

Design & construction of an ergonomic footrest for an electric three wheeler vehicle and development of an entrepreneurship scheme including supply chain management

A dissertation submitted in partial fulfillment of requirement for the degree of Bachelor of Science in Mechanical Engineering from Islamic University of Technology

Organization of Islamic Cooperation



Submitted By :

Mohimenu Islam (101404)

Md. Rakin Mashrur Khan (101418)

Khandaker Noman (101426)

Under Supervision of

Dr. A R M Harunur Rashid

Assistant Professor,

Department of Mechanical and Chemical Engineering,

Islamic University of Technology (IUT), Bangladesh.

Design & construction of an ergonomic footrest for an electric three wheeler vehicle and development of an entrepreneurship scheme including supply chain management

Approved By

Prof. Dr. Md. Abdur Razzaq Akhanda
Head of the Department & Professor
Department of Mechanical and Chemical Engineering
Islamic University of Technology (IUT)
Gazipur-1704, Bangladesh.

Supervised by

Dr. A R M Harunur Rashid
Thesis Supervisor & Assistant Professor
Department of Mechanical and Chemical Engineering
Islamic University of Technology (IUT)
Gazipur-1704, Bangladesh.

DECLARATION OF THE CANDIDATES

This is to certify that the work presented in this thesis is the outcome of the analysis and investigation carried out by Mohimenu Islam, Md. Rakin Mashrur Khan and Khandaker Noman under the supervision of Dr. A R M Harunur Rashid in the Department of MCE, IUT, Gazipur, Bangladesh. It is also declared that neither of the thesis nor any part of this thesis has been submitted anywhere else for any degree or diploma. Information derived from the published and unpublished work of others has been acknowledged in the text and a list of references is given.

Signature of the Candidates:

Mohimenu Islam
Student ID: 101404

Md. Rakin Mashrur Khan
Student ID: 101418

Khandaker Noman
Student ID: 101426

Dedication

To our respected mentor Prof. Dr. Abu Raihan Md. Harunur Rashid.

Acknowledgement

Every honor on earth is due to the Great Almighty, descended from Him and must be ascribed to Him. He has given us the capability to do this work with good health. This thesis is a result of research of one year and this is by far the most significant scientific accomplishment in our life. It would be impossible without support and appreciation of those who mattered the most.

We would like to thank our supervisor, Dr. A R M Harunur Rashid for his continuous guidance, inspiration and enthusiasm during the progress of the work. He has always been generous with his time, listening carefully and criticizing fairly.

We are also grateful to the Head of the Department Prof. Dr. Md. Abdur Razzaq Akhanda for his inspirations to complete the work.

Last but not the least we are thankful to our family and friends for their support over the whole time of our work. Without them it would never have been possible for us to make this far.

ABSTRACT

At present Bangladesh, electrical three wheeler vehicles are the most common means of short-distance transport. It is actually a modification of “Rickshaw”, a very old and popular transport of this region. Unlike rickshaw it runs on electricity, there is no use of pedals. That requires a footrest where the driver can keep their feet while driving. But the position and design of this footrest is delicate because it is directly related to human comfort and can cause health problems. In this study we have designed and built an ergonomic footrest for these vehicles.

In the second part of this Project we have worked on the supply-chain management of the small and médium industries of Bangladesh. Most of them do not use any scientific method for managing the drivers of the supply-chain in their factory like forecasting, inventory etc. As a result they cannot reach the desired profit. So, we did an overall research on developing an entrepreneurship scheme including supply chain management (SCM) for small and médium industries of Bangladesh.

Table of Contents

1. Introduction

1.1 Introduction.....13

1.2 Aims and Objective.....13

2. Literature Review

2.1 Literature Review.....15

2.2 Ergonomics.....15

2.2.1 Domains of ergonomics.....15

2.2.2 Importance of ergonomics.....17

2.3 Supply Chain Management.....18

2.3.1 Drivers of Supply Chain Management.....18

3 Theoretical Analysis of Driving Posture

3.1 Posture Angles in Rebiffe.....20

3.1.1 Recommended ranges for body segment angles from rebiffe.....21

4. Practical analysis of the problem

4.1 Problem of existing footrest.....23

4.2 Measurement of different portion of human body.....24

4.3 Percentage of problems faced by electric three wheeler drivers.....25

5. Designing of an ergonomic footrest

5.1 Design specification.....28

5.2 SolidWork design.....29

5.3 Design of parts in solidworks.....30

5.4 Footrest we built.....	32
5.5 Setup for feedback.....	34
5.6 Feedback process.....	35
6. Supply Chain Management for small and médium industries	
6.1 Present condition.....	37
6.2 Industry visitation.....	37
6.2.1 Industry visitation (Pushon Garments).....	37
6.2.2 Industry visitation(super shop).....	38
6.3 Comparison between these visits.....	38
6.4 Our suggestion	38
6.5 Application of ZAITUN.....	39
6.6 Graphs obtained by ZAITUN.....	39
7 Conclusion	
7.1 Conclusion.....	45
8 Bibilography.....	46

List of Figures

Figure 3.1: Driving posture angles.....	20
Figure 4.1: Problems faced in conventional three wheeler.....	23
Figure 4.2: Pie chart about major problems drivers facing.....	26
Figure 5.1: Overall view of the footrest.....	29
Figure 5.2: Footrest rod.....	30
Figure 5.3: Auto Rickshaw rod with through-hole.....	30
Figure 5.4: Pedals.....	31
Figure 5.5: Overview of footrest we built.....	32
Figure 5.6: Model assembly of the footrest.....	33
Figure 5.7: Setup of footrest in three wheeler during feedback.....	34
Figure 5.8: Using the footrest during feedback.....	34
Figure 6.1: Curve of actual sales vs. Time.....	40
Figure 6.2: Actual & Predicated graph over time.....	42
Figure 6.3: Residual graph.....	43

List of Charts

Chart 1: Measurement of different portions of human body.....	24
Chart 2: Percentage of problems faced by electric three wheeler drivers	25
Chart 3: Chart of actual sale over the year.....	39
Chart 4: Chart for actual sale, demand, forecast over the year.....	41

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This Project deals with designing and building an ergonomic footrest for electric three wheeler vehicle to ensure human comfort and satisfaction. It also deals with the study of supply chain management with an aim to establish an entrepreneurship scheme for small and medium industries of Bangladesh.

1.2 Aims and Objectives

- To study about ergonomics and its applications.
- To study about problems of footrest in electric three wheeler vehicle's .
- To design an ergonomic footrest of these vehicles.
- To build the footrest.
- To setup the footrest in three wheelers to collect feedback.
- To be familiar with supply chain management(SCM)
- To know about the driving parameter of SCM of an industry.
- To know about decision phases of SCM of an industry.
- To develop an entrepreneurship scheme for small and medium industries of Bangladesh.

CHAPTER TWO

LITERATURE REVIEW

2.1 Literature review

In this section a brief background of related literature is presented. Literature review is divided into two sections. First section summarizes the importance of ergonomics and its applications in case of footrest of an electric three wheeler and in the second part we will discuss about the SCM in small and medium industries of Bangladesh.

2.2 Ergonomics

Ergonomics is about designing for people, wherever they interact with products, systems or processes. We usually don't notice good design (unless perhaps, it's exceptional) because it gives us no cause to, but we do notice poor design. The emphasis within ergonomics is to ensure that designs complement the strengths and abilities of people and minimize the effects of their limitations, rather than forcing them to adapt. In achieving this aim, it becomes necessary to understand and design for the variability represented in the population, spanning such attributes as age, size, strength, cognitive ability, prior experience, cultural expectations and goals[1].

2.2.1 Domains of Specialization:

Mainly of three domains:

- Physical ergonomics.
- Cognitive ergonomics.
- Organizational ergonomics [2].

Physical ergonomics

Physical ergonomics is concerned with human anatomy, and some of the anthropometric, physiological and bio mechanical characteristics as they relate to physical activity. Physical ergonomic principles have been widely used in the design of both consumer and industrial products [2].

Cognitive Ergonomics

Cognitive ergonomics is concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. Relevant topics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system and Human-Computer Interaction design [2].

Organizational ergonomics

Organizational ergonomics is concerned with the optimization of socio-technical systems, including their organizational structures, policies, and processes. Relevant topics include communication, crew resource management, work design, work systems, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work programs, virtual organizations, telework, and quality management [2].

2.2.2 Importance of ergonomics

1. Increased savings

- Fewer injuries
- More productive and sustainable employees
- Fewer workers compensation claims

2. Increased productivity

• Ergonomic improvements can reduce the primary risk factors for MSDs, so workers are more efficient, productive, and have greater job satisfaction.

3. Increased morale

• Attention to ergonomics can make employees feel valued because they know their employer is making their workplace safer.

4. Reduced absenteeism

• Ergonomics leads to healthy and pain-free workers who are more likely to be engaged and productive [3].

2.3 Supply Chain management

Supply chain management (SCM) is the management of the flow of goods, flow of cash, and flow of information internally and externally of a company or a group of companies that share the same value chain. It includes the movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption; cash or credit in purchasing or selling of products or services; as well as the information that conducts those activities, such as orders, demand forecast, or even picking lists. Interconnected or interlinked networks, channels and node businesses are involved in the provision of products and services required by end customers in a supply chain.*[2]

2.3.1 Drivers of supply chain management

- Facilities
- Inventory
- Transportation
- Information
- Sourcing
- Pricing

CHAPTER THREE
THEORETICAL
ANALYSIS OF
DRIVING POSTURE

3.1 Posture Angles in Rebiffe

In this study, only four subjects were involved. Each participant must at least one year driving experience. This is important in order to ensure the drivers are familiar and had gained adequate driving experienced. The objective and procedures of the study were explained in details and subjects are required to fill-in their personal information in a form given to them. Having done that, then subject will be required to sit on the driver’s seat in their comfortable driving postures. It is given in a figure below:



Figure 3.1: Driving posture angles

3.1.1 Recommended ranges for body segment angles from Rebiffe (1969)

Recommended Ranges for Body Segment Angles from Rebiffé (1969)

Angle	Recommended Range (degrees)
A. Back	20 - 30
B. Trunk/Thigh	95 - 120
C. Knee	95 - 135
D. Ankle	90 - 110
E. Upper Arm	10 - 45*
F. Elbow	80 - 120

*[4]

CHAPTER FOUR

PRACTICAL ANALYSIS OF THE PROBLEM

4.1 Problems of existing footrest



Figure 4.1: Problems faced in conventional three wheeler

4.2 Measurement of different portions of human body

Measurement were taken on different portions of human body .For this 10 random person were selected and their measurement was taken. It is given in a table below:

(* All values are taken in inches)

Sl No.	Waist – Knee	Knee-Foot	Foot size	Hand
01	18	17	10*3.5	31
02	17	18	9*3	29
03	15	17	9*3	25.5
04	15.5	20	10*3.5	28
05	18	18	8.5*3.5	27
06	18	19	9*3	27
07	19	18	9*3.5	27
08	17	18	8*2.5	28
09	18	17	8.5*3	28
10	19	18	9.5*3.5	27.5

Chart 1: Measurement of different portions of human body

4.3 Percentage of problems faced by electric three wheeler drivers

It is a study while people were asked about their problems after using the conventional footrest of faulty design. Maximum of them responded about different pains they feel. Mainly they are ankle pain, knee pain, foot pain, back pain & thigh pain. After their response while it was summarized we can obtain a data chart like this, we also took the data of feedback when we set our designed footrest in their vehicle.

SL No.	Back pain	Ankle pain	Knee pain	Foot pain	Thigh pain	Feedback
01.	Yes	-	-	-	-	Good
02.	Yes	-	-	-	-	Good
03.	-	Yes	-	-	-	Good
04.	Yes	-	-	-	-	Good
05.	-	Yes	-	-	-	Good
06.	-	-	Yes	-	-	Good
07.	Yes	-	-	-	-	Good
08.	-	-	-	-	Yes	Good
09.	-	-	-	Yes	-	Good
10.	Yes	-	-	-	-	Good
11.	-	-	-	-	Yes	Good
12.	-	-	Yes	-	-	Good
13.	Yes	-	-	-	-	Good
14.	-	-	-	-	Yes	Good
15.	-	Yes	-	-	-	Good

Chart 2: Percentage of problems faced by electric three wheeler drivers

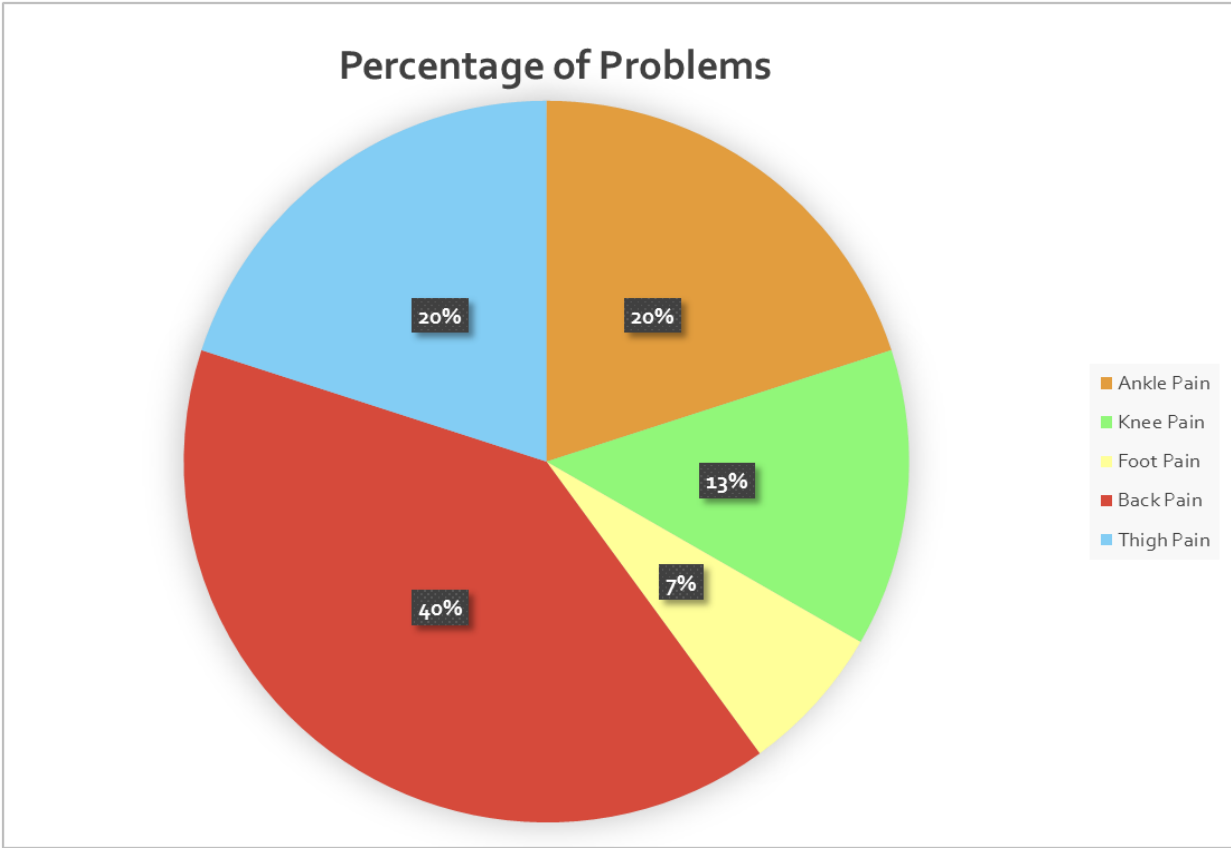


Figure 4.2: Pie chart about major problems drivers facing

CHAPTER FIVE

DESIGNING OF AN ERGONOMIC FOOTREST

5.1 Design specification

Auto Rickshaw Rod: 30 Inches

Through Hole Diameter: .5 inches (12.5 mm)

Distance From One Hole To Another: 4 Inches

Carbon Steel Bar: 15 Inches

Carbon Steel Bar Diameter: .47 inches (12 mm)

Screw Thread Diameter : .1969 inches (5 mm)

Pedal Specification:

Pedal Length: 10 Inches

Pedal Width: 4 Inches

Pedal depth: 1.5 Inches

Pedal Hole Diameter: .47 inches (12 mm)

Pedal Hole Depth: 1.5 Inches

Pedal Hole Screw Thread Diameter: .1969 inches (5 mm)

With the help of this design specification an ergonomic footrest has been designed.

5.2 Solidwork design:

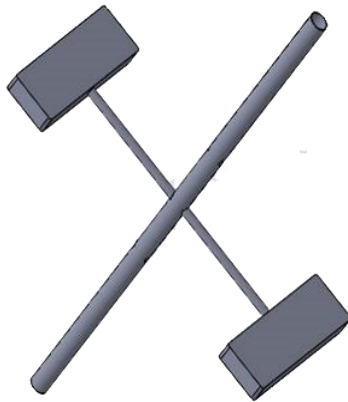


Figure 5.1: Overall view of the footrest

5.3 Design of parts in solid work

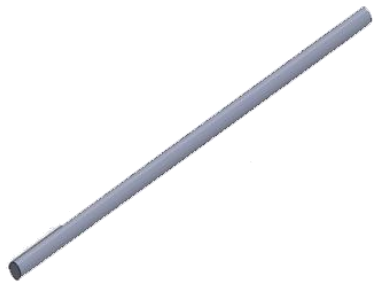


Figure 5.2: Footrest rod



Figure 2.3: Auto Rickshaw rod with through-hole

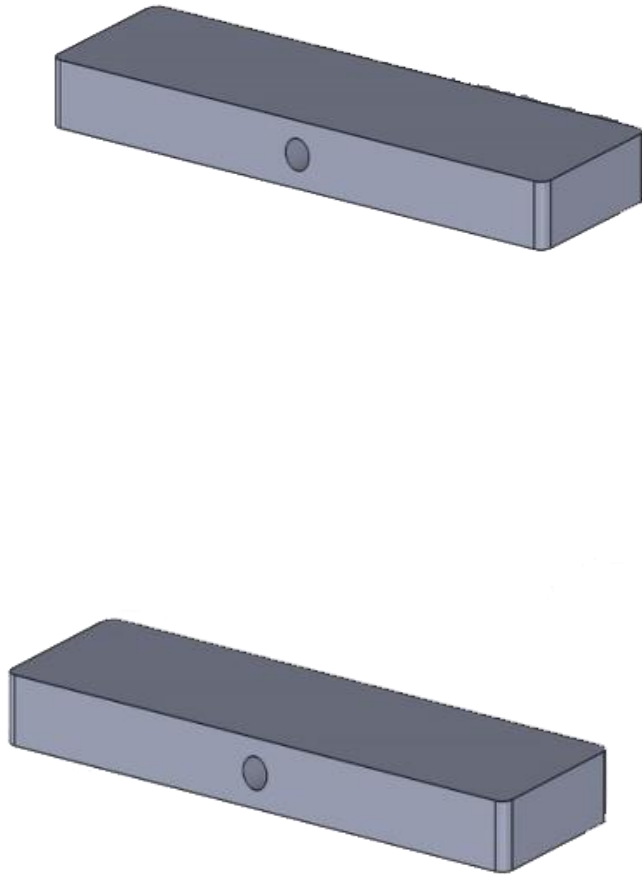


Figure 5.4: Pedals

5.4 Footrest We Built



Figure 5.5: Overview of footrest we built



Figure 5.6: Model assembly of the footrest

5.5 Setup For Feedback



Figure 5.7: Setup of footrest in three wheeler during feedback



Figure 5.8: Using the footrest during feedback

5.6 Feedback Process

- After assembly of the footrest we went out for survey.
- We set the footrest in several electric powered rickshaw.
- Due to the previous setup of their faulty footrest we couldn't set the footrest properly and faced some difficulties.
- Also, Rickshaw owners wouldn't let us to make the through holes in their rickshaw.
- We had to set the footrest lower than the measured length.
- So, we couldn't set the footrest according to the design and the Rabiffe angle of posture couldn't be met.
- But, according to the watched measurement we assumed that the angles would be perfect if they were set in measured length.
- Rickshaw pullers we asked for feedback replied us with satisfactory reply.

After taking satisfactory feedback we think we built an ergonomic footrest as the demand of posture angles and human comfort was met successfully.

CHAPTER SIX
**SUPPLY CHAIN
MANAGEMENT FOR
SMALL & MEDIUM
INDUSTRIES**

6.1 Present condition

In this study we have found that maximum small & medium industries of Bangladesh don't follow any scientific method for maintaining their supply chain management. They mainly depend on the experience & previous data. That's why they can't achieve the result they should get within the definite time.

6.2 Industry Visitation

We have visited one small local garment factory of Bangladesh named "Pushan Garments" at Gazipur and one of the largest super shop of Bangladesh & discussed their supply chain with their officials and engineers.

6.2.1 Industry Visitation (Pushon Garments)

- A small garments in Tongi.
- Don't follow any definite method.
- Depends completely on business experience.
- Demand is nearly constant over the year.

6.2.2 Industry Visitation(A super shop)

- One of the largest & popular super shop of Bangladesh.
- Uses licensed SCM software.
- Uses Bin type inventory.
- Uses “CONTINUOUS REVIEW “method for forecast.

6.3 Comparison Between these visits

1. The Super shop we visited is highly advanced in their sector of maintaining business.

2. Product management & employee management of that Super shop is too good that's why they have advanced at this level while pushon has failed to increase their demand.

6.4 Our suggestion

- By applying a specified SCM method the small & medium level industry of our country can gain success in many regards.
- Application of e –system while establishing a supply chain can be more efficient.
- Different software are used while maintaining different portion of supply chain
- Here we have shown one model for doing forecasting using a free software named “Zaitun”.

6.5 Application of Zaitun

Here we have demonstrated the use of a supply chain management software naming “Zaitun”. We have used demo data to demonstrate the result as factories are concerned for providing the actual data. We believe that these data will be helpful enough to show the companies the benefits of utilization of these software.

The graphs we achieved are given below. Though we have used the software named “zaitun” there are also some software which are suitable for small and medium industries of Bangladesh like Bizripp. An internationally recognized software in this case is “SAP”.

6.6 Graphs obtained by Zaitun

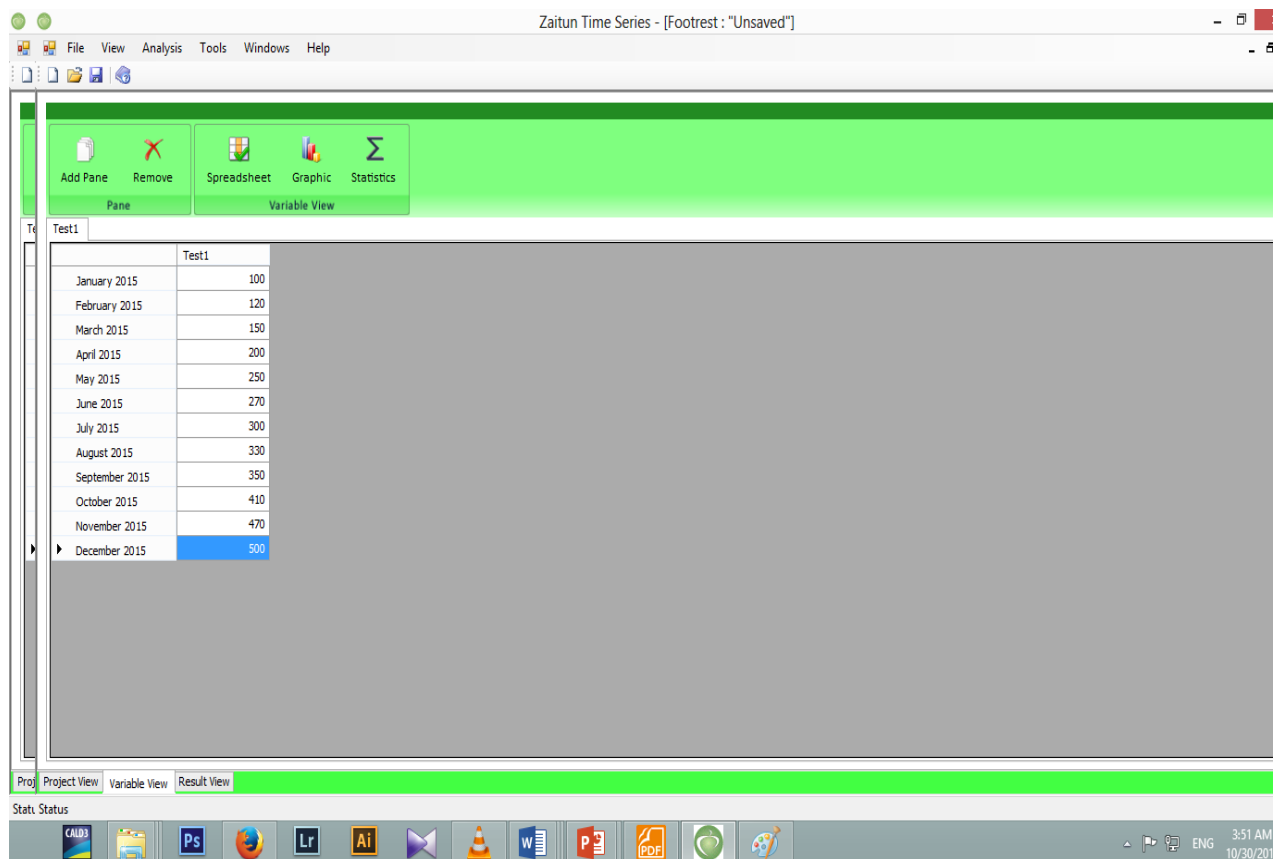


Chart 3: Chart of actual sale over the year

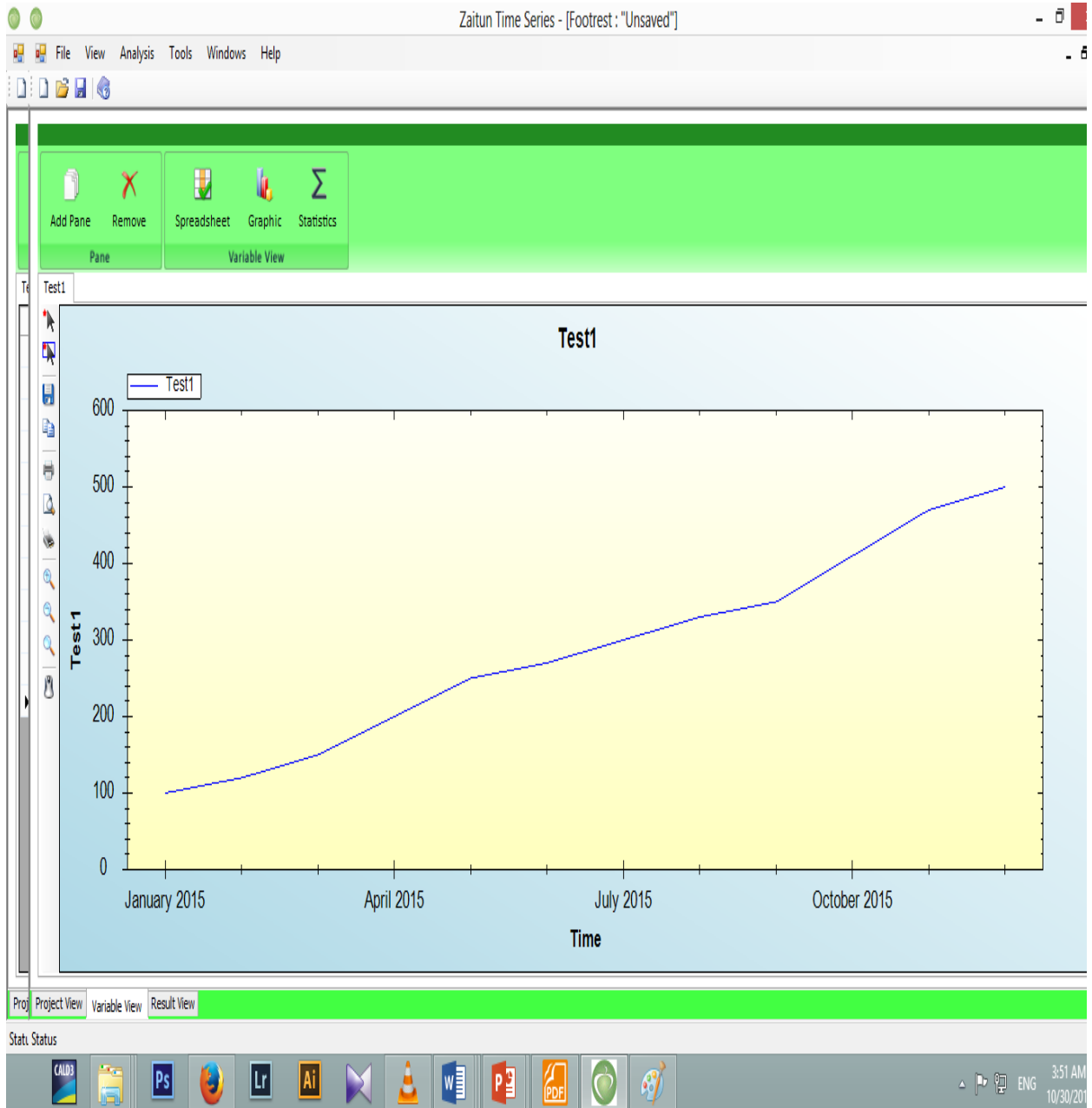


Figure 6.1: Curve of actual sales vs. time

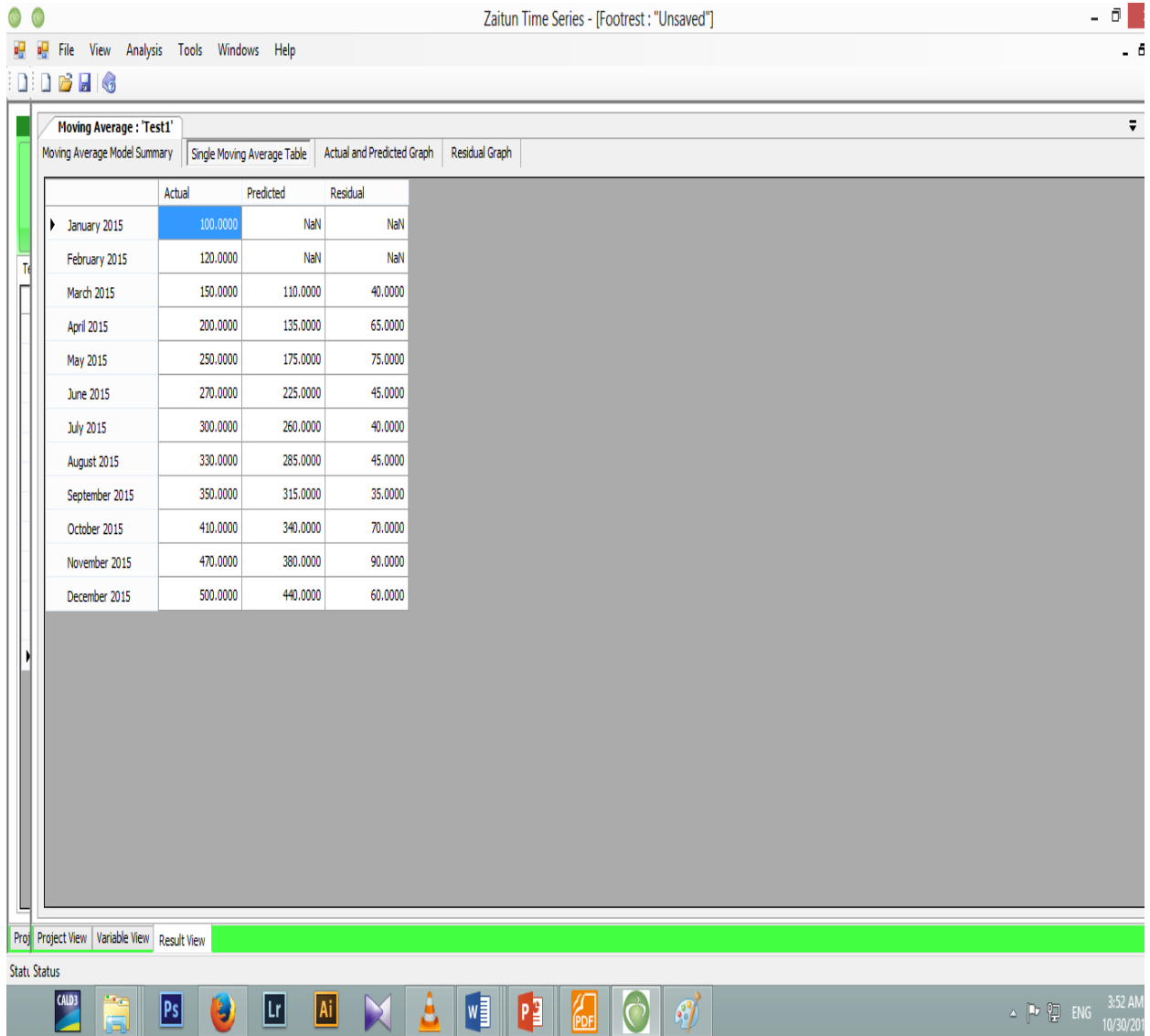


Chart 4: Chart for actual sale, demand, forecast over the year

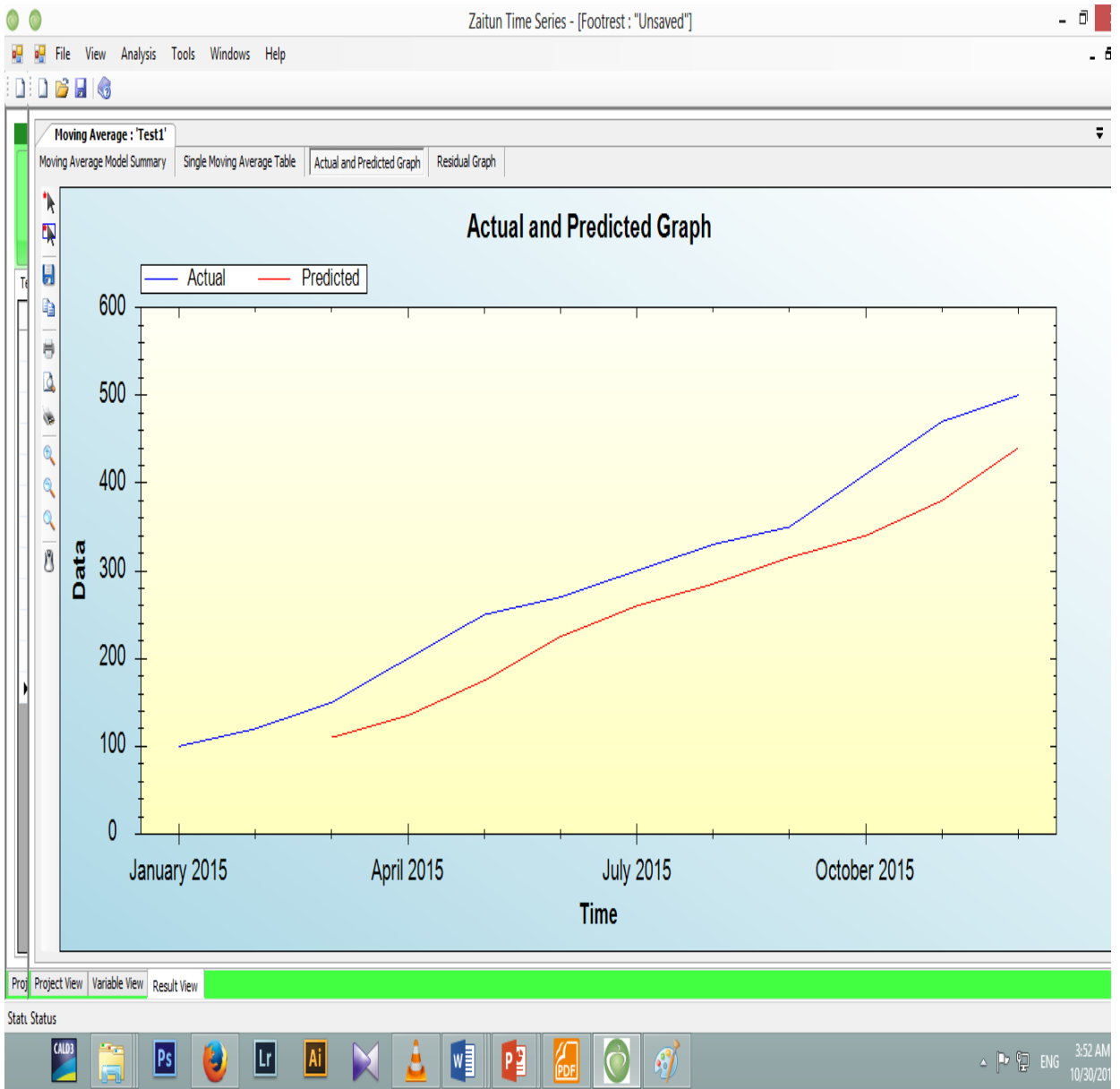


Figure 6.2: Actual & Predicated graph over time

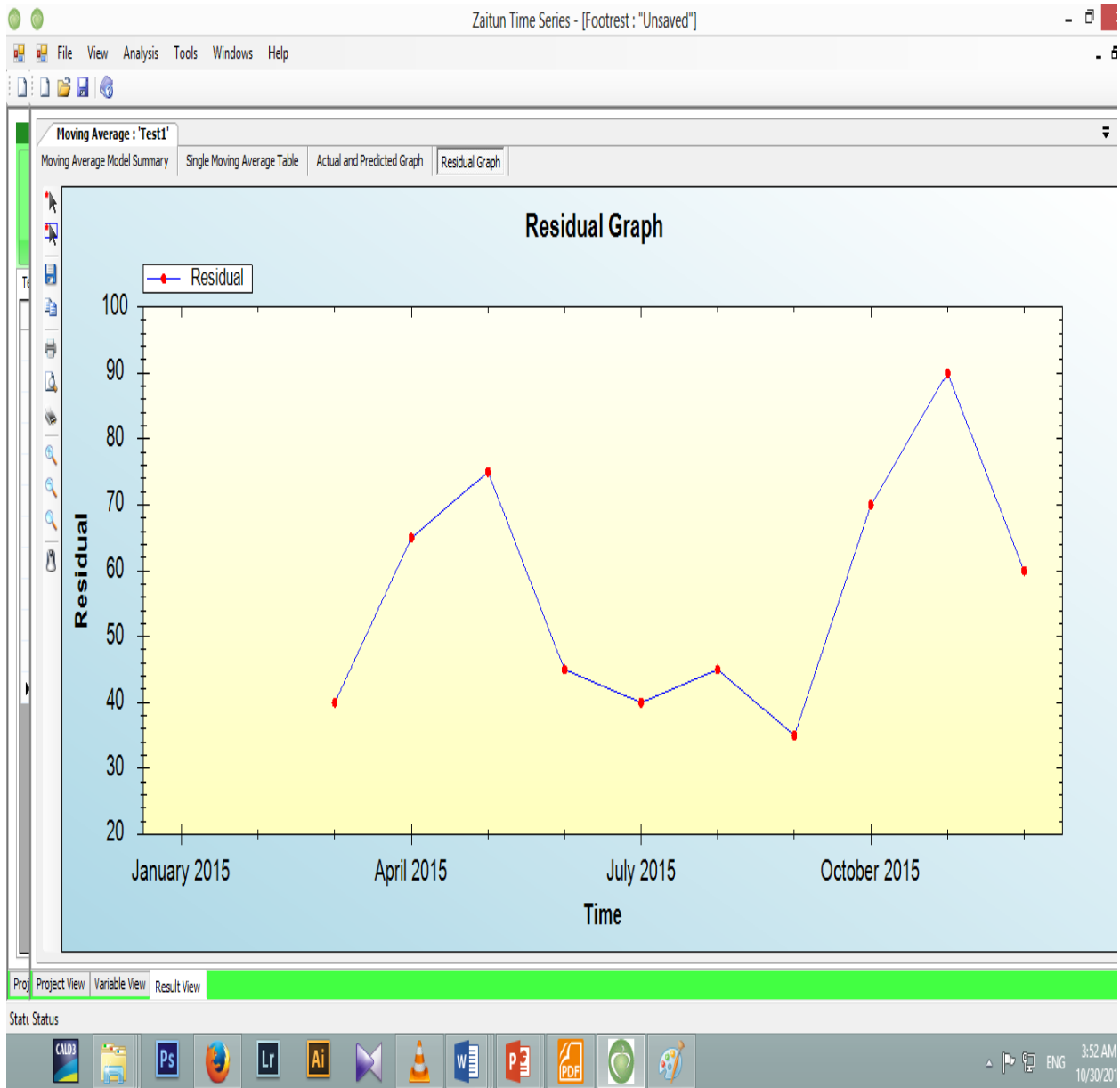


Figure 6.3: Residual graph

CHAPTER SEVEN

CONCLUSION

7.1 Conclusion:

- We have built an ergonomically footrest for three-wheeler vehicle.
- Further researches can be done for developing it.
- Showed the importance of SCM in small & medium sized business of Bangladesh.
- On the basis of this an entrepreneurship scheme can be established.

Bibliography

[1] <http://www.ergonomics.org.uk/>

[2] www.wikipedia.com

[3] <http://www.cbs.state.or.us/osha/pdf/ergo/ergoadvantages.pdf>

[4] [http://www.academia.edu/1091240/Postural Angle Measurement Manual v s. Picture Recognition Software](http://www.academia.edu/1091240/Postural_Angle_Measurement_Manual_v_s._Picture_Recognition_Software)