engine) ☐

vi. Mention three common automobile mechanical fault usually brought to your workshop

(a)..... (b)..... (c).....

Vii what kind of spare parts do customers prefer for replacing the damaged one.

Second hand ☐

Brand new ☐

vii what effect do you think this has on you as a mechanic?

.....

.....

.....

EQUIPMENTS AND TOOLS RELATED QUESTIONS

i Do you have:

(a) Pit Yes/ No.....

if (No) how do you check for and repair faults under the car

.....

.....

.....

.....

(b) Engine Test Bed. Yes/No.....

If (No) how do you test an overhauled engine prior mounting

.....

.....

.....

.....

ii Name any trouble shooting equipment if none explain your mode of finding fault.

.....

.....

.....

iii for all the basic tools to be acquired what is your expected minimum set up cost.....

iv what was your minimum set up cost?.....

v do you have any material handling system? Yes or No.....

if yes tick the one available in your workshop

- Hydraulic lift
- Crane
- Chain lift
- Fork lift

vi Tick any of the Engine Recondition machine mentioned below that are available in your workshop

- Injection servicing Machine
- Crankshaft grinding machine
- Submerged arc welding machine
- Lathe machine
- Milling machine
- Drilling machine

If any of these machines is unavailable, then how you carry out activities involving them? Explain below.

.....

.....

.....

.....

AVAILABILITY OF SPARE PARTS

i How far the nearest spare part-selling outfit to your workshop (km).....

ii do you always get all the spare parts you need from the spare part outfit or any other one within the town?.....

iii if (No) what percentage of the needed spare part do you normally get within this scope and how do you get others

.....

.....

.....

.....

WORKSHOP AND TENANCY

i How do you acquire the land you are using for your workshop? (Tick as appropriate).

Lease ☐

Rent ☐

Given freely for a period of time ☐

Bought ☐

ii If lease or rented, what is your relationship with your landlord

Cordial ☐

Not cordial ☐

iii How do you compare your treatment rate with your income.....

iv How frequent do you repair work?.....

TRADE ASSOCIATION IMPACT

i. How many mechanics Trade Union do you have in the town where your workshop is located.....

ii. Name the one you belong.....

iii. In what area is your Trade Union making to ameliorate the problem facing members of the union?

iv. What benefits in form of incentives do you derive from your union to facilitate your work?

v. How many are you paying as due to your union, how frequently (Tick as appropriate)

Daily ☐

Weekly ☐

Monthly ☐

Yearly ☐

vi. Tick any similar outfit you share your workshop with

- Panel beater
- Welder
- Rewire
- Vulcanizer
- Painter

vii. Do you prefer to be organized and located in a selected ----- like a mechanic village?

YES / NO

If Yes why?.....

If No why? .....

CAR OWNERS

1. Do you use your car for private or commercial?
2. What part do you prefer to use in repairing your car?
3. Tick your level of satisfaction as regards repair/service done by your Technicians.

Highly satisfied ☐ Satisfy ☐ Moderately satisfied ☐

Low ☐ Very low ☐

TRADE ASSOCIATION IMPACT

i How many mechanics Trade union do you have in the town where your workshop is located.....

ii Name the one you belong.....

iii I what area are your trade union making to ameliorate the problem facing members of the union.

iv What benefits in form of incentives do you derive from your union to facilitate your work?

v How much are you paying as due to your union, how frequently (TICK as appropriate)

Daily ☐

Weekly ☐

Monthly ☐

Yearly ☐

vi Tick any similar outfit you have around your workshop

- Panel beater
- Welder
- Rewire
- Vulcanizer
- Painter

vii Do you prefer to be organized and located in selected place like a mechanic village. Yes/No

If yes why?

If No why?

CAR OWNERS

i Do you use your car for private or commercial

ii What part do you prefer to use in repairing your car

iii Tick your level of satisfaction as regards repair/service done by your mechanic.

Highly satisfied, satisfied, moderate, low, very low

APPENDIX V: RESEARCH QUESTIONNAIRE II FOR SPARE PART SELLERS

AND CAR OWNERS

THE FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE
DEPARTMENT OF MECHANICAL ENGINEERING
RESEARCH QUESTIONNAIRE

TITLE OF RESEARCH STUDY: PROBLEMS FACING AUTOMOBILE MECHANICS IN NIGERIA, A SYSTEM APPROACH

IMPORTANT NOTE: This questionnaire has been prepared to assist in problem analysis and system formulation, with a view of solving to a large extent, the problems facing Automobile technicians in Nigeria. We wish to assure the respondents that all information supply in respect of this questionnaire shall be treated in confidence. It will be strictly considered for the purpose of problem analysis that will lead to suggestion of probable solution. Thank you for your anticipated cooperation.

SPARE PART VENDORS

i. How long have you been in this business?.....

ii. Do you always have all the spare parts required by your customers?.....

if (No) what can you say is responsible for this shortcoming?

.....

.....

iii. What is the possible solution you can suggest to eradicate the problem? .....

.....

iv. What percentage of your spare parts can be locally sourced?.....

v. Can you fix/install some of the parts bought by your customer in the absence of a mechanic?....

If Yes, what percentage of the spare parts do you always fix for the car owners?.....

vi. What kind/type of spare parts do you sell to the customers? Tick as appropriate

Second hand (SH) [ ]

Brand new (N) [ ]

Both (SH & N) [ ]

If both indicate the percentage composition: (SH).....%, (N) .....%

vii. Out of the type of spare parts as in (vi) indicate the one the mechanic/customers always prefer to buy for the different types of parts used below:

For Second hand write (SH) and for Brand new write (N) in front of the part.

- Bolts and Nuts	- Brake pad	- Spark plug
- Radiator	- Silencer/muffler	- Carburetor
- Kick starter	- Piston cup	- Injector
- Engine block	- Piston rings	- Crankshaft
- Cylinder head	- Connecting rod	- Camshaft
- Fuel pump	- Gear and Gear box	- Timing belt