ANALYSIS OF THE STATUS OF THE RUBBER PRODUCT MANUFACTURING INDUSTRY IN SRI LANKA: BARRIERS AND SOLUTIONS

Mahawaduge Nevil Chaminda Perera Dissanayake

(138105T)

Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

December 2018

ANALYSIS OF THE STATUS OF THE RUBBER PRODUCT MANUFACTURING INDUSTRY IN SRI LANKA: BARRIERS AND SOLUTIONS

Mahawaduge Nevil Chaminda Perera Dissanayake

(138105T)

Thesis/Dissertation submitted in partial fulfilment of the requirements for the Master of Engineering in Manufacturing Systems Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

December 2018

DECLARATION

This report contains no material which has been accepted for the award of any other degree or diploma in any university or equivalent institution in Sri Lanka or abroad, and that to the best of my knowledge and belief, contains no material previously published or written by any other person, except where due reference is made in the text of this report.

I carried out the work described in this report under the supervision of Dr.Himan K.G. Punchihewa.

Signature : Date :

Name of Student : M.N.C.P. Dissanayake

Registration No : 138105T

Signature : Date :

Name of Supervisor : Dr.Himan K.G. Punchihewa

Abstract

The Sri Lankan rubber industry is currently experiencing burning problems. Mainly rubber industries are facing issues such as, low production, lack of cultivation area, low productivity, reduction of re-planting area and new planting area, decline trend of rubber prices, increase of cost of production, reduction of export of raw rubber, increase of domestic consumption and declined trend of exports earnings, lack of skilled labour. However no one has identified which factors are affecting to create these problems and also hardly to find any solution to the most important problems which are presently available in rubber industry. Therefore, this research is aiming to find most important barriers of rubber product industry and find out what they are and how to avoid or minimize those barriers.

Objective of this survey was to gather information related to the present status of the rubber product industry in Sri Lanka and analyse the gathered information to propose the way forward in terms of barriers in the rubber products manufacturing sector. Survey was carried out by using questionnaires to find out the present situation, barriers, difficulties, issues, and solutions for rubber products industry. Large and medium scale rubber industries were targeted, and questionnaires were distributed according to the annual export performance (turnover) in each rubber products sectors. Gathered information from questionnaire was analysed by using PESTLE with Cobweb diagram, quantitative analysis, statistical analysis with linear correlation and qualitative analysis.

During this survey, three major factors were identified which affect the rubber products industry, and they are Economic, Legal and Technological factors. Under above factors, identified several key barriers are Impact of globalization on market share, Effect of Health and Safety issues, Insufficient facilities for the development of technology in the organization, Lack of Research and Development activities compared to the Competitors, Lack of proper techniques to absorb international technology. Proposed several solutions are Free trade agreement with developed countries, Promote to follow (Occupational Safety and Health Standards) OSHS for rubber industry, Need free technology Alliance with developed countries, Need to increase budget allocation for R&D activities, Govt should provide facilities for Reverse Engineering. Extension of this survey to the small scale rubber industry is proposed as future work.

Keywords: Rubber industry, barriers, solutions, PESTLE factors.

Acknowledgements

The writing of this dissertation has been one of the most significant academic challenges I have ever had to face. Without the support, patience and guidance of the following people, this study would not have been completed. It is to them that I owe my deepest gratitude.

Dr. H.K.G. Punchihewa, who undertook to act as my supervisor despite his many other academic and professional commitments, His wisdom, knowledge and commitment to the highest standards inspired and motivated me.

I also thank Dr.R.A.R.C. Gopura, Coordinator of Manufacturing Systems Engineering master's degree, for his enthusiastic support and motivation extended towards me in completing this report. My special thanks go to Mr. S.Nilhan Niles, who gave excellent knowledge for the success of my report and he improved my presentation skills.

I thank profoundly the Head of Department and all the other staff members of the Department of Mechanical Engineering for their assistance during the master's degree Program. In addition to that I would like to thank my wife Ms. S.L.M.D.A. Umayangani and other family members of their unstinted support and motivation.

CONTENT

1 Introduction....10
1.1. Introduction to research project----10
1.2. Aim & Objectives----12
1.3. Methodology ----13
1.4. Chapters Outline ----13
2 Literature Review....14
2.1. Key indicators of rubber industry ----14
2.2. Rubber plantation ----17
2.2.1. Rubber extent----17
2.2.2. Rubber production, exports and consumption ----20
2.2.3. Colombo auction prices of rubber - 2004-2015 ----23
2.2.4. Cost of rubber production small holding and estate sectors ----23
2.2.5. Import of raw rubber ----26
2.3. Rubber product industry ----27
2.3.1. Latex industry ----27
2.3.2. Dry rubber industry----28
2.3.3. Import of rubber finished products ----28
2.3.4. Export of rubber finished products ----29
2.4. Global rubber industry review ----33
2.4.1. World rubber production ----34
2.4.2. Key indicators of rubber industry in ANRPC -2015----35
2.4.3. The annual average yield per hectare in ANRPC ----37
2.4.4. Trends of natural rubber supply in major producing countries ----37
2.4.5. Trends of natural rubber demand by major consumers----38
2.4.6. Total rubber demand ----39
2.5. Barriers for the industry----39
2.5.1. Classification of barriers----40
2.6. Barriers and solutions for the rubber industry ----40
2.6.1. Barriers and solutions for manufacturing ----42
2.6.2. Barriers and solutions for technological capabilities ----42
2.6.3. Barriers and solutions for human resources----43
2.6.4. Barriers and solutions for supply ----43
2.6.5. Barriers and solutions for marketing ----44
2.6.6. Barriers and solutions for investment ----45

2.7. Summary ---- 45
3 Study the Status of the Rubber Industry in Sri Lanka 48
3.1. Introduction ---- 48
3.2. Aim and objectives ---- 49
3.3. Methodology ---- 49
3.3.1. Sampling ---- 49
3.3.2. Questionnaire formulation ---- 51
3.3.3. Data collection ---- 53
3.3.4. Data analysis ---- 53
3.4. Results ---- 58
3.4.1. Results of PESTLE analysis ---- 61
3.4.2. Identification of barriers ---- 63
3.4.3. Identification of solutions ---- 96
3.5. Discussion ---- 100
4 Conclusion 105
References 111

LIST OF FIGURES

Figure 2-1: Extent of rubber plantation by districts.....18
Figure 2-2: Rubber production and exports.....21
Figure 3-1: Percentage values for PESTLE.....62
Figure 3-2: Cobweb diagram for PESTLE.....63
Figure 3-3: Linear correlation between Economic and Technology factors.....90
Figure 3-4: Linear correlation between Political and Legal factors.....91
Figure 3-5: Linear correlation between Economic and Environmental factors.....91

LIST OF TABLES

Table 2-1: Key indicators of rubber industry....16
Table 2-2: Rubber extends by district-2010 RDD census of rubber lands....19
Table 2-3: Rubber area by ownership-2004-2015....20
Table 2-4: Rubber production, exports and consumption - 2004-2015....21
Table 2-5: Raw rubber export quantity and value of different type....22
Table 2-6: Colombo auction rubber prices by different types Rs/kg....23
Table 2-7: Cost of rubber production - smallholding sector....24
Table 2-8: Cost of rubber production estates - 20 acres and above....25
Table 2-9: Rubber imports by type - 2004-2015....26
Table 2-10: Import of rubber finished products-2015....29
Table 2-11: Export income from different product categories of rubber in Rs million....31
Table 2-12: Extent of world rubber plantations....33
Table 2-13: World rubber production (in million kg)....34
Table 2-14: Key indicators of rubber industry in ANRPC members -2015....36
Table 2-15: The annual average yield per hectare in ANRPC member countries....37
Table 2-16: Trends of NR supply in major producing countries.....38
Table 2-17: Trends in NR demand by major consumers.....38
Table 3-1: Export performance of rubber products -2015 and distributed samples....50
Table 3-2: Collected data samples and response rate....58
Table 3-3: Number of YES or NO answers and percentage values....60
Table 3-4: Minimum education level....61
Table 3-5: Average rate of value addition of product....61
Table 3-6: Calculated average value and percentage value for PESTLE....62
Table 3-7: Most important questions for Political factor....64
Table 3-8: Most important questions for Economic factor....64
Table 3-9: Most important questions for Social factor....65
Table 3-10: Most important questions for Technology factor....67
Table 3-11: Most important questions for Legal factor....68
Table 3-12: Most important questions for Environmental factor....69
Table 3-13: ANOVA: Single factor results for Political factor....69
Table 3-14: T-test used with Bonferroni and Holm method for Political questions....71
Table 3-15: ANOVA: Single factor results for Economic factor....72
Table 3-16: T-test used with Bonferroni and Holm method for Economic questions....73
Table 3-17: ANOVA: Single factor results for Social factor....74

Table 3-18: T-test used with Bonferroni and Holm method for Social questions 75
Table 3-19: ANOVA: Single factor results for Technological factor 76
Table 3-20: T-test used with Bonferroni and Holm method for Technological questions 79
Table 3-21: ANOVA: Single factor results for Legal factor 85
Table 3-22: T-test used with Bonferroni and Holm method for Legal questions 86
Table 3-23: ANOVA: Single factor results for Environmental factor 87
Table 3-24: T-test used with Bonferroni and Holm method for Environmental questions 88
Table 3-25: Correlations of each factor 90
Table 3-26: Identified barriers under Political factor 92
Table 3-27: Identified barriers under Economic factor 92
Table 3-28: Identified barriers under Social factor 93
Table 3-29: Identified barriers under Technological factor 93
Table 3-30: Identified barriers under Legal factor 95
Table 3-31: Identified barriers under Environment factor 95
Table 3-32: Identified solutions under Political factor 96
Table 3-33: Identified solutions under Economic factor 96
Table 3-34: Identified solutions under Social factor 97
Table 3-35: Identified solutions under Technological factor 97
Table 3-36: Identified solutions under Legal factor 98
Table 3-37: Identified solutions under Environmental factor 99
Table 4-1: Identified barriers and proposed solutions under Political factor 105
Table 4-2: Identified barriers and proposed solutions under Economic factor 106
Table 4-3: Identified barriers and proposed solutions under Social factor 106
Table 4-4: Identified barriers and proposed solutions under Technological factor 107
Table 4-5: Identified barriers and proposed solutions under Legal factor 108
Table 4-6: Identified barriers and proposed solutions under Environmental factor 109

LIST OF APPENDICES

Appendix 1 Survey questionnaire for rubber industry

Appendix 2 Survey data for barriers

Appendix 3 Suggestion to overcome barriers

CHAPTER 1

1 Introduction

1.1. Introduction to research project

Sri Lankan Rubber industry has a long history and crucial to the national economy because it generates over 1,000 million US dollars as an aggregate annual turnover while providing more than 500,000 employment opportunities to peoples in rural as well as urban areas. Sri Lanka produces all types of natural rubber including Ribbed Smoked Sheets, Latex Crepe, Technically Specified Rubber and Centrifuged Latex as a leading producer of natural rubber [1]. Sri Lanka has a rapidly expanding rubber products manufacturing sector which produces diverse types of rubber products for various uses that include industrial solid tyres, passenger car tyres, commercial vehicle tyres, automotive components, foam cushions and latex gloves. Sri Lanka is the world's best supplier of solid tyres. End of the economic life, rubber trees are converted to high value furniture popular in the western markets [1].

Natural rubber plays a key role in the economies of many of the nations that have the climate and resources for growing and processing this valuable commodity [1]. Sri Lanka is bestowed with rich resources of natural rubber and other process materials as well as the availability of comparatively cheap labour [2]. Rubber exports are one of highest foreign exchange earners in Sri Lanka; therefore the rubber is an important agriculture crop for Sri Lanka to improve foreign income [2].

In the last two decades, privately owned and operated Sri Lankan industries have entered global markets for value-added rubber products, such as solid rubber tyres, and surgical gloves. Sri Lanka was captured world premium solid tyre market and now this small island becomes the world's top supplier of solid rubber tyres. Their success is the best indicator of a strategy for Sri Lanka's rubber industry as a whole: increase value-addition in Sri Lanka by increasing the volume and variety of value-added rubber products [2].

However, Rubber production of Sri Lanka has shown a declining trend since 1996 [2]. So, there is a burning issue in the Sri Lankan rubber industry and the researcher assumes that there can be a major component missing in the whole supply chain of rubber industry and that would have been the technology component that is more advanced in other

countries [2]. Several researchers had carried out detailed studies to identify technological lagging of Sri Lanka with compared to the natural rubber processing state of the art country by assessing the technology status of Sri Lankan raw rubber industry. Research was targeted to identify the significance of technology status to the industrial productivity, i.e. annual yield per hectare [2]. Model analysis was concluded that Sri Lanka is lagging technologically in raw rubber industry behind bested to the technology status of global industry leaders like Malaysia, Thailand, and India and that has resulted in a lower productivity of this industry [2].

Factors affected to lower the status of each technology component was evaluated with the qualitative techniques like, SWOT analysis, value chain analysis and caused an effect diagrams and found out that lower consideration on workforce and their education background as well as training and retraining facilities, bad management practices due to the poor managerial competence, and rigid organizational structure has resulted in major drawbacks of this industry [2].

If Sri Lanka does not improve plantation productivity, it could lose its rubber products industry to locations that have stable supplies of competitively priced rubber [3]. Liberalising rubber imports will help Sri Lanka to avoid that kind of ruin and, combining with another strategy could offer even more benefits [3].

Sri Lanka had focused to improve human resources and capabilities in research and development, product development, and specifications standardization since the beginning of rubber era [3] [4]. But it has seen the other nations have improved their technology since the World War II, especially Japan, and Germany became best competitive leaders in the world rubber products. So that, it was very important to establish a research chair for the rubber industry in a local university and launch a Technical Innovation Centres. Establishing proper organizations such as Plastic and Rubber Institute (PRI) Sri Lanka, National Institution of Plantation Management (NIPM) improve the industrial level knowledge of human resources. In addition to that, national universities improve the prototyping and product development [3] [4].

Sri Lanka has focused to increase manufacturing capacities and enhance value-added conversions of raw rubber and latex into semi-finished and finished products for export to select markets and specified applications, and to set up a central latex storage, fulfilment

facility, and begin repositioning crepe rubber in the market. A custom compounding facility, a joint procurement programme, and a dedicated industrial park with all support services for rubber goods are all recommended [4].

Sri Lanka's domestic supply is shrinking mainly due to lower selling prices of past 30 years and that have prevailed since the Asian financial crisis of 1997. In addition to that, the plantation sector faces other systemic constraints, such as inadequate marketing, extension services, and credit facilities. Smallholders lack organized long-term purchase and sale agreements. Rubber prices in the world have been reduced due to the increases of synthetic rubber supply and that has led to yields and productivity being deterred investments in plantations**.** As a result of that, the owners and operators have postponed investments and even maintenance, while government regulations have discouraged private sector development. Given low prices, poor productivity, and policy barriers to enter production, it is not surprising that manufacturers and other investors have little interest in rubber plantations [4].

Sri Lankan rubber industry requires many inputs to realize the goals of the master plan. Such specialized inputs can come from overseas by way of: technology; machinery and equipment; various materials including chemicals; ancillary equipment such as moulds and dies; markets and market information including trade contacts; new product ideas and design skills; human resource development expertise; quality management and certification services; environmental management knowledge; industry infrastructure facilities; packaging materials among many other inputs. Most crucially, Sri Lankan rubber industry needs large amounts of investments over a long period. Therefore, rubber industry provides opportunities for such investors [1] [4].

1.2. Aim & Objectives

The aim was to identify barriers pertinent to the rubber manufacturing sector in Sri Lanka and propose recommendations to overcome the barriers.

- To identify the barriers faced by the rubber manufacturing sector.
- To analyse the status of the rubber product manufacturing industry.
- To propose the way forward in terms to overcome the barriers.

1.3. Methodology

The study was started by reviewing the literature regarding the barriers for rubber products manufacturing industry. Then, a questionnaire survey was carried out to find out the present situations, barriers, difficulties, issues and solutions in rubber products manufacturing industry. Target rubber industries were large and medium category and one hundred and fifty-three questionnaires were distributed according to the annual export performance (turnover) in each rubber products sectors. Ninety-six copies of questionnaires were distributed through Tyres and Tubes industry; thirty-four copies of questionnaires were distributed through Latex/Gloves industries and twenty-three copies of questionnaires were distributed through Other Articles industries. The gathered data was analyzed using PESTLE criteria and was illustrated using a Cobweb diagram. Quantitative analysis was performed using statistical techniques such as linear correlation and qualitative analysis was also performed to identify barriers and solutions to them. The ways forward to overcome the barriers were prioritized according to the views of the respondents.

1.4. Chapters Outline

Chapter 1 includes an introduction to the research, aim and objectives and methodology of the project. Literature has been reviewed in Chapter 2, and it includes ten key performance indicators of the rubber industry such as production, area and yield, and information related to rubber plantation, rubber product industry, global rubber industry review, barriers for the industry and barriers and solution for the rubber industry. In Chapter 3, the study on the status of the rubber industry in Sri Lanka is presented. The Chapter includes the introduction, aim and objectives and methodology of the study which discusses regarding the method of sampling based on the annual turnover of each rubber sector, formulation of the questionnaire, method of data collection and data analysis using the PESTLE criterion, quantitative analysis and qualitative analysis. In addition, results are discussed according to the PESTLE analysis and finally, identification of barriers and solution are discussed. Chapter 4 includes the conclusion of the study and it shows the achievement of aim and objectives through the PESTLE analysis, quantitative analysis and qualitative analysis by showing identified barriers and solution under each factor.

CHAPTER 2

2 Literature Review

The rubber industry has played a significant role in the Sri Lankan economy as a key sector, connecting Sri Lanka with the world. Rubber industry that is perceived by many as a plantation activity has been a key pillar of the Sri Lankan economy for over a century and its significance has not been diminished [4]. In fact, its stature is growing with the value added products segment reaching great heights having been recognized as world‘s preferred supplier of industrial solid tyres and rubberized tracks. On the contrary, market share of Sri Lanka‘s raw rubber including famous Latex Crepe rubber has steadily declined. Nevertheless, in 2013, the entire rubber industry reached one-billion-dollar mark in total export value demonstrating its growth potential [4].

Future of Sri Lanka’s rubber industry rests on industry-wide productivity growth from small-farm based rubber production to large scale manufacturing operations. Achieving sustained global competitiveness will depend on our ability to shed age old unproductive practices and adopting of new technologies coupled with enhancing effectiveness in managing value chain activities [4]. There is no other way to withstand relentless competition that emanate from unexpected sources making viable industries nearly irrelevant. The best example is Sri Lanka’s Latex Crepe rubber which stubbornly refuses to change its character and image. It is at its last stage of a remarkable life cycle. If stakeholders remain complacent, even some of the rubber products made in Sri Lanka could experience a similar outcome [4].

2.1. Key indicators of rubber industry

The rubber production depends on the reasons such as the growth of replanting area, as well as matured area, price fluctuations in global market and weather condition, etc. [5]. There are several indicators in rubber industry and it shows in the Table 2-1. Those are Rubber Production, Area, Yield, Replanting, New Planting, Prices, Cost of Production (COP), Export of Raw Rubber, Domestic Consumption and Export Earnings. Area includes under cultivation and under tapping areas. Prices include Export FOB (Raw Rubber) and Colombo Auction RSS1 prices. Export earnings include Raw Rubber, Semi-processed and End Products Earnings. Starting from 2010 to 2015 production, yield per hectare, new planting and replanting, prices, export of raw rubber had been reduced,

although the area cost of production and domestic consumption increased. In 2011, the total export earning was US$ million 1,091 and it has reduced to US$ million 785 in the 2015 [5].

Table 2-1: Key indicators of rubber industry

Item	*Unit*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
1. Production	million kg	153.0	158.2	152.1	130.4	98.6	88.6
2. Area							
2.1 Under cultivation	thousand ha	125.6	128.1	130.8	132.9	133.1	132.8
2.2 Under tapping	thousand ha	96.7	101.7	104.4	104.7	107.8	107.6
3. Yield	kg/ ha	1,582	1,555	1,459	1,245	914	823
4. Replanting	ha	5,942	3,050	3,243	4,484	2,897	1,917
5. New planting	ha	2,888	3,016	3,382	3,629	1,561	825
6. Prices							
6.1 Export FOB (Raw Rubber)	Rs/kg	338.23	535.41	420.77	389.81	362.83	342.03
6.2 Colombo Auction RSS 1	Rs / kg	402.71	513.05	416.61	376.78	285.76	245.93
7. Cost of Production (COP) - for smallholding sector	Rs / kg	119.80	129.56	136.00	150.00	160.00	170.00
8. Export of raw rubber	million kg	51.50	42.61	37.38	23.58	16.31	10.37
9.Domestic consumption	million kg	107.2	128.2	125.7	118.4	116	127.4
10.Exports earnings							
10.1 Raw rubber	Rs. million	19,256	22,811	15,726	9,195	5,916	3,548
10.2 Semi Processed	Rs. million	_	2,664	5,535	4,733	3,912	1,836
10.3 End products	Rs. million	63,968	95,169	103,921	110,048	112,246	101,426
Total export earnings	**Rs. million**	**83,224**	**120,644**	**125,182**	**123,976**	**122,074**	**106,810**
	US$ million	**736**	**1091**	**981**	**960**	**935**	**785**

Note: In Some Sources 10.2 and 10.3 treated as end products

Source: Rubber Development Department-2016.

: Sri Lanka Customs-2016.

2.2. Rubber plantation

The natural rubber was first introduced to the South East Asia from its native South America when seeds sent by Henry Wickham were germinated in the Kew Garden in UK and the infant seedlings were planted at Henarathgoda Garden in Colombo district in Sri Lanka in 1876. The commercial planting of rubber in Sri Lanka began in 1883 [4], [6]. In order to develop technology demanded by the growers, a committee consisting of members of British plantation interests in this country was formed in 1909 [4], [6]. Sri Lanka embarked on the rubber industry in 1876 with planting of a few hundreds of Brazilian rubber seeds received from Kew Gardens in London which resulted in large extents of land coming under rubber in the wet zone by early 1900s [4], [6]. By the 1970s, over 200,000 hectares were under rubber that includes estates as well as smallholdings [4].

Rubber was among the three main income earners in the national economy and had a strong impact on the socio-economic conditions of thousands of people in the country. Landmark events associated with the rubber growing industry is the rubber price boom engendered with the Korean War in 1950s and the "Rubber Rice Pact" trade agreement with the Peoples' Republic of China executed in 1952 [4].

As in the past, the aim to enhance the rubber industry by continuous development of the productivity of rubber plantation to cater to the fast-growing needs of the value added rubber products industry. For this purpose, plans are under way to extend the rubber plantations to non-traditional areas in the country [6].

2.2.1. Rubber extent

There are seventeen districts which have the rubber plantations in Sri Lanka, as shown in Figure 2-1. Out of seventeen, there are three major districts for rubber plantation according to the 2010 RDD (Rubber Development Department) census of rubber lands. Those are Kalutara, Rathnapura, and Kegalle as shown in Table 2-2 [5]. Total rubber extent in the country at the end of 2015 was around 134.8 thousand hectares against 134 thousand hectares at the end of 2014 while the tapping area was around 119 thousand hectares. The increase in rubber plantation areas was due to the extent of new plantings, that accounted for 800 ha and replanting of 1,000 ha of lands [7].

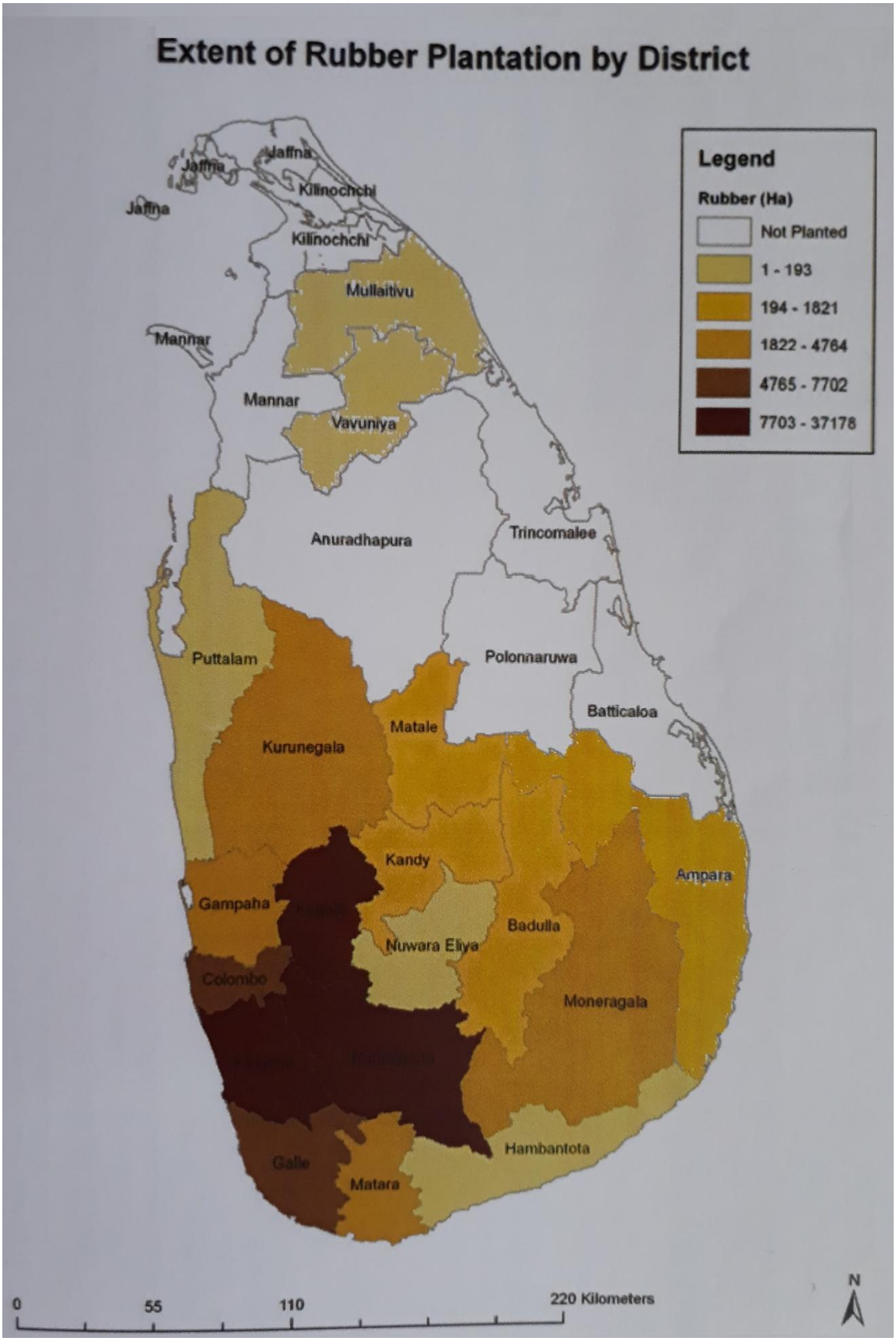


Figure 2-1: Extent of rubber plantation by districts

Table 2-2: Rubber extends by district-2010 RDD census of rubber lands

District	*Size class of <20 hectare*	*Size class of >20 hectare*	*Total*
	Extent (ha)	*Extent (ha)*	*Extent (ha)*
Colombo	4,159	2,161	6,320
Gampaha	3,548	287	3,835
Kalutara	17,804	10,961	28,765
Kandy	1,548	306	1,854
Matale	542	769	1,311
Nuwaraeliya	6	0	6
Galle	2,815	3,167	5,982
Matara	2,719	1,286	4,005
Hambantota	155	0	155
Kurunegala	1,512	1,506	3,018
Puttalam	193	0	193
Badulla	352	1,274	1,626
Monaragala	4,402	403	4,805
Rathnapura	14,048	12,557	26,605
Kegalle	21,316	15,849	37,165
Total	**75,119**	**50,526**	**125,645**

Source: Rubber Development Department-2016.

After the agriculture Census -2002 of Department of Census and Statistics (DCS), it was revealed that total rubber extent stood at approximately 115,000 ha. The extent under smallholder sector ownership of rubber reported as 65,219 ha in 2004. Since 2004 to 2015, smallholder land ownership indicated a significant improvement with annual average growth of 1,700 ha extent of new planning. The census of rubber lands conducted by Rubber Development Department (RDD) in 2010 confirmed that 79,395 ha belong to the ownership of smallholders. This extent reached 85,808 ha in 2015 that is an increase of 6,413 ha from the extent reported in 2010. In the estate sector, however there was a decrease of 984 ha in 2015 compared to the previous year. The total rubber extent in 2015 reached to 132,799 ha that is a decrease of 276 ha compared to 2014 and it shows in Table 2-3 [7].

Table 2-3: Rubber area by ownership-2004-2015

Year	*Estate sector (ha)*	*Smallholder sector (ha)*	*Total (ha)*
2004	50,100	65,219	115,319
2005	47,941	68,109	116,050
2006	50,360	69,140	119,500
2007	49,867	69,676	119,543
2008	50,360	71,736	122,096
2009	48,968	75,332	124,300
2010	46,250	79,395	125,645
2011	48,516	79,604	128,120
2012	49,435	81,345	130,780
2013	47,821	85,083	132,904
2014	47,975	85,100	133,075
2015	46,991	85,808	132,799

Source: Rubber Development Department-2016.

2.2.2. Rubber production, exports and consumption

Rubber demand is created through raw rubber export market and domestic consumption for local manufacturing industry. Table 2-4 shows export of raw rubber increased up to 2009 and since then declined drastically in the decade. The export peaked in 2009 recording 56 million kg or 41% of the production. In 2015, volume of export decreased by 5.9 million kg compared to 2014 and ratio adjusted to 12% of production. Within five consecutive years since 2010, raw rubber exports declined by 41.1 million kg or 80%. The average ratio of export that prevailed for the decade is 30% of production. Rubber prices in global markets and government policy favourable for rubber product manufacturing industry are the factors contributing to adjust the rubber demand ratio between export and consumption [5]. The domestic raw rubber consumption is recorded as 127.4 million kg for 2015. The dry rubber content, bulk of which goes for tyre sector, was 56% of domestic consumption in 2015. The latex component is used for the highest level of value addition such as surgical and examination gloves that was 44% of total domestic consumption [5]. Fluctuation of rubber production and export is shown in Figure 2-2. Raw Rubber Export Quantity and Value of Different Types Rubbers are shown in Table 2-5. Export quantity of the all types reduced with the time. In 2015, the exported rubber amounted to 10,373 tons and earning was Rs. 3,548 million and out of that, Rs. 2,136 million earning is from the Latex Crepe [5].

Table 2-4: Rubber production, exports and consumption - 2004-2015

Year	*Production*	*Exports*		*Domestic consumption*				
				Dry rubber		*Latex*		*Total*
	million kg	*million kg*	*%*	*million kg*	*%*	*million kg*	*%*	*million kg*
2004	94.70	40.30	43	29.30	54	25.10	46	54.40
2005	104.40	31.60	30	41.80	57	30.90	43	72.70
2006	109.20	46.30	42	36.40	58	26.70	42	63.10
2007	117.60	51.40	44	42.40	57	31.50	43	73.90
2008	129.20	48.60	38	46.10	58	34.00	42	80.10
2009	136.90	56.00	41	48.00	57	36.90	43	84.90
2010	153.00	51.50	34	60.60	57	46.60	43	107.20
2011	158.20	-	27	71.80	56	56.40	44	128.20
2012	152.10	37.40	25	69.10	55	56.60	45	125.70
2013	130.40	23.60	18	65.10	55	53.30	45	118.40
2014	98.60	16.30	17	66.10	57	49.90	43	116.00
2015	88.60	10.40	12	71.30	56	56.10	44	127.40

Source: Rubber Development Department-2016.

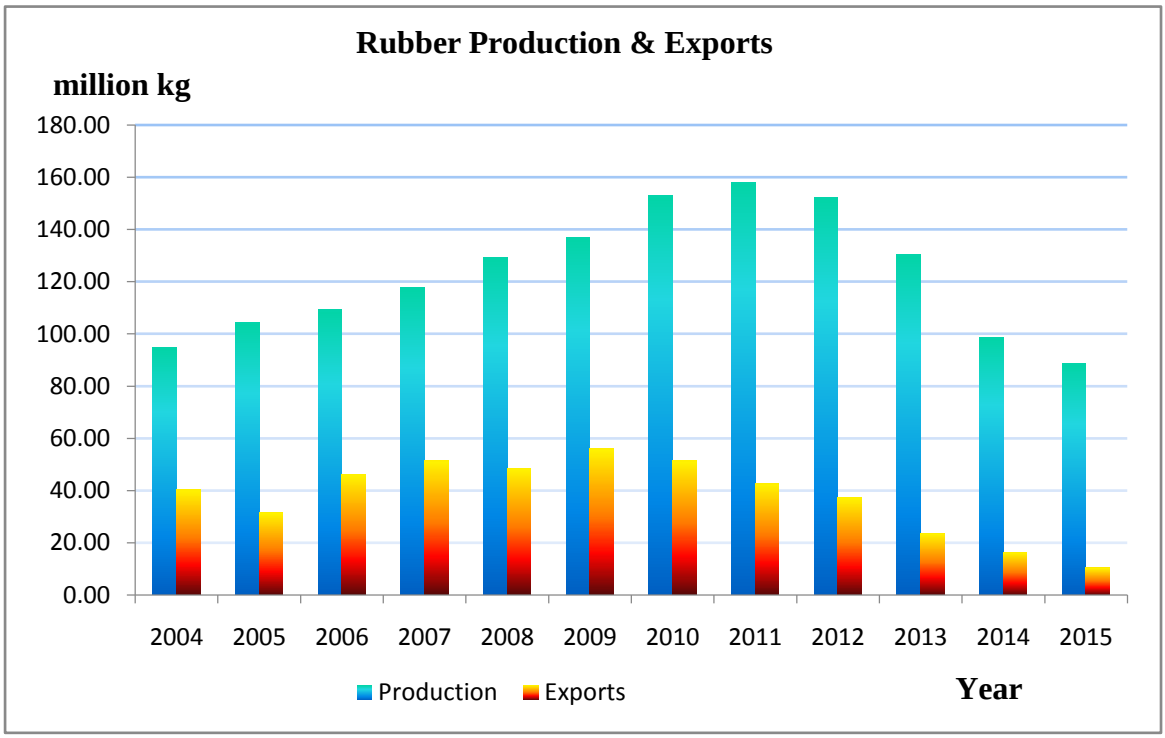


Figure 2-2: Rubber production and exports

Table 2-5: Raw rubber export quantity and value of different type

Year	*RSS sheets*		*Sole crepe*		*Scrap crepe*		*Latex crepe*		*TSR*		*Centrifuged Latex and Others*		*Total*	
	tons	*Rs. million*	*tons*	*Rs. million*	*tons*	*Rs. million*	*tons*	*Rs. million*	*tons*	*Rs. million*	*tons*	*Rs. million*	*tons*	*Rs. million*
2004	18502	2204	1996	344	2723	77	11669	1848	2880	389	2554	275	40324	5137
2005	12246	1706	2724	519	305	34	12371	1866	2136	310	1853	249	31635	4684
2006	19800	3759	2493	709	601	79	16333	3467	4515	911	2601	417	46343	9342
2007	18079	4014	3225	1155	656	102	17503	4112	5979	1311	5979	1372	51421	12066
2008	17257	4583	3283	1077	506	98	15335	4255	4986	1391	7251	2131	48618	13535
2009	24402	4863	2110	659	226	28	13683	2732	6541	1251	9028	1794	55990	11327
2010	20914	7563	2152	1085	71	14	18472	6927	2844	1023	7050	2644	51503	19256
2011	13561	6936	2471	1743	-	-	20904	11101	3655	1822	2014	1209	42605	22811
2012	11057	4758	1486	919	-	-	17645	7187	4582	1609	2607	1252	37377	15725
2013	4752	1744	2022	1126	17	3	13171	4965	2225	778	1399	579	23586	9195
2014	1966	587	2296	1234	17	5	9860	3313	913	306	1253	470	16305	5915
2015	903	217	1847	926	13	1	6888	2136	417	142	305	126	10373	3548

Source: Rubber Development Department-2016

*Includes block rubber also

2.2.3. Colombo auction prices of rubber - 2004-2015

Table 2-6 shows the Colombo auction prices and attractive auction prices were realized in 2010 above 99% for RSS-1, 106% for Scrap Crepe and 118% for Latex Crepe compared with the previous year. The auction price showed a further growth (average 25%) in 2011 for all types. All types of products recorded the highest auction price in 2011 due to depreciation of local currency, benchmarks in other rubber markets in Asia, prevailed gap between global rubber supply-demand, and favourable domestic market response, etc [5].

Table 2-6: Colombo auction rubber prices by different types Rs/kg

Year	*RSS1*	*RSS2*	*RSS3*	*RSS4*	*RSS5*	*Scrap crepe (IXBR)*	*Latex crepe (IX)*
2004	127.04	126.59	122.96	120.76	118.34	117.62	142.43
2005	141.17	138.66	136.66	134.89	133.75	124.68	152.7
2006	202.34	196.82	192.93	189.08	186.07	179.5	242.75
2007	233.69	229.2	226.62	222.6	219.29	206.96	236.82
2008	267.9	264.79	262.22	257.89	254.93	245.61	273.79
2009	202.79	198.62	194.76	190.25	183.82	176.28	208.62
2010	402.71	394.52	390.63	379.47	373.01	364.11	455.94
2011	513.05	504.56	492.45	486.12	470.92	461.83	575.65
2012	416.27	407.99	395.13	388.7	391.92	375.93	409.1
2013	376.78	369	360.7	337.3	341.79	309.04	397.33
2014	285.76	279.75	268.5	264.37	262.4	212.75	309.9
2015	245.93	241.02	235.18	224.16	236.52	187.74	299.17

Source: Rubber Development Department-2016

2.2.4. Cost of rubber production small holding and estate sectors

In 2015, the cost of production in small holding sector increased marginally by Rs.10 per kg compared to the previous year shows in Table 2-7. In the estate sector, cost of tapping and collecting and maintaining of immature rubber estate were increased while cost of other components decreased during 2015 [5]. Based on a separate methodology adopted for the calculation of estate sector cost of production was recorded a decrease of Rs. 15.63 per kg in 2015. In 2014/15 rubber COP of estate sector shows 5.5% decline after recording a continuous increasing trend from 2007 to 2014 and it is shown under the Table 2-8.

Table 2-7: Cost of rubber production - smallholding sector

Item	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
1. Cultivation Cost									
Labour	43.00	66.01	80.00	80.00	85.30	88.50	92.00	95.00	98.00
Materials	7.53	27.42	7.50	8.00	8.40	8.50	11.00	12.50	13.50
Maintenance	3.23	8.13	2.50	2.50	3.20	3.40	4.50	5.50	6.50
Sub Total	**53.75**	**101.56**	**90.00**	**90.50**	**96.90**	**100.40**	**107.50**	**113.00**	**118.00**
2. Processing cost									
Labour	43.00	4.69	12.00	12.00	14.25	15.50	17.00	18.00	19.00
Materials	1.19	0.95	1.56	2.30	1.81	2.00	3.00	4.00	5.00
Sub Total	**44.19**	**5.64**	**13.56**	**14.30**	**16.06**	**17.50**	**20.00**	**22.00**	**24.00**
3. Marketing cost	4.00	2.35	5.00	5.00	5.50	6.25	7.50	8.00	9.00
4. Other charges									
Maintenance	10.75	4.45	10.00	10.00	11.10	11.85	15.00	17.00	19.00
Grand Total	**112.69**	**114.00**	**118.56**	**119.80**	**129.56**	**136.00**	**150.00**	**160.00**	**170.00**

Source: Rubber Development Department-2016

Table 2-8: Cost of rubber production estates - 20 acres and above

Cost item	*2007/2008*	*2008/2009*	*2009/2010*	*2010/2011*	*2011/2012*	*2012/2013*	*2013/2014*	*2014/2015*
1. Maintenance of mature Rubber	19.67	28.78	33.68	30.52	37.23	41.27	48.3	32.96
2. Tapping and collecting Cost	31.47	33.78	39.52	44.98	50.59	57.71	59.1	66.06
3. Maintenance of immature rubber	13.00	18.27	21.38	28.52	43.32	45.45	48.44	51.35
4. Factory cost	11.67	6.71	7.85	12.32	18.54	18.03	19.6	18.64
5. Estate maintenance	5.85	7.42	8.69	8.48	13.79	16.5	21.7	15.6
6. General charges	37.23	40.15	46.98	61.92	57.58	77.27	80.3	78.81
7. Marketing and related expenses	1.00	0.72	0.84	1.49	2.66	3.19	4.6	2.98
Total	**119.89**	**135.83**	**158.94**	**188.23**	**223.71**	**259.42**	**282.04**	**266.40**

Note: This estimate includes the transport cost from factory to Colombo also.

Source: Department of Census and Statistics-2016.

2.2.5. Import of raw rubber

As one of the NR producing countries, Sri Lanka discourages the import of NR through high import Cess rate (5% to 15%on CIF) in addition to usual other taxes and Customs duties. On the other hand, fairly a high Cess rate (Rs. 15per kg at present) on export of NR in raw form is imposed in order to discourage the export of raw rubber out of local production and in turn divert local production to local consumption for finished products manufacturing [5].

Table 2-9 shows that other than NR types, the main imported semi-product was synthetic rubber. In 2015, the quantity imported was 71,699 tons valued at Rs. 15,644 million [5]. As Sri Lanka is not a producer of synthetic rubber, the certain products must incorporate synthetic rubber to meet required standard and the need is there to import synthetic rubber. In a decade Synthetic Rubber import was within the range of minimum 19,000 tons and maximum 71,000 tons on yearly basis [5].

Table 2-9: Rubber imports by type - 2004-2015

Year	*Natural rubber*							*Total Synthetic rubber (*tons*)*
	*RSS (*tons*)*	*Sole crepe (*tons*)*	*Scrap crepe (*tons*)*	*Latex crepe (*tons*)*	*TSR (*tons*)*	*Centrifuged Latex & other (*tons*)*	*Total (*tons*)*	
2004	8,836	0	0	44	261	5,116	14,257	20,634
2005	9,101	0	0	0	40	1,164	10,305	19,593
2006	4,505	1	0	90	0	2,589	7,185	45,346
2007	7,467	0	0	0	0	1,181	8,648	30,234
2008	2,805	0	0	0	0	830	3,635	29,521
2009	3,139	0	0	0	61	1,992	5,192	21,974
2010	8,236	0	0	2,035	197	4,156	14,624	29,101
2011	11,773	0	0	0	42	4,707	16,522	42,084
2012	8,887	68	0	17	187	6,517	15,676	33,789
2013	7,790	18	17	0	188	1,886	9,899	35,888
2014	21,744	0	15	0	208	4,359	26,326	42,359
2015	38,182	0	0	0	892	15,302	54,376	71,699

Source: Rubber Development Department-2016

Sri Lanka Customs-2016

2.3. Rubber product industry

As a resource based technologically sophisticated industry with global linkages, rubber industry plays an important role in Sri Lanka's economy. Its centre of gravity has shifted rapidly to value addition from raw rubber production. This transformation needs to be nurtured and managed and consolidated to optimise benefits [4]. Although value addition to raw rubber began in the 1940s, the real impetus came when the economy was liberalised in late 1970s especially since the 1980s opening doors for industrial investments, both local and foreign, attracting not only funds but technology, management and markets. This set the foundation for a modern rubber products manufacturing industry that has made an indelible mark in global markets with industrial tyres, latex gloves and numerous other assorted products [4].

Manufacturing of value-added products based on raw rubber commenced gradually since 1940s and at present the centre of gravity of Sri Lankan rubber industry has shifted to rubber products manufacturing. In 2013, value of rubber-based products made locally exceeded US$ 1,084 million whereas export value of all types of raw rubber was US$ 71 million. Although Sri Lanka is not a producer of Synthetic Rubbers (SR), the consumption of SR was over 12% of total rubber consumption in 2013 which rose to 17% in 2015. Rubber wood-based industry too makes a contribution that is estimated at around US$ 80 million today [4].

As a producer, Sri Lanka has a current market share of around 0.7% of the global market for natural rubber. Once (in 1970, over 155,000 metric tons per year), Sri Lanka ranked 5th as a rubber producer in the world but regrettably this rank dropped to 14th place by 2015 (88,567 metric tons per year) [7].

2.3.1. Latex industry

By upgrading technology on raw rubber processing, and promoting the premium grades of Latex Crepes, Sri Lanka exclusively manufactured Latex products for food, pharmaceutical and infant toy industry to gain highest price payable from the correct end-users and developed the rubber product manufacturing industry by eliminating problems such as protein allergy, sulphur blooming and environmental pollution [6].

Surgical, household, agricultural, and examination gloves, hygienic or pharmaceutical articles, balloons, Halloween masks, latex thread and articles of apparel and clothing products and rubber toys are among the major products manufactured by the Latex

product industries in Sri Lanka. Latex product industry has expanded significantly over the last decade and presently it attributes to around 35% of the local consumption of NR [6].

2.3.2. Dry rubber industry

Sri Lankan rubber product manufacturers and suppliers produce a wide range of value-added rubber based products by processing raw rubber. This product range consists of extrusion products such as rubber bands, beadings, industrial products such as hoses, auto spare parts, industrial components, tyres, tubes, automotive and aviation tyres and general rubber products such as floor mats, carpets, sports goods, footwear, hot water bottles and related components. Solid rubber products mainly consist of two categories, namely tyre and non-tyre. Tyre sector includes pneumatic tyres, solid tyres and tread materials. In the dry rubber sector, tyre category dominates the non-tyre sector [6].

2.3.3. Import of rubber finished products

As shown in Table 2-10, Sri Lanka imported different types in quantity of 10,227 tons and total number of units 8.4 million with total CIF value of Rs.19,614 million. Only tyres and tubes are given in units while all other products are in metric tons [5].

The main types of imported rubber product was new pneumatic tyres that accounted for 3.2 million units with corresponding value of Rs.10,538 million or 54% of total CIF value. In terms of CIF value, the next type ranked second was articles of vulcanized rubber (floor mats, gaskets, washers, seals, machinery parts) that accounted for Rs.3,675.7 million or 19% of total. Inner tube of rubber, belts, pipe/hoses were followed by CIF value Rs.1,953 million, 856 million, 751 million respectively. Other type of import (threads, cellular and non-cellular rubber products, solid tyres, gloves and contraceptives) carried moderate quantity and value of CIF at Rs.1,842 million or 9% of Total CIF [5].

In 2015, Sri Lanka exported new pneumatic tyres almost 2-fold of such imports in value terms. In respect of solid tyre category compared to import value, export from Sri Lanka was more than 123 times. Similarly gloves were exported 70-fold of import value of the same. As rubber product imports are subject to 5% to 15% range of Cess rate on CIF value in 2015, the Cess income collected was Rs.2,256 million [5].

Table 2-10: Import of rubber finished products-2015

Description	*Performance*	
	Quantity (tons)	*Value(Rs. millions)*
Rubber thread and cord	918.00	280.70
Plates, sheets, strip, rods and profile shapes	1,058.30	669.60
Tubes, pipe and hoses of vulcanised Rubber	1,283.00	750.70
conveyer/transmission belts or belting V-belts and other types	1,105.00	856.00
New pneumatic tyres of rubber (No)	3,170,224.00	10,537.90
Retreated and solid tyre (No)	519,065.00	331.70
Inner tubes of rubber (No)	4,673,600.00	1,952.70
Hygienic/pharmaceutical articles	101.00	157.50
Gloves of vulcanised, unhardened rubber	388.90	321.20
Other articles of vulcanised rubber	4,869.10	3,675.70
Articles of hard rubber	503.90	80.70
Total tons value	**10,227.20**	**6,792.10**
Total No(Unit) value	**8,362,889.00**	**12,822.30**
Total Value		**19,614.40**

2015 Annual Average Exchange Rate -1US$ = Rs. 135.94

Source: Sri Lanka Customs- Data from Statistical Unit

2.3.4. Export of rubber finished products

In 2015, the export earnings of finished products were recorded as Rs.101 billion. During the period from 2009 to 2015, total rubber product export earnings increased by Rs.57 billion [5].

In 2015, as highlighted in Table 2-11 the highest export earnings were realised by solid tyres export of Rs.41 billion corresponding to 18.6 million units. This was followed by new pneumatic tyre export amounting to Rs.22.3 billion and 14.1 million units. Thus, for tyre and tube sector alone, export earning was Rs.63.91 billion or 63% of total earnings. Other than tyre sector, gloves exported earned Rs.22.3 billion or 22% of total value of

export. Other article of vulcanized rubber (mats, gaskets, washers, seals and machinery parts) accounted Rs.12.3 billion or 12% of total export value. Balance 3% of export earnings were realised from export of cellular and non-cellular rubber products, inner rubber tubes, and contraceptives [5].

Thus, in 2015, total export income of Rs.101 billion was earned by exporting rubber finished products manufactured in local firms. Total units of tyres and tubes exported were 36.3 million while other products measured in metric tons were 60,522 [5].

Table 2-11: Export income from different product categories of rubber in Rs million

Rubber products	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
(1) Rubber thread and cord	23.6	5.2	22.0	7.0	1.0	1.5	-
(2) Unhardened rubber -plates, sheets, strips, rods and profile	1383.3	1908.0	1812.0	2258.0	2533.0	2440.0	2684.2
Products of cellular rubber			1023.0	1404.0	1417.0	1419.0	1954.5
Products of non-cellular rubber			789.0	854.0	1116.0	1021.0	729.7
(3) Rubber hoses	0.7	5.3					
Tubes, pipes and hoses			30.0	20.0	41.0	42.0	30.3
(4) Rubber belts	-	1.0					
V-belts and other type belting			13.0	26.0	2.0	3.0	2.3
(5) Tyre and tubes of which:	24519.8	39396.0	63169.0	69049.0	71176.0	74103.4	63,862.9
New pneumatic tyres			23821.0	26463.0	26385.0	27054.58	22,299.9
Solid tyres			39065.0	42208.0	44920.0	46565.0	41035.7
Tubes			283.0	378.0	411.0	483.8	527.3
(6) Apparel Clothing Accessories of Which:	13070.3	15335.4	20012.0	22546.0	25247.0	22970.0	22337.3
Surgical gloves			4553.0	5731.0	8262.0	5599.0	5338.2
Industrial gloves			15,459.0	16,815.0	16,985.0	17,371.0	16,999.1

Rubber products	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
(7) Articles of hardened rubber of which:	4762.2	6772.3	9871.0	9773.0	10329.0	12458.0	12295.3
- Floor covering and mats			1165.0	1126.0	1211.0	1438.0	1307.3
- Gaskets, washers and other seals			2482.0	1963.0	1919.0	1782.0	1574.0
- Parts of machinery and equipment			6224.0	6684.0	7175.0	9238.0	9413.6
(8) Footwear	137.3	153.5	-	-	-	-	-
(9) Rubber products unclassified (Contraceptives, ebonite, etc.)	376.6	392.1	240.0	242.0	179.0	228.0	214.2
Total of rubber products	44300.8	63968.8	95169.0	103921.0	110.048	112246	101426.5
Raw rubber total	11327.0	19255.7	22810.0	15726.0	9195.0	5916	3547.9
Semi processed rubber total*			2664	5535	4733	3912	1836.4
Total Export Value	**55627.8**	**83224.5**	**120643.0**	**125182.0**	**123976.0**	**122074**	**106810.8**

Source: Sri Lanka Customs-2016

Note: Since 2011,this table is improved incorporating disaggregated value in main products under product categories 2, 5, 6, and 7 to understand easily and compatible to similar other tables.

*Semi processed include grnules, reclaimed andcompounded rubber mainly.

2.4. Global rubber industry review

Table 2-12 shows that at present total extent of world rubber plantation stands at 12,951,000 ha. Out of this extent, 11,212,000 ha or 87% belongs to 9 ANRPC member countries in Asia. The extent of rubber in rest of the world (non ANRPC countries in Asia, Africa and America) is about 7,739,000 ha or 13% of the World Total. Although data coverage is not comprehensive around 80% of the extent came under the smallholding sector while 20% was in the estate sector representing the large-scale plantations with the ownership of state or private sector companies. Also 78% or 8,719,100 ha were at matured (tapped area) stage from which NR production of 11,042,000 tons is realised at present [5].

Table 2-12: Extent of world rubber plantations

Country	*Year*	*Total ('000 ha)*
Brazil	2014	145.40
Guatemala	2010	90.00
Mexico	2010	14.00
Cameroon	2012	57.00
Ivory Coast	2014	434.00
Gabon	2013	11.50
Ghana	2010	28.50
Liberia	1999	108.90
Nigeria	2011	182.00
Congo	1999	35.00
Bangladesh	2009	40.80
Cambodia	2015	388.90
China	2015	1159.00
India	2015	811.00
Indonesia	2015	3621.00
Malaysia	2015	1078.60
Myanmar	2013	567.80
Papua N.G	2007	24.50
Philippines	2015	222.60
Sri Lanka	2015	132.80
Thailand	2014	2816.60
Vietnam	2015	981.00
Total		**12950.90**

Source: International Rubber Study Group (IRSG)-2016

Association of Natural Rubber Producing Countries (ANRPC)-2016

2.4.1. World rubber production

Despite the increase of total world rubber production since 2009 to 2015 at an average annual growth of 3.8%, the growth of ANRPC member countries alone averaged to 3.4% during the said period. With regard to ANRPC member countries, Thailand, Indonesia, Vietnam, China, Malaysia and India are the major producers ranked in order for the period between 2009 and 2015. Among Non-ANRPC countries major share of rubber production comes from Ivory Coast, Brazil, and Myanmar throughout. Total production of this group of countries increased from 786 million kg in 2009 to 1,226 million kg in 2015 by 56% while annual average growth of production recorded was 8% which is much higher than ANRPC as highlighted in Table 2-13 [5].

Table 2-13: World rubber production (in million kg)

Country	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
1. India	820	851	893	919	849	705	575
2. Indonesia	2440	2736	3013	3040	3180	3153	3145
3. Malaysia	856	939	996	923	826	669	722
4. Philippines	98	99	106	111	111	113	100
5. Sri Lanka	137	153	158	152	130	99	89
6. Thailand	3164	3252	3569	3778	4170	4323	4473
7. Vietnam	711	752	812	864	949	954	1017
8. China	644	687	727	795	865	840	794
9. Cambodia	34	42	51	65	85	97	127
ANRPC member countries total	**8904**	**9511**	**10325**	**10647**	**11165**	**10953**	**11042**
Other countries							
10. Liberia	60	62	65	64	69	60	60
11. Brazil	129	136	166	172	173	185	194
12.Myanmar	112	120	128	136	147	148	228
13.Guatemala	81	83	89	95	94	96	91
14. Nigeria	45	54	55	56	57	58	57
15. Ivory Cost	203	232	234	254	275	317	338
16.Others	156	208	200	200	201	254	258
Non-ANRPC countries total	786	895	937	977	1016	1118	1226
World Total	**9690**	**10406**	**11261**	**11623**	**12181**	**12070**	**12267**

Source: International Rubber Study Group (IRSG)-2016

Association of Natural Rubber Producing Countries (ANRPC)-2016

2.4.2. Key indicators of rubber industry in ANRPC -2015

Key indicators of Rubber industry as given in Table 2-14 highlighted that the highest yield was recorded for Vietnam (1,695 kg/ha) followed by Thailand and India in 2015. Thus, in 2015 average yield was recorded at 1,265 kg per hectare/year while varying yield level range (823-1,695 kg/ha) is recorded for individual countries [5]. In ANRPC group the NR consumption out of ANRPC production was 69% leaving the balance for export, at present. The formula on NR production, plus import, minus export, equal to consumption adjusting with stock almost tallied in respect of cumulative parameter values for ANRPC in 2015. Total area replanted of ANRPC stood at the rate of 1.9% while new planted area was 1.6% of total rubber extent in 2015 [5].

Table 2-14: Key indicators of rubber industry in ANRPC members -2015

Item		*Unit*	*Cambodia*	*China*	*India*	*Indonesia*	*Malaysia*	*Philippines*	*Sri Lanka*	*Thailand*	*Vietnam*
1. Area	Total area	('000) ha	388.9	1,159.0	811.0	3,621.0	1,078.6	222.6	132.8	Not Available	981.0
	Tapped		111.2	711.0	391.0	3,016.0	650.0	116.9	107.6	3,015.4	600.0
2. NR production		('000) tons	127.0	794.0	575.0	3,145.0	722.0	100.0	89.0	4,473.0	1,017.0
3. Average annual yield to tapped area		kg/ha	1,140.0	1,117.0	1,471.0	1,043.0	1,410.0	851.0	823.0	1,483.0	1,695.0
4. Annual growth rate of production		%	30.6	-5.5	-18.4	-0.2	8.0	-12.2	-10.1	3.5	6.6
5. NR consumption		('000) tons	-	4,680.0	993.3	541.0	483.7	29.6	127.4	600.5	176.0
6. NR gross export		('000) tons	128.0	43.4	1.1	2,674.3	1,131.8	76.9	10.4	3,749.5	1,137.8
7. NR gross import		('000) tons	-	4,101.5	450.0	32.7	957.3	7.0	54.4	2.7	300.0
8. Area planted	New planted	('000) ha	30.1	5.0	16.0	15.0	15.0	23.4	0.8	20.0	7.3
	Replanted	('000) ha	0.6	12.0	15.0	45.0	35.7	1.7	1.9	25.0	22.0

Source: Association of Natural Rubber Producing Countries (ANRPC)-2016

2.4.3. The annual average yield per hectare in ANRPC

Below Table 2-15 gives the annual average yield and mature area in the ANRPC group in years 2014 and 2015. While the average yield declines, the mature area expands in all the countries during 2015 [6]. The expansion in mature area reflects the larger scale planting undertaken during the period from 2005 to 2012. Average annual yield figures reflect the achievements made by producing countries in clone improvements, and crop management. Adoption of harvesting technologies has not been translated into improvements in average yield. The sharp fall in rubber prices especially during the year 2015 has aggravated the yield performance further [7].

Table 2-15: The annual average yield per hectare in ANRPC member countries

Country	*Total area ('000 ha)*		*Tapped area ('000 ha)*		*Yield (kg/ha/year)*	
	2014	*2015*	*2014*	*2015*	*2014*	*2015*
Cambodia	357.8	388.9	90.5	111.2	1072	1140
China	1161	1159	695.0	711	1209	1117
India	795	811	447.0	391	1576	1513
Indonesia	3606	3621	2995.0	3016	1053	1058
Malaysia	1065.6	1078.6	600.0	650	1370	1410
Philippines	217.7	-	120.2	-	942	-
Sri Lanka	134.1	134.8	110.9	119	914	823
Thailand	2816.6	-	2775.0	-	1566	-
Vietnam	981	972	563.6	600	1692	1695
(*Source:*ANRPC,2016)						

2.4.4. Trends of natural rubber supply in major producing countries

Total world Natural Rubber (NR) production increased to 12,267 thousand tons in 2015 against the NR production which was around 12,111 Thousand tons in the year 2014. World NR production has increased by 1.3% according to IRSG statics. Nevertheless, the provisional data received from the member countries of ANRPC indicated a drop of 0.6% year-on-year [8]. This is mainly due to the impact of E1 Nino condition on the rubber growing areas in the Asia Pacific Region. Table 2-16 gives the annual natural rubber production of major producers in the world their year-on-year growth against the previous year [8].

Table 2-16: Trends of NR supply in major producing countries.

Country	*Quantity (tons)*		*Annual growth (%)*
	2014	*2015*	
Thailand	4324.0	4473.4	3.5
Indonesia	3153.2	3175.4	0.7
Malaysia	668.1	695.4	4.1
India	704.5	575.0	-18.4
Vietnam	953.7	1017.0	6.6
China	840.1	794.0	-5.5
Cote d Ivories	317.3	337.6	6.4
Brazil	193.3	194.4	0.6
Sri Lanka	98.6	88.6	-10.1
Myanmar	198.0	227.5	14.9
Philippines	113.2	111.1	-1.9
Guatemala	96.4	90.7	-5.9
Cambodia	97.1	126.8	30.6
Liberia	59.9	60.0	0.2
Others	293.5	297.2	1.3
World Total	**12111.0**	**12266.8**	**1.3**

(*Source:* IRSG, 2016)

2.4.5. Trends of natural rubber demand by major consumers

Apart from the economy's dominant role, the demand for NR is greatly influenced by geographical shifting of manufacturing base, capacity expansion in automotive tyre industry, substitution between natural and synthetic rubber and change in consumption basket. Table 2-17 shows the trends in NR consumption and their annual growth of demand for major consumers in the world [8].

Table 2-17: Trends in NR demand by major consumers.

Country	*Consumption ('000 tons)*			*Annual growth (%)*	
	2013	*2014*	*2015*	*2014*	*2015*
China	4210	4760	4820	13.1	1.3
Total EU 28	1060	1139	1174	7.5	3.1
India	962	1012	991	5.2	-2.1
USA	913	932	936	2.1	0.4
Japan	710	709	721	-0.1	1.7
Thailand	521	541	606	3.8	12.0
Indonesia	509	540	568	6.1	5.2
Malaysia	434	447	475	3.0	6.3
Other Countries	2067	2054	2057	-0.6	0.1
World	**11386**	**12134**	**12348**	**6.6**	**1.8**
(*Source:* IRSG, 2016)					

China consumed 39% of the total consumption of natural rubber globally during 2015. Other major consuming countries or regions are the European Union (9.5%), India (8%), the US (7.6%), Japan (5.8%), Indonesia (4.6%), Thailand (4.9%), and Malaysia (3.8%). In all these countries, the annual growth rate of demand for NR has increased except for India. The unsatisfactory performance reflected through continued growth deceleration in emerging and developing economies is seen, including China [8].

2.4.6. Total rubber demand

Total rubber consumption was 26,779 thousand tons in 2015 compared to 26,404 in the previous year. This increase accounted for an increase of 1.4% year-on-year growth. World NR consumption is being dominated by China with 4,820 thousand tones followed by India with 991.6 and USA with 936.5 [8]. China was the highest SR consumer in 2015 followed by USA and European Union countries. China consumed 4,067.2 thousand tons of SR and USA consumed 1,963.3 in 2015(IRSG, 2016) [8].

2.5. Barriers for the industry

Transfer of innovations is affected by numerous barriers understood as "any kind of limitations and features that hamper the effective functioning of a technology transfer and research commercialisation system, and, as a result, block interactions between the R&D sector and enterprises, therefore impeding the development of innovative entrepreneurship" [9]. Taking into account the importance of the problem from the scientific and practical points of view, the application of technological innovations is acknowledged as a driver for economic and social development [9].

The topic of barriers concerning technology transfer, because of its importance for the economy, is a field of interest for numerous scholars and practitioners. The first studies on barriers to the successful movement of technologies from scientific organization to industry can be found in the 1950s and 1960s [9], but the majority of early publications on this issue actually date back to the 1970s and 1980s [9]. One of the very first researchers to deal with this complex issue was Jung [10], who mainly focused on human and organizational barriers to the successful transfer of technologies. Most authors concentrate on the relation between barriers and the socio-political and economic situation of a given country, and their analysis typically concern only a particular domain [11] [12]. The topic has also found wide coverage in Polish literature. Polish scholars and practitioners take the specificity of the Polish economy into consideration and analyse the

barriers both on the macro–national level and less often on the micro level – namely on the level of an R&D organization [11].

2.5.1. Classification of barriers

Numerous classifications of barriers are proposed by scholars. In 1974, Mock JE [9] listed twenty-six barriers to technology transfer, particularly stressing the importance of the following barriers: financial, competence, communication, and market related barriers. Sharif MILLION [9] also divides technology transfer barriers into four groups: organisation-ware, information-ware, technique-ware, and human-ware. Mojaveri et al. [9] also use a four-group classification; however, the categories they use are different and include technical, attitudinal, cultural, and market barriers. Creighton et al. [9] indicate two groups of barriers - formal (procedural) and informal (behavioural), whereas Jervis and Sinclair [9] indicate political and institutional ones. Taking into account the classifications of barriers proposed by other scholars and having in mind the authors' own experience in executing research projects and co-operating with industry, the authors propose their own classification of barriers comprising the following: technical barriers, organizational-economic barriers, and system barriers to technology transfer. Furthermore, the authors want to stress that all the mentioned types of barriers may be observed at different levels: strategic, tactical, and operational ones [10] [12].

2.6. Barriers and solutions for the rubber industry

Despite improving global financial conditions and reduced short-term risks, the world economy continues to expand at a subdued pace [10]. After a marked downturn over the past two years, global economic activity was expected to slowly gain momentum in the first half of 2015. Most world regions saw a moderate strengthening, but growth still remains below potential. As per a baseline outlook, global growth has moved slightly downward from the forecasts presented in the World Economic Situation and Prospects 2015 [10].

Rubber industry pays a major role in Sri Lankan economy. At present, the strategies and actions of other countries and global corporations in the rubber industry have contributed to excess supply and falling prices for natural rubber. In any case, Sri Lanka, which supplies only 0.73% of the world's Natural Rubber but cannot affect the global market or prices. This poses a dilemma for Sri Lanka:

• The plantation sector's return on investment and profitability is low;

- Rubber supply to local industry is uncertain;
- Smallholders, who are receiving insufficient revenue because of low yields, low prices, and the absence of effective extension services, are converting land to other crops;
- The domestic market cannot consume the base-load volumes of semi-finished and finished rubber products that normally reduce the cost of goods sold in a manufacturing scenario; and
- Privatisation of plantations is not complete and many "private companies" merely lease land and assets from the government under long-term agreements.

In addition, government policies and activities do not seem to address these problems effectively. Restrictions on the import of raw rubber, for example, discourage foreign and domestic investment in value-added products. The many agencies (e.g. the Ministry of Plantation Industries, Ministry of Enterprise Development, Industrial Policy, and Investment Promotion; Ministry of Commerce and Consumer Affairs) and the institutions under them directly influence the industry but do not have a common strategy for supporting it. Some, such as the Ministry of Agriculture and Forestry, and the Land Use Ministry have resources and strengths to support the industry, but they are keeping quiet. Moreover, the government's subsidising of the state-owned rubber manufacturing company (Sri Lanka Rubber Manufacturing & Export Company Ltd.) affects market dynamics. Nor does the government collect the data and information necessary for informed policymaking [13].

Human resources, long a comparative advantage for Sri Lanka's rubber industry, are beginning to lose competitiveness because universities, the Plastics and Rubber Institute (PRI), and the National Institute of Plantation Management (NIPM), work in isolation, lack adequate professional resources, and have no input on strategy [13].

The rubber industry as a whole has limited advocacy power with respect to the government. Elements of the value chain have rarely advocated a joint, industry-wide development agenda. Individual associations have addressed policy issues in response to problems (or a donor program) without enlisting others in the value chain. The industry does, however, credit four associations with solving some problems: Planters' Association of Ceylon, Colombo Rubber Traders' Association, PRI, and Sri Lanka Association of Manufacturers and Exporters of Rubber Products (SLAMERP) [13].

2.6.1. Barriers and solutions for manufacturing

Even as other rubber-producing countries are expanding manufacturing and enjoying lower input costs and higher productivity, Sri Lanka's competitive advantages are threatened by rising costs for materials, labour, and other inputs and a diminishing supply of raw rubber. In addition, relative costs may increase because Sri Lanka does not produce petroleum based synthetic rubber, and natural rubber production is declining. Global pricing of secondary materials and local government policies may drive up costs for manufacturing goods and services. If Sri Lanka achieves new manufacturing success it should be wary of threats to that success. At present, for example, local stakeholders do not have the critical mass or resources to ensure that products are delivered on time and according to specifications. Converting from short-run to long-run manufacturing could move production, human resources, and technology offshore. And a drive for expansion could be stymied by the lack of infrastructure and other facilities in rural areas, where other industries may take precedence [13].

More specialty raw rubber and better research and development would enable Sri Lanka's manufacturers to enter new and promising niche markets. To ensure adequate supply, raw rubber can be imported at competitive prices. If research and development consortium and prototyping centres are established, synthetic rubber could be imported for value addition and new products could be developed. Growth in the manufacturing sector could encourage domestic production of such materials. The industry should be able to attract investment as foreign corporations seek to relocate manufacturing facilities. A dedicated industrial park with well-designed central treatment facilities would allow Sri Lanka's processors to consolidate and control processing costs [13].

2.6.2. Barriers and solutions for technological capabilities

Sri Lanka's rubber industry is threatened by inadequate product development capabilities, which discourages corporate manufacturing projects, and by the lack of cooperation and resource sharing among technical institutions under different ministries. Likewise, its technological capacities are threatened by declining raw rubber production and exports and decreasing hectares under rubber, all of which could diminish the importance of RRISL and steadily erode government support for the industry. In competing countries, small and medium-size firms are well supported by public sector research and development. Sri Lankan firms that are not similarly supported will be severely challenged by international competition [13].

If the RRISL is prepared to change its objectives, outlook, and management systems and structures, private sector involvement could remedy this situation. In addition, institutional programs should be rationalized, and the industry should consider contracting directly with the institutes or creating research and development consortia to collaborate in precompetitive research, such as protein allergy research. Government could support private research and development through tax credits, scholarships for training overseas, and other incentives [13].

2.6.3. Barriers and solutions for human resources

Although Sri Lanka's rubber industry for a long time had a skilled and competitive workforce, the best and brightest are leaving the country to earn higher wages. If trends continue, the rubber industry faces long-term threats to its human resource base. The quality of teaching could decline for various reasons, and graduates could be increasingly deterred from joining the industry, instead choosing to emigrate for better salaries and quality of life. If the plantation and smallholder sectors do not become profitable, the government will allocate fewer resources to support the industry [13].

To better serve the needs of the rubber industry, Sri Lanka Rubber Manufacturing & Export Company (SLRMEC), NIPM, and RRISL could work jointly to establish a dedicated training centre, with private sector participation, similar to the Rubber Research Institute Malaysia Sungei Buloh training centre. Affiliation with foreign universities and institutions and joint programs could expose university faculty to other countries' industries. And the private sector could help upgrade outmoded teaching facilities. If Sri Lanka's rubber industry successfully pursues niche markets and higher value-added production, it will realise higher profits and be able to offer profit sharing and better wage incentives to retain and upgrade its workforce [13].

2.6.4. Barriers and solutions for supply

Solutions to supply-side problems are long term; meanwhile, producers, lacking capital and responding to current cost-benefit analyses, may choose to replant other crops, such as Palm. A clear trend of supply decline will feed the perception that rubber plantations are a sunset industry and the government and private sector may do little to revive the sector with investments. In addition, if smallholders remain disorganised they will probably continue to generate low yields and revenues, and then switch to tea and other crops. If supply and manufacturing sectors do not pursue strong contractual relationships,

the value chain will remain fragmented. In fact, pressure to replant other crops will increase if the manufacturing sector de-couples from domestic supply. If smallholders upgrade, markets may not pay premiums for higher quality and improved compliance with specifications. If the government cannot fund infrastructure improvements, the industry will continue to bear unnecessarily high fixed and variable costs and the government may be tempted to continue its protectionist strategy vis-à-vis imports [13].

All these problems can be corrected. Technology can increase yields per hectare and lower costs; new high-yielding clones can improve quality and sustain profits; and timber can be used to supplement income. If strong commercial linkages are established in the value-added sector, value-added applications will begin yielding profits all along the supply chain. Smallholders should pursue long-term commercial contracts linked to improved collection practices and quality certifications; they should also seek assistance through the RDD and SLRMEC (Sri Lanka Rubber Manufacturing & Export Company). Along with better methodologies and procedures, standardised specifications and certifications for field latex will raise quality, consistency, and selling price.

Manufacturers should establish long-term supply contracts with a price index tied to international posted prices, with discounts and premiums depending on market conditions. Producer and manufacturers should pursue formal vertical integration through joint ventures, mergers, and other contractual obligations. A needs analysis has shown that infrastructure development would significantly lower fixed and variable costs and spur progress across all economic sectors [13].

2.6.5. Barriers and solutions for marketing

Other producers are outpacing Sri Lanka and the latex protein allergy issue is affecting the viability of natural rubber products. Successful short-run products could go into large-scale production, but offshore; and the success of “super latex” could be threatened by land constraints that limit maximum domestic production of field latex. If Sri Lanka pursues technology or trade agreements, it must be aware that such agreements may favour larger producers’ market strengths. Existing foreign investors and some local investors could choose to relocate their expansion programmes. In the absence of a unified industry marketing strategy, the industry depends on government-led and international donor-led marketing schemes, but government may choose to re-allocate resources to tea and other industries and donor agencies could pull support from the rubber sector [13].

Sri Lanka's traditional image can be used to promote rubber products around the world. To begin attracting buyers' attention, the industry should focus on short-run, high-value products for international companies and establish a new standard for organic, pure "super latex," available in limited quantities. Sri Lanka should investigate technology or trade protocols between large rubber producing countries as well as trade agreements directly relevant to the rubber industry. Such agreements will open markets and improve investment policy to boost local industry. The industry should also unite to pursue a market.

2.6.6. Barriers and solutions for investment

International donor agencies and other sources of funds are in Sri Lanka, but credit costs are high because of political risk, government intervention, and arbitrary premiums. If peace initiatives fail or political and social unrest continues, investors will not invest in Sri Lanka. Unless plantation companies improve productivity and reduce unit costs, investors' may not want to share the costs of inefficiency when raw rubber is available cheaper elsewhere. Without unified, convergent objectives, the industry will not be able to make effective use of what little investment funds there are. Investment may be attracted to India's rubber industry parks and to other countries with better infrastructure and facilities [13].

Plantation companies can form mutually beneficial joint ventures with foreign or local companies in the products sector, especially to produce items based on latex crepe grade. The industry could pursue networking and cooperation among international agencies for specific projects and the establishment of a dedicated industrial park for the rubber and plastics industries with proper zoning (plots for such development are available in rubber growing areas). Success in peace initiatives may improve investor confidence [13].

2.7. Summary

Under the literature, it was identified the key indicators of rubber industry and those were Rubber production, Area, Yield, Replanting, New planting, Prices, Cost of Production (COP), Export of Raw Rubber, Domestic Consumption and Export Earnings. Area includes under cultivation and under tapping areas. Prices include Export FOB (Raw Rubber) and Colombo Auction Prices. Export earnings include Raw Rubber, Semi-processed and End Products Earnings. By considering those indicators, it was identified

that there were many barriers for the rubber industry and therefore it was needed to investigate about the rubber plantation industry and rubber product industry.

Under the rubber plantation, it was found that total rubber extent in the country at the end of 2015 was around 134.8 thousand hectares against 134 thousand hectares at the end of 2014 while the tapping area was around 119 thousand hectares. The increase in rubber plantation areas was due to the extent of new plantings, which accounted for 800 ha and replanting of 1000 ha of lands. Regarding rubber production, export and consumption are also noted. In 2010, rubber production was 153 million kg and in 2015 it was come down to 88.6 while export quantities are reducing from 51.5 million kg to 10.4 but domestic consumption of dry rubber as well as latex was increased. Prices of the rubber were drastically decreased during above period. Rubber cost of production for small holding sector was increased from Rs. 119.80 to Rs. 170 while for estate sector was increased from Rs. 188.23 to Rs. 266.40. Import of Natural Rubber was increased from 14,624 tons to 54,376 tons while synthetic rubber from 29,101 tons to 71,699 tons during 2010 to 2015. By considering all these factors, it was obvious that there must be barriers in rubber plantation industry.

Under the rubber product industry, Latex product industry has expanded significantly over the last decade and presently it attributes to around 35% of the local consumption of NR Upgrading Technology on raw rubber processing, promoting the premium grades of Latex Crepes manufactured exclusively in Sri Lanka for food, pharmaceutical, and infant toy industry and also Sri Lankan rubber products manufacturers and suppliers have produced a wide range of value added rubber based products by processing raw rubber such as extrusion products, general rubber products, and solid rubber products.

Sri Lanka has imported different types in quantity of 10,227 tons and total number of units 8.4 million with total CIF value of Rs.19,614 million. The main types of imported rubber product were new pneumatic tyres which accounted for 3.2 million units with corresponding value of Rs.10,538 million or 54% of total CIF value. In 2015, Sri Lanka exported new pneumatic tyres almost 2-fold of such imports in value terms. In respect of solid tyre category compared to import value, export from Sri Lanka was more than 123 times. Similarly gloves were exported 70-fold of import value of the same. As rubber product imports are subject to 5% to 15% range of Cess rate on CIF value in 2015, the Cess income collected was Rs.2,256 million.

In 2015, the export earnings of finished products were recorded as Rs.101 billion. During the period from 2010 to 2015, the total rubber product export earnings were increased by Rs.23 billion or 128%. Considering the above period, export earnings were decreased for rubber tread and cord, rubber belts, rubber products unclassified, while increasing unhardened rubber, rubber hoses, tyre and tubes, apparel clothing accessories, and articles of hardened rubber. In 2015, the highest export earnings were realized by solid tyre export of Rs.41 billion, corresponding to 18.6 million units. This was followed by new pneumatic tyre export amounting to Rs.22.3 billion and 14.1 million units. Thus for tyre and tube sector alone, the export earning was Rs.63.91 billion or 63% of total earnings. Other than tyre sector, gloves exported earned Rs.22.3 billion or 22% of total value of export.

When compared the rubber production with the other rubber producing countries, Sri Lanka was in the fifteenth position from sixteen rubber producing countries. Rubber production was decreased from 153 million kg to 89 during 2010 to 2015 while it is increasing in most of the countries. By comparing the key indicators of ANRPC members, it was identified that Sri Lanka is having the lowest annual yield per hectare. This is mainly due to the technological barriers. Growth rate is -10.1%, new planted and replanted area is very low. These figures imply that Sri Lanka is lagging from the most of rubber producing countries, therefore there must be barriers for the rubber industry in Sri Lanka.

It was identified the barriers for the whole industry and those barriers were belonged to Political, Economic, Social, Technological, Legal, and Environmental factors. Then it was identified the solutions for the above barriers in the rubber industry by discussing Manufacturing, Technological Capabilities, Human Resources, Supply and Investment. Those were same as above barriers. Therefore it was found out that there is a lot of barriers for the rubber industry in Sri Lanka and those barriers were belonged to Political, Economic, Social, Technological, Legal and Environmental (PESTLE) factors.

CHAPTER 3

3 Study the Status of the Rubber Industry in Sri Lanka

3.1. Introduction

The rubber industry has played a significant role in the Sri Lankan economy as a key sector. Its stature is growing with the value added products segment reaching great heights having been recognized as world‘s preferred supplier of industrial solid tyres and rubberized tracks. But market share of Sri Lanka‘s raw rubber is steadily declining during past years. During the literature review, it has been observed that key indicator for the rubber industry and their fluctuation since 2010 to 2015, when considering the raw rubber production in 2011, it had been reached to the maximum level and coming down but there is no indication of stooping the down trend. Therefore, there must be barriers for rubber production. Considering the area of cultivation, both under-cultivation area and under-tapping area were also increasing since 2010 but production is reducing year by year. It can be observed by checking yield per hectare; it has been reduced from 1582 kg/ha in 2010 to 823 kg/ha in 2015. This implies that there are more barriers in rubber plantation sector such as technological barriers. By considering the replanting area and new planting area, it can be observed that both are having declining trend. It means that Sri Lankan people are going to give up the rubber cultivation in near future and there may be reasons for that such as political, social barriers or economic barriers.

Since 2010, the rubber prices of Free on Board (FOB) and Colombo Auction have reached its maximum level in 2011 and thereafter coming down till 2015. It is obvious that no fair prices for raw rubber production due to cost of production of around Rs. 170 per kg for small holdings sector and around Rs, 266 for estate sector and also cost of production was increasing since 2010 up to 2015 although the other indicators were decreased. This is also implied that there are big problems in rubber industry such as technology transferring, legal, environmental or political barriers.

Exports of raw rubber were continuously reducing since 2010 to 2015. No maximum export recorded in 2011 but domestic consumption was increasing till 2015. When we are overlooking the export earning, the raw rubber earning had reduced but semi-processed has some fluctuation and got peak in 2012. End rubber products were the major earnings in rubber industry and also it has some fluctuation with time. It has reached its maximum value in 2014 but it shows reduction in 2015. By considering the entire exports,

maximum rupee value was recorded in 2012 while maximum dollar value in 2011 and there is a decline trend up to 2015.

3.2. Aim and objectives

1. To design a study to identify the barriers and propose solutions.
2. To develop a questionnaire.
3. To collect data.
4. To analyse gathered data to identify the barriers.
5. To propose solutions.

3.3. Methodology

According to the finding from literature survey, it is required to create the objectives to investigate the barriers and identify the solutions for rubber products industry in Sri Lanka. The number of samples was decided as explained in section 3.3.1 and Questionnaire was formulated as explained in section 3.3.2 and planned to collect the data as explained in section 3.3.3 and then carry out the survey by using questionnaire to find out the present situations and collect the data in rubber products industry. Finally, analysing the gathered information from questionnaire by using PESTLE with cobweb diagram, statistically analyse for significance to identify differences among barriers, and propose the solutions using qualitative analysis.

3.3.1. Sampling

According to the information gathered from Sri Lanka Customs regarding export performance of rubber products industry as shown in Table 3-1, the percentage values of annual turnover for each sector out of the total turnover is calculated to find out the contribution of each sector to the rubber industry. Tyre and tube industry has been given around 63% contribution, while gloves industry 22% and other article industry 15% contribution to the total annual turnover of rubber products. Therefore, one hundred and fifty three (153) questionnaires were distributed according to the percentage value throughout the industries to collect the hundred samples (100). For the “tyre and tube” industry, 96 questionnaires were distributed while 34 questionnaires for “Gloves” industries and 23 for the “Other Articles” industries.

Table 3-1: Export performance of rubber products -2015 and distributed samples

Type	*unit*	*2015*			*Annual Turnover %*	*Number of Questionnaire Distributed*
		Qty	*USD million*	*LKR million at LKR 135.94 per 1 US$*		
Rubber Products						
(1) Tires & Tubes					**62.96**	**96**
-Solid Tire	000 unit	18,625	301.9	41,036		
-Pneumatic Tire	000 unit	14,094	164.0	22,300		
-Rubber Tubes	000 unit	3,535	3.9	527		
Sub Total		**36,254**	**469.80**	**63,863**		
(2) Gloves					**22.02**	**34**
-Surgical Gloves	tons	4,379	39.3	5,338		
-Industrial Gloves	tons	22,155	125.0	16,999		
Sub Total		**26,534**	**164.30**	**22,337**		
(3) Other Articles					**15.01**	**23**
-Auto/Machine components	tons	22,537	80.7	9,389		
-Cellular/Non cellular products	tons	4,648	19.7	2,683		
-Gaskets, washers, Seals	tons	1,337	11.6	1,574		
-Floor covering/ Mats	tons	5,839	9.6	1,307		
-Miscellaneous	tons	964	2.0	274		
Sub Total		**35,325**	**123.60**	**15,227**		
Total		**98,113**	**757.70**	**101,427**	**100**	**153**

Source: Sri Lanka Customs

3.3.2. Questionnaire formulation

A questionnaire was designed by considering all the details to get feedback from the rubber industry by performing a survey. Questionnaire includes sixty-six questions under six topics to analyse the barriers according to the PESTLE analysis and it can mention any barriers related to rubber industry which are not in this questionnaire under relevant topic and also can suggest solutions to overcome these barriers. It contained mainly ranking and choices questions and a few questions in the form of short-answers to write down in order to suggest their own opinions. Most of the questions were raised in technological factor. Six factors and questions were raised as follows.

- **Political**

Under this factor, it is to find out several problems which are mostly affecting the rubber industry. Trade policies and international legislation can have impact on the industry and sometime industry may need some amendments for existing legislation and also information regarding whether any new legislation passed during last year. Effectiveness of export restrictions for rubber industry, budget allocation of the government for the development of rubber industry, fluctuation of rubber prices due to political impact and government taxation which are not fair for the rubber industry is the other questions raised in this factor.

- **Economic**

Within this factor, it is to find out several problems which can affect the rubber industry. Observation of economic improvement of rubber industry, impact of globalisation on market share, effect of prevailing interest rate on rubber industry, effectiveness of exchange rate and impact of cost of living on rubber industry, are the questions raised in this factor.

- **Social**

Under this topic, several questions were created to identify the real barriers for rubber industry. Effectiveness of change of consumer opinion on products, impact of social attitude, ethic, and different religions on rubber industry, change of purchasing habits of

customers and impact of lifestyle of people on rubber industry are the questions raised in this factor.

- **Technological**

Most important one is Technological barriers because any industry cannot be developed without technology. To confirm the barriers, around twenty four questions were raised and they were related to technology development, new technology, third party technological support, rate of change of modern technology, research and development activities, application of new technology to eliminate bottleneck, productivity improvement with new technology, impact of technology on quality and pricing, available patent and license, Knowledge Management System (KMS), being competitive in the market, facilities for development of the technology, qualified technologist, educational level of technologists, technologists turnover, established institutions to develop rubber industry, budget allocation for technical training, technical trainings, training evaluation procedure, foreign technical training, techniques to absorb international technology, reference materials, latest technology and value addition of the products in rubber industry.

- **Legal**

This is one of the major topics which affect the rubber industry and to confirm the barriers several questions were raised with regard to effect of employment issue, import and export issues, effect of customer complaints, effect of health, safety, and compliance issues on rubber industry.

- **Environmental**

Environmental is one of the major factors in the questionnaire and some questions were created to confirm the effectiveness on rubber industry. Questions were related to impact of whether condition on productivity, methods of disposal of waste materials, ecological consequences, impact of environmental issues, effect of environmental regulations to narrow down the product range and effect of lack of resources on rubber industry.

3.3.3. Data collection

It was used two methods to collect the data from the industry. Getting information in person (one-to-one) may be the most effective way of gaining trust and cooperation from the respondent. It is easier to react to puzzled facial expressions, answer questions, probe for clarification, or redirect responses. Face to face contact is particularly useful to detect respondent discomfort when discussing sensitive issues or attempts to respond in a socially desirable way. Therefore, 100 printed questionnaires were distributed. Emailing the questionnaire was used as second data collection method due to fast transmission, possible response rate and large number of questions involved in the study which affected the length of the questionnaire. Therefore 53 questionnaires by emailing were distributed to collect the 100 samples.

3.3.4. Data analysis

Under the data analysis, several methods were followed to analyse the gathered data. Based on the questionnaire, the answers were mainly categorised based on YES and NO conditions and tabulated the number of samples which have the answer YES or NO and its percentage values in front of each question under each factor and calculated the importance of each question based on that.

Under the question Q54 asked about minimum education levels of technologist, five answers were given: 1. Diploma, 2. B.Sc. Degree, 3. Master's degree, 4. PhD, 5. Other, According to these five answers; the collected data were categorized and identified the present minimum education levels of technologist in rubber product industry.

Under the question Q64 asked about the average rate of value addition of rubber products according to their industry, three answers were given: (1) 0-500%, (2) 501-1000%, and (3) 1001-2000%. According to these three answers, the collected data was categorized and identified the present average rate of value addition of rubber products in rubber industry.

PESTLE analysis

It was categorized the gathered data according to the Political, Economic, Social, Technological, Legal, Environmental factors (PESTLE) and recorded the average value of each question under the PESTLE factors and total average values under each factor. Then that average value was tabulated and taken the corresponding percentage values under each factor. By using those data, importance of each factor could be identified and presented with Cobweb diagram and pie chart.

Quantitative analysis

According to the data gathered, it was calculated the average values for each question under each factor. Also the important questions were categorized with another two methods: (1) Based on the average value of each factor that means the values greater than the average value have taken as important barriers. (2) Based on the value which is in the middle (neutral point) of the nine-point scale that means the values greater than the neutral point value (5) have taken as important barriers.

When we consider the statistical analysis, there are two important tests. Student's T-test and Analysis of Variance test. Student's T-test is most important when considering the statistical test for significance. The T-test is any statistical hypothesis test in which the test statistic follows a Student's t-distribution under the null hypothesis. It can be used to determine whether two sets of data are significantly different from each other.

ANOVA test for collected data under six factors

Other important test is Analysis of Variance Test. Analysis of Variance (ANOVA) is a collection of statistical models that can be used to analyse the significant differences among and between group means. ANOVA provides a statistical test of whether or not the means of several groups are equal, and therefore generalizes the T-test to more than two groups. ANOVAs are useful for comparing (testing) three or more means (groups or variables) for statistical significance.

When comparing the large number of categories of data, T-test cannot apply for that because it normally uses to compare mean of two samples. Therefore, it was chosen the Analysis of Variance (ANOVA) test for the bulk sample (for each factor) first, and then checked the availability of statistical difference for significance between groups. That means checking the probability value under the null hypothesis (P value) with the

significance level (α=0.05) which is the probability of making the wrong decision when the null hypothesis is true and check the F value and F critical value but normally check only the P value condition. If P<α (0.05) then the null hypothesis can be rejected. If P >α then the null hypothesis cannot be rejected. If the null hypothesis is rejected then there is statistical difference for significance between groups therefore it is important to check two samples at a time by using T-test to identify which samples are significantly differences. By using Microsoft Excel, the P (T<=t) value for two- tail T-test was calculated.

Non-parametric (Post-hoc) test for collected data under six factors

T-test is not sufficient to take the decisions and we need Post-hoc test to minimize the type I error which occurs during the rejection of null hypothesis when null hypothesis is true. Therefore it was used Post–hoc test called Bonferroni correction which is an adjustment made to α value when several dependent or independent statistical tests are being performed simultaneously on a single data set. To perform a Bonferroni correction, dividing α value by the number of comparisons (m) and checking P value of T-test with this Bonferroni α value (P< Bα) were done. By using this method it can be checked whether null hypothesis is true or false. It was done second Post-hoc test to minimize more Type I error and it called as Holm-Bonferroni method. To perform Holm-Bonferroni correction, it is needed calculating Holm-Bonferroni α Value (Holm α Value).

$$\text{Holm } \alpha \text{ Value} = \frac{\text{Target Alpha Level } (\alpha)}{\text{n-Rank number of pair (by degree of significance)} + 1}$$

Where:

- Target alpha level = overall alpha level (usually α=0.05),
- n = number of tests.

After calculating Holm α Value (Hα) it can be checked (P< Hα) with P value of T-test to make sure the availability of statistical difference for significance. If received answer is "TRUE" then there is a significance difference between that two questions, then we can reject the null hypothesis, If answer is" FALSE" there is no significance difference and we can accept the null hypothesis. It was considered the null hypothesis as both questions have equal means.

Correlations analysis

The Correlations of each factor were calculated by using Microsoft Excel and compared the strength level of relationships according to the Correlation Coefficient (r) [15] define below.

Positive	Negative
0< r < 0.19 - relationship very weak	-0.19< r <0 - relationship very weak
0.2< r < 0.39 - weak relationship	-0.39< r <-0.2 - weak relationship
0.4< r <0.59 - medium relationship	-0.59< r <-0.4 - medium relationship
0.6< r < 0.79 - strong relationship	-0.79 <r< -0.6 - strong relationship
0.8< r < 1 - very strong relationship	-1 < r <-0.8 - very strong relationship

After comparing, it can separate the strong and very strong relationships and understand the linear correlation between those groups by using scatted chart with linear trend line.

Qualitative analysis

Generally a lot of suggestions were able to identify relation to the areas which were discussed. As a qualitative analysis it was decided to go for the thematic analysis to obtain solutions from gathered data (Appendix 3). Thematic analysis is a method for systematically identifying, organising, and offering insight into, and patterns of meaning (themes) across a dataset. Through focusing on meaning across a dataset, thematic analysis allows to see and make sense of collective or shared meanings and experiences. This method is a way of identifying what is common to the way a topic is talked or written about, and of making sense of those commonalities.

First step requires to be fully immersed and actively engaged in the data by firstly transcribing the interactions and then reading (and re-reading) the transcripts. Initial ideas should be noted down. It is important to have a comprehensive understanding of the content of the interaction and has familiarized with all aspects of the data. This step provides the foundation for the subsequent analysis.

Once familiar with the data, it is required to start identifying preliminary codes, which are the features of the data that appear interesting and meaningful. These codes are more

numerous and specific than themes but provide an indication of the context of the conversation. The third step in the process is the start of the interpretive analysis of the collated codes. Relevant data extracts are sorted (combined or split) according to overarching themes. The thought process should allude to the relationship between codes, subthemes, and themes.

This step involves ‘refining and defining’ the themes and potential subthemes within the data. On-going analysis is required to further enhance the identified themes and to provide theme names and clear working definitions that capture the essence of each theme in a concise and punchy manner. At this point, a unified story of the data needs to emerge from the themes.

Finally, it is required to transform analysis into an interpretable piece of writing by using vivid and compelling extract examples that relate to the themes, research question, and literature. Solutions must relay the results of the analysis in a way that convinces the reader of the merit and validity of the analysis. It must go beyond a mere description of the themes and portray an analysis supported with empirical evidence that addresses the research question.

3.4. Results

During the survey, it was distributed 153 questionnaires and could be able to collect ninety-three (93) questionnaires as data samples. For the "tyre and tube" industry, 96 questionnaires were distributed and 64 collected and response rate was 67%, and 34 questionnaires were distributed among "gloves/Latex" industry and collected 17 and response rate was 50%, and also 23 questionnaires were distributed among the "other articles" industry and collected 12 and 52% response rate was recorded. Numbers of 12 questionnaires were collected by email and 81 questionnaires by visiting the industry. Response rate was good as it was around 61% as shown in table 3-2.

Table 3-2: Collected data samples and response rate

Rubber Products	*Annual Turnover %*	*No of Questionnaire Distributed*	*No of Questionnaire Collected*	*Response %*
Tires & Tubes	63	96	64	67
Gloves/Latex	22	34	17	50
Other Articles	15	23	12	52
Total	**100**	**153**	**93**	**61**

According to the survey, 93 samples were gathered and separated based on the YES or NO answers. When considering all questions, most of the answers are YES and it is around 87.33% and NO answers around 12.67%. That means most of the people have given the YES answers to the questions and average response rate is 87.33%. Therefore, when summarized the questions which have the percentage value more than 95% and it was shown in the Table 3-3. Under political factor, Q1 asked about the impact level of Trade Policies or International Legislations on Rubber Product Industry and it has received 98.92% YES. Q5 also received same percentage value and it asked about the satisfaction level of government budget allocation for development of rubber industry.

Under the Economic factor, four questions have received the percentage value more than 95%. Q10 was asked about the observation of economic improvements in rubber industry since 2010 and it received 100% YES and Q11 asked about the impact level of globalization on market share in rubber industry and received 98.92% YES. Q12 is asked about the effect of prevailing interest rate on rubber industry and received 97.85% YES

and Q14 is asked about the impact level of cost of living on rubber industry and received 97.85% YES. Under the Social factor, Q22 asked about the impact level of life style of the people on rubber industry and received 95.7% YES.

Most important questions seem to be in Technological factor and fifteen questions received more than 95% YES. Q41 asked regarding competitiveness in Technology development related to rubber industry and received 100% YES and Q45 asked about the satisfaction level with research and development activities compared to the competitors and received 100% YES. Q46 asked about application of new technologies to eliminate bottleneck and received 100% YES and also Q47 asked application of new technologies to improve the productivity and received 100% YES answer. Q51 asked about view of being competitive in the market to develop your products and received 98.92% YES answer and also Q52 asked regarding the facilities for the development of technology in organization and received 100% YES. Q53 asked regarding the qualified technologist in the organization and received 100% YES.

From Q56 to Q63 received 100% YES answer and Q56 asked that satisfaction level of the performance of established institutions to develop rubber industry knowledge, Q57 asked that the company budget allocation for technical training, Q58 asked about the technical training for technologists in the organization, Q59 asked about availability of standard training evaluation procedures, Q60 asked about availability of foreign technical training in the organization, Q61 asked about the availability of proper techniques to absorb international technology, Q62 asked regarding the availability of good resources for reference materials, Q63 asked about availability of mechanism to access the latest technology in the world and all got 100% YES.

Under the legal factor, Q28 asked the health and safety issues related to rubber industry and received 98.92% YES. Under the environmental factor, Q32 asked about the environmental restrictions related to rubber industry and received 98.92% YES, and Q36 asked regarding the environmental issues related to rubber industry and received 95.7% YES.

Table 3-3: Number of YES or NO answers and percentage values

Section	*Question No.*	*Number of "YES"*	*% Value>95%*	*Number of "NO"*	*% Value*
Political	*1*	92	98.92	1	1.08
	5	92	98.92	1	1.08
Economic	*10*	93	100.00	0	0.00
	11	92	98.92	1	1.08
	12	91	97.85	2	2.15
	14	91	97.85	2	2.15
Social	*22*	89	95.70	4	4.30
Technological	*41*	93	100.00	0	0.00
	45	93	100.00	0	0.00
	46	93	100.00	0	0.00
	47	93	100.00	0	0.00
	51	92	98.92	1	1.08
	52	93	100.00	0	0.00
	53	93	100.00	0	0.00
	56	93	100.00	0	0.00
	57	93	100.00	0	0.00
	58	93	100.00	0	0.00
	59	93	100.00	0	0.00
	60	93	100.00	0	0.00
	61	93	100.00	0	0.00
	62	93	100.00	0	0.00
	63	93	100.00	0	0.00
Legal	*28*	92	98.92	1	1.08
Environmental	*32*	92	98.92	1	1.08
	36	89	95.70	4	4.30

Under the technological factor, there are four questions without nine point scale and all 93 samples answered to these questions. Q49 asked about the availability of Patent or Licence relevant to their products and out of the 93 samples 51% gave the YES answer and 49% gave NO answer. Q50 asked about the availability of Knowledge Management Systems (KMS) in the organisation and 62% YES answer and 32% NO answers. Q54 asked that about minimum education levels of technologist in your organization, as a result of the survey out of the 93 samples 53% said that minimum education levels is diploma in their rubber industry and 47% says that the minimum education levels is B.Sc. Degree in their rubber industry while PhD or other qualification level were not mentioned as the minimum education level as shown in Table 3-4. Therefore, it can be decided that minimum education level of the technologist is one of identified problem in the rubber product industry through this survey.

Table 3-4: Minimum education level

	Question No. 54				
	Minimum Education Level				
	Diploma	*B.Sc. Degree*	*Master Degree*	*Ph.D.*	*Other*
No. of Sample	49	44	0	0	0
% Value	53	47	0	0	0

The data regarding average rate of value addition of product is also collected under the Q64 in technological factor according to given three answers in the questionnaire. Out of 93 samples, 64 (69%) said that their average rate of value addition of product is 0 to 500 while 20 samples (21%) saying it is 501 to 1000 although 9 samples (10%) said that their figure is 1000 to 2000 as shown in Table 3-5. Therefore we can decide that average rate of value addition of product is identified as problem in the rubber product industry through this survey.

Table 3-5: Average rate of value addition of product

	Question No 64		
	Average rate of value addition		
	0-500	*501-1000*	*1001-2000*
No of Sample	64	20	9
% Value	69	21	10

3.4.1. Results of PESTLE analysis

According to the survey data, the average values for each questions under each factor was calculated. Under the political factor, there are seven questions. It has taken the average values of each question and total seven questions and calculated average value is 4.81 and percentage value is 15.38% as calculated for all factors. For Economic factor, there are five questions and average value of factor is 6.09 and percentage value is 19.50%. For social factor, there are six questions and average value of factor is 4.81 and percentage value is 15.38%. For technological factor, there are twenty questions and average value of factor is 5.28 and percentage value is 16.88%. For legal factor, there are five questions and average value of factor is 5.42 and percentage value is 17.35%. For environmental factor there are seven questions and average value of factor is 4.85 and percentage value

is 15.52% as shown in the Table 3-6 and percentage values shows in Figure 3-1 as pie chart.

Table 3-6: Calculated average value and percentage value for PESTLE

Factors	*Avg Value*	*% value*
Political	4.81	15.38
Economic	6.09	19.50
Social	4.81	15.38
Technological	5.28	16.88
Legal	5.42	17.35
Environmental	4.85	15.52
Total	**31.26**	**100**

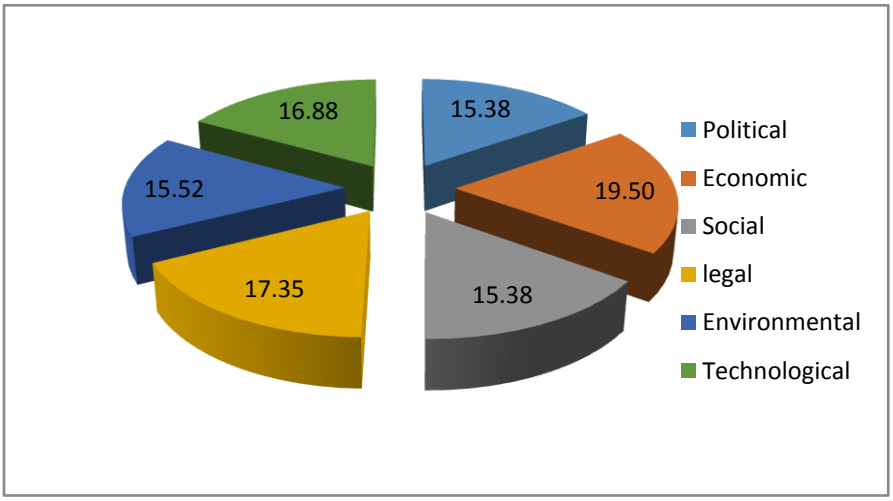


Figure 3-1: Percentage values for PESTLE

For graphical representation by comparing six factors average values, it was drawn a Cobweb diagram (Radar) as shown in Figure 3-2 to show the differences among the average values. The highest value (19.50%) is shown in the economic axis, second highest value is in legal axis (17.35), third highest value in technological axis (16.88), forth is in environmental axis (15.52) and the last two have the same value and those are shown in social (15.38) and political axis (15.38). According to these calculations and graphical representation, the economic, legal and technological factors are mainly affected on the rubber product industry.

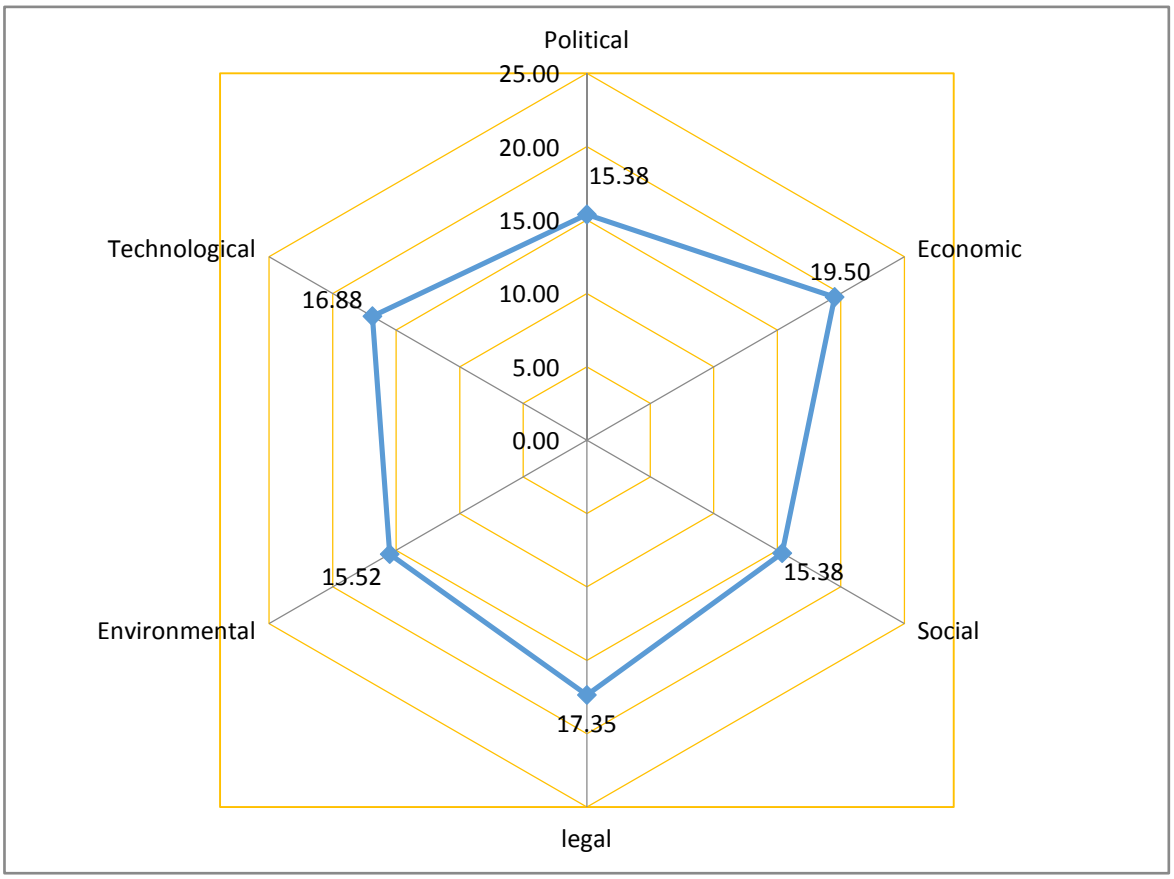


Figure 3-2: Cobweb diagram for PESTLE

3.4.2. Identification of barriers

Under the political factor, most important questions are categorized in Table 3-7. In this table, the second raw shows the average values for seven questions and total average value is 4.81. The third raw shows the values which are greater than the total average value (4.81). According to that raw, there are four major questions; namely Q1, Q4, Q5 and Q6. Q1 asked about the impact level of trade policies or international legislations on rubber product industry. Q4 asked about export restrictions which affect for the rubber Industry. Q5 asked about the satisfaction level of the government budget allocation for development of rubber industry and Q6 asked about political impact on raw rubber prices fluctuation.

Considering the neutral point (5) of the nine point scale, it was calculated the value for forth raw and it has shown that the values which are greater than neutral point (>5) and, according to that condition, there are four major questions in political factor which are Q1, Q4, Q5 and Q6 as same as the above. Therefore we can decide these four questions are most important under political factor.

Table 3-7: Most important questions for Political factor

	Q1	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Avg value*	*Neutral point of the nine point Scale*	*No of barriers*
x	6.47	4.67	3.59	5.16	5.11	5.09	3.56	4.81	5	
x >Avg	6.47	0	0	5.16	5.11	5.09	0			4
x > 5	6.47	0	0	5.16	5.11	5.09	0			4

Under the economic factor, most important questions are categorized in Table 3-8. In this table, the second raw shows the average values for five questions and total average value is 6.09. The third raw shows the values which are greater than the total average value (6.09). According to that raw, there are three major questions. Those are Q11, Q13, and Q14. Q11 asked about the impact level of globalisation on market share in rubber industry. Q13 asked about the effect of the exchange rates and Q14 is asked about the impact level of cost of living on rubber industry.

Considering the neutral point (5) of the nine-point scale, it was calculated the value for forth raw and it has shown that the values which are greater than neutral point (>5) and, according to that condition, there are four major questions namely Q11, Q12, Q13, and Q14 and those are same as the above and one additional question is there. That is Q12 and it asked about the effect of prevailing interest rate on rubber industry. By comparing above two results we can decide Q11, Q13, and Q14 are most important questions under economic factor.

Table 3-8: Most important questions for Economic factor

	Q10	*Q11*	*Q12*	*Q13*	*Q14*	*Avg value*	*Neutral point of the nine point Scale*	*No of barriers*
x	4.32	7.06	5.97	6.57	6.55	6.09	5	
x > Avg	0	7.06	0	6.57	6.55			3
x > 5	0	7.06	5.97	6.57	6.55			4

Under the social factor, most important questions were categorized in Table 3-9. In this table, second raw shows the average values for seven questions and total average value is 4.81. The third raw shows the values which are greater than the total average value (4.81). According to that raw, there are three major questions, namely Q17, Q19, and Q22. Q17 asked about effect of change of consumers opinions related to product. Q19 asked about impact level of social attitudes on rubber industry as the educational levels improve and Q22 asked about impact level of life style of the people on rubber Industry.

Considering the neutral point (5) of the nine-point scale, it was calculated the value for forth raw and it has also shown that the values which are greater than neutral point (>5) and according to that condition, there are three major questions namely Q17, Q19, and Q22 and those are same as the above. Therefore, by comparing above two results, we can decide these three questions are most important under social factor.

Table 3-9: Most important questions for Social factor

	Q17	*Q18*	*Q19*	*Q20*	*Q21*	*Q22*	*Avg value*	*Neutral point of the nine point scale*	*No of barriers*
x	5.18	4.40	6.48	2.84	4.06	5.88	4.81	5	
x > Avg	5.18	0	6.48	0	0	5.88			3
x > 5	5.18	0	6.48	0	0	5.88			3

Under the technological factor, most important questions were categorized in Table 3-10. In this table, the second raw has shown the average values for seven questions and total average value is 5.28. The third raw has shown the values which are greater than the total average value (5.28). According to that raw, there are thirteen major questions. They are Q42, Q45, Q46, Q48, Q51, Q52, Q56, Q58, Q59, Q60, Q61, Q62 and Q63. Q42 is asking about effect of new technology on rubber product industry. Q45 asked about the satisfaction level with research and development activities compared to the competitors. Q46 asked about application of new technologies to eliminate bottleneck. Q48 asked about the impact level of new technology related to the quality and pricing of products. Q51 asked about view of being competitive in the market develops your products and also Q52 asked regarding the facilities for the development of technology in the organization.

Q56 asked about satisfaction level of the performance of established institutions to develop rubber industry knowledge. Q58 asked about the technical training for technologists in the organization. Q59 asked about availability of standard training evaluation procedure. Q60 asked about availability of foreign technical training in the organization. Q61 asked about the availability of proper techniques to absorb international technology. Q62 asked regarding the availability of good resources for reference materials and Q63 asked about availability of mechanism to access the latest technology in the world.

Considering the neutral point (5) of the nine point scale it was calculated the values for forth raw and it has shown that the values which are greater than neutral point (>5) and, according to that condition, there are fourteen major questions, namely Q42, Q45, Q46, Q48, Q51, Q52, Q56, Q58, Q59, Q60, Q61, Q62 and Q63. In addition to the above thirteen questions, Q57 identified in this method and Q57 asked about the company budget allocation for technical training. Therefore by comparing above two results it can be decided these thirteen questions are most important under technological factor and there were more major questions under this factor when comparing with the other factors.

Table 3-10: Most important questions for Technology factor

	41	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*51*	*52*	*53*	*55*	*56*	*57*	*58*	*59*	*60*	*61*	*62*	*63*	*Avg value*	*Neutral point of the nine point Scale*	*No of barriers*
x	3.63	6.63	4.13	5	5.51	5.35	4.56	6.05	6.55	5.49	4.04	2.91	5.96	5.23	5.51	6.10	5.65	5.83	5.60	5.81	5.28	5	
x > Avg	0	6.63	0	0	5.51	5.35	0	6.05	6.55	5.49	0	0	5.96	0	5.51	6.10	5.65	5.83	5.60	5.81			13
x > 5	0	6.63	0	0	5.51	5.35	0	6.05	6.55	5.49	0	0	5.96	5.23	5.51	6.10	5.65	5.83	5.60	5.81			14

Under the legal factor, most important questions are categorized in Table 3-11. In this table, second raw shows the average values for seven questions and total average value is 5.42. The third raw has shown the values which are greater than the total average value (5.42). According to that raw, there are three major questions, namely Q25, Q26, and Q28. Q25 asked about effect of employment issues on rubber industry. Q26 asked about imports and export issues and Q28 asked about health and safety issues related to rubber industry.

Considering the neutral point (5) of the nine-point scale, it was calculated the value for forth raw and it has shown that the values which are greater than neutral point (>5) and, according to that condition, there are three major questions, namely Q25, Q26, and Q28 and those are same as the above. Therefore, by comparing above two results we can decide these three questions are most important under Legal factor.

Table 3-11: Most important questions for Legal factor

	Q25	*Q26*	*Q27*	*Q28*	*Q29*	*Mean value*	*Neutral point of the nine point scale*	*No of barriers*
x	5.96	5.49	5	6.01	4.85	5.42	5	
x > Avg	5.96	5.49	0	6.01	0			3
x > 5	5.96	5.49	0	6.01	0			3

Under the environment factor, most important questions were categorized in Table 3-12. Total average value is 4.85. The third raw shows the values which are greater than the total average value (4.85). According to that raw, there are four major questions. Those are Q32, Q33, Q34 and Q36. Q32 asked about environmental restrictions related to rubber industry. Q33 asked about weather condition reduce the productivity of rubber industry. Q34 asked about application of standard methods for disposal of waste material in rubber industry and Q36 asked about environmental issues related to rubber industry.

Considering the neutral point (5) of the nine-point scale it was calculated the value for forth raw and it has shown that the values which are greater than neutral point (>5) and according to that condition also there are three major questions namely Q32, Q33, Q34 and Q36. Those are same as the above four questions, therefore by comparing above two

results, we can decide these four questions are most important under Environmental factor.

Table 3-12: Most important questions for Environmental factor

	Q32	Q33	Q34	Q35	Q36	Q37	Q38	*Avg value*	*Neutral point of the nine point scale*	*No of barriers*
x	6.51	5.69	6.55	4.85	5.88	2.48	2	4.85	5	
x > Avg	6.51	5.69	6.55	0	5.88	0	0			4
x > 5	6.51	5.69	6.55	0	5.88	0	0			4

Political factor

The single factor ANOVA in Microsoft Excel was used for seven questions under the Political factor and received result as shown in Table 3-13. It has shown the sum of the value, average value, and variance for each question under the summary. It has shown source of variation, Sum of Squares (SS), degree of freedom, Mean Square (MS), F-value, P-Value and F-critical value under the ANOVA table. Result shows that average values have no big difference and considered as equal. P-value ($1.73x10^{-15}$) is very small and <0.05. It says that there are significant differences within the group and also F>F-critical therefore, doing T-test and Post-hoc tests are required to identify the significance of each question.

Table 3-13: ANOVA: Single factor results for Political factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Q1	93	602	6.47	2.12
Q2	93	434	4.67	6.88
Q3	93	334	3.59	8.90
Q4	93	480	5.16	7.62
Q5	93	475	5.11	3.38
Q6	93	473	5.09	7.36
Q7	93	331	3.56	9.77

ANOVA

Source of variation	*SS*	*df*	*MS*	*F*	*P-value*	*F- critical*
Between Groups	569	6	94.92	14.44	$1.73x10^{-15}$	2.11
Within Groups	4234	644	6.57			
Total	**4803**	**650**				

Table 3-14 shows that the results, (P value) of T-test under the column "*P (T<=t) two-tail"* and 21 tests were carried out to get the P-value to compare the seven questions with each other. Under the column "*Bonferroni α value"*, calculated the value by dividing the 0.05 by 7 and it was around 0.00714 then checked whether P-value < Bα value under the *"True/ False"* column. Then under the "Rank" column, ranked the P-value as mentioned in the analysis part and 21 ranks have done under the "*Holm α value"* column. The Holm α value was calculated according to its formula and checked whether significant difference is there or not under the *"True/ False (P< Hα)"*column.

Q1 asked about the impact level of Trade Policies or International Legislations on rubber product industry. Q2 asked about the requirement of any amendments or changes to the existing regulations related to rubber industry. Q3 asked about the pass new legislations during last year relevant to rubber product industry. Q4 asked about export restrictions which affect the rubber industry. Q5 asked about the satisfaction level of the government budget allocation for development of rubber industry. Q6 asked about Political impact on raw rubber prices fluctuation and Q7 asked about the government taxation which is not fair for rubber industry. By comparing these seven questions of Q1 with other six questions, we can decide it has significant difference with other six and it is the highest value. By comparing Q2 with other five questions, we can decide it has no significant difference with other five questions. Likewise, we can decide Q3 has significant difference with Q4, Q5, Q6 and it is low value but no significant difference with Q7. Q4 has significant difference with Q7 but no significant difference with Q5, and Q6. Q5 has no significant difference with Q6 but Q5 has significant difference with Q7. Q6 has significant difference with Q7. Therefore, by considering all these decisions, Q1 is the major question. Second major questions are Q4, Q5, and Q6, third one is Q2 and lasts are Q3 and Q7.

Table 3-14: T-test used with Bonferroni and Holm method for Political questions

Question No.	*Compared question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q1	**Q2**	**$2.73X10^{-8}$**	**$7.14x10^{-3}$**	**TRUE**	**3**	**$2.63X10^{-3}$**	**TRUE**
	Q3	**$1.40x10^{-14}$**	**$7.14x10^{-3}$**	**TRUE**	**1**	**$2.38x10^{-3}$**	**TRUE**
	Q4	**$7.42x10^{-5}$**	**$7.14x10^{-3}$**	**TRUE**	**8**	**$3.57x10^{-3}$**	**TRUE**
	Q5	**$7.16x10^{-8}$**	**$7.14x10^{-3}$**	**TRUE**	**4**	**$2.78x10^{-3}$**	**TRUE**
	Q6	**$2.31x10^{-5}$**	**$7.14x10^{-3}$**	**TRUE**	**5**	**$2.94x10^{-3}$**	**TRUE**
	Q7	**$5.49x10^{-14}$**	**$7.14x10^{-3}$**	**TRUE**	**2**	**$2.50x10^{-3}$**	**TRUE**
Q2	Q3	$9.77x10^{-3}$	$7.14x10^{-3}$	FALSE	14	$6.25x10^{-3}$	FALSE
	Q4	$2.12x10^{-1}$	$7.14x10^{-3}$	FALSE	16	$8.33x10^{-3}$	FALSE
	Q5	$1.86x10^{-1}$	$7.14x10^{-3}$	FALSE	15	$7.14x10^{-3}$	FALSE
	Q6	$2.85x10^{-1}$	$7.14x10^{-3}$	FALSE	17	$1.00x10^{-2}$	FALSE
	Q7	$9.59x10^{-3}$	$7.14x10^{-3}$	FALSE	13	$5.56x10^{-3}$	FALSE
Q3	**Q4**	**$2.59x10^{-4}$**	**$7.14x10^{-3}$**	**TRUE**	**9**	**$3.85x10^{-3}$**	**TRUE**
	Q5	**$4.63x10^{-5}$**	**$7.14x10^{-3}$**	**TRUE**	**6**	**$3.13x10^{-3}$**	**TRUE**
	Q6	**$4.48x10^{-4}$**	**$7.14x10^{-3}$**	**TRUE**	**11**	**$4.55x10^{-3}$**	**TRUE**
	Q7	$9.43x10^{-1}$	$7.14x10^{-3}$	FALSE	20	$2.50x10^{-2}$	FALSE
Q4	Q5	$8.76x10^{-1}$	$7.14x10^{-3}$	FALSE	19	$1.67x10^{-2}$	FALSE
	Q6	$8.81x10^{-1}$	$7.14x10^{-3}$	FALSE	18	$1.25x10^{-2}$	FALSE
	Q7	**$2.79x10^{-4}$**	**$7.14x10^{-3}$**	**TRUE**	**10**	**$4.17x10^{-3}$**	**TRUE**
Q5	Q6	$9.50x10^{-1}$	$7.14x10^{-3}$	FALSE	21	$5.00x10^{-2}$	FALSE
	Q7	**$5.77x10^{-5}$**	**$7.14x10^{-3}$**	**TRUE**	**7**	**$3.33x10^{-3}$**	**TRUE**
Q6	**Q7**	**$4.76x10^{-4}$**	**$7.14x10^{-3}$**	**TRUE**	**12**	**$5.00x10^{-3}$**	**TRUE**

Economic factor

The single factor ANOVA in Microsoft Excel was used for five questions under the Economic factor and received result as shown in Table 3-15. It shows the sum of the value, average value, and variance for each question under the summary and it also shows source of variation, Sum of Squares (SS), degree of freedom, Mean Square (MS), F-value, P-Value and F-critical value under the ANOVA in the table. Result shows that Average values have no big difference and considered as equal. P-value ($3x10^{-19}$) is very small and <0.05. It says that there are significant differences within the group and also F>F-critical, therefore doing T-test and Post-hoc tests are required to identify the significance of each question.

Table 3-15: ANOVA: Single factor results for Economic factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Q10	93	402	4.32	3.87
Q11	93	657	7.06	3.73
Q12	93	555	5.97	3.94
Q13	93	611	6.57	6.10
Q14	93	609	6.55	2.82

ANOVA

Source of variation	*SS*	*df*	*MS*	*F*	*P-value*	*F-critical*
Between groups	421	4	105.29	25.73	$3x10^{-19}$	2.39
Within groups	1882	460	4.09			
Total	**2303**	**464**				

Table 3-16 also shows that the results of *P(T<=t)* value by doing 10 T-tests to compare the five questions with each other, Bonferroni α value had taken by dividing the 0.05 by 5 and it was 0.01 and then checked whether P value < Bonferroni α value under the *"True/ False"* column. The P value ranked from 1 to 10, after that calculated Hα and checked whether significant difference is there or not by referring to *"True/ False (P< Hα)"* column.

Q10 is asked about the observation of economic improvements in rubber industry since 2010. Q11 asked about the impact level of globalisation on market share in rubber industry. Q12 asked about the effect of prevailing Interest rate on rubber industry. Q13 asked about the effect of the Exchange rates and Q14 about the impact level of cost of living on Rubber Industry. By comparing Q10 with other four questions, we can decide that it has significant difference with other four questions and it was the lowest value. By comparing Q11 with other three questions, it can be decided Q11 has significant difference with Q12 and, Q12 is lower than Q11 value but Q11 has no significant difference with Q13, and Q14. Likewise we can decide Q12 has no significant difference with other two and Q13 has no significant difference with Q14. Therefore, by considering all these decisions, Q11 is the major question. Second major questions are Q13, Q14, third one is Q12 and last one is Q10.

Table 3-16: T-test used with Bonferroni and Holm method for Economic questions

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value(Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q10	**Q11**	**$6.56X10^{-18}$**	**$1x10^{-2}$**	**TRUE**	**1**	**$5.00x10^{-3}$**	**TRUE**
	Q12	**$5.33x10^{-8}$**	**$1x10^{-2}$**	**TRUE**	**4**	**$7.14x10^{-3}$**	**TRUE**
	Q13	**$9.92x10^{-11}$**	**$1x10^{-2}$**	**TRUE**	**3**	**$6.25x10^{-3}$**	**TRUE**
	Q14	**$2.19x10^{-14}$**	**$1x10^{-2}$**	**TRUE**	**2**	**$5.56x10^{-3}$**	**TRUE**
Q11	**Q12**	**$1.85x10^{-4}$**	**$1x10^{-2}$**	**TRUE**	**5**	**$8.33x10^{-3}$**	**TRUE**
	Q13	$1.30x10^{-1}$	$1x10^{-2}$	FALSE	9	$2.50x10^{-2}$	FALSE
	Q14	$5.33x10^{-2}$	$1x10^{-2}$	FALSE	7	$1.25x10^{-2}$	FALSE
Q12	Q13	$6.85x10^{-2}$	$1x10^{-2}$	FALSE	8	$1.67x10^{-2}$	FALSE
	Q14	$3.26x10^{-2}$	$1x10^{-2}$	FALSE	6	$1.00x10^{-2}$	FALSE
Q13	Q14	$9.45x10^{-1}$	$1x10^{-2}$	FALSE	10	$5.00x10^{-2}$	FALSE

Social factor

The single factor ANOVA in Microsoft Excel is also used for five questions under the Social factor and received result as shown in Table 3-17. Result shows that average values have no big difference and considered as equal. P-value ($8.18x10^{-18}$) is very small and <0.05. It says that there are significant differences within the group and also F>F-critical therefore doing T-test and Post-hoc tests are required to identify the significance of each question.

Table 3-17: ANOVA: Single factor results for Social factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
17	93	482	5.18	10.11
18	93	409	4.40	9.00
19	93	603	6.48	4.82
20	93	264	2.84	9.83
21	93	378	4.06	10.78
22	93	547	5.88	5.52

ANOVA

Source of variation	*SS*	*df*	*MS*	*F-value*	*P-value*	*F- critical*
Between groups	809	5	161.84	19.40	8.18×10^{-18}	2.23
Within groups	4605	552	8.34			
Total	**5414**	**557**				

Table 3-18 also shows that the results of *P(T<=t)* value by doing 15 T-tests to compare the six questions with each other, Bonferroni α value had taken by dividing the 0.05 by 6 and it was around 0.0083 and then checked whether P-value <Bα value under the *"True/ False"* column. The P value ranked from 1 to 15 and it was calculated Hα value and checked whether significant difference is there or not by referring *"True/ False (P< Hα)"* column.

Q17 asked about effect of change of consumers opinions related to product. Q18 asked regarding impact of demographic on rubber industry. Q19 asked impact level of social attitudes on rubber industry as the educational levels improve. Q20 asked about the impact level of ethics and different religions on rubber Industry. Q21 asked about effectiveness of changes of purchasing habits of customers related to products in the organisation. Q22 asked about impact level of life style of the people on rubber industry. By comparing Q17 with other five questions, we can decide Q17 has no significant difference with Q18, Q21, and Q22 but Q17 has significant difference with Q19 and Q20. Q19 is the highest value and Q20 is the lowest value and, by comparing Q18 with other four questions, we can decide Q18 has no significant difference with Q21 but Q18 has significant difference with Q19, Q20, and Q22. Likewise, we can decide Q19 has no

significant difference with Q22 but Q19 has significant difference with Q20, and Q21. Q20 has no significant difference with Q21 but Q20 has significant difference with Q22. Q21 has significant difference with Q22. Therefore, by considering all these decisions, Q19 and Q22 are major questions. Second major question is Q17, third major questions are Q18, Q21 and last major one is Q20.

Table 3-18: T-test used with Bonferroni and Holm method for Social questions

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q17	Q18	$8.50x10^{-2}$	$8.33x10^{-3}$	FALSE	13	$1.67x10^{-2}$	FALSE
	Q19	**$1.38x10^{-3}$**	**$8.33x10^{-3}$**	**TRUE**	**9**	**$7.14x10^{-3}$**	**TRUE**
	Q20	**$1.00x10^{-6}$**	**$8.33x10^{-3}$**	**TRUE**	**5**	**$4.55x10^{-3}$**	**TRUE**
	Q21	$1.93x10^{-2}$	$8.33x10^{-3}$	FALSE	11	$1.00x10^{-2}$	FALSE
	Q22	$8.99x10^{-2}$	$8.33x10^{-3}$	FALSE	14	$2.50x10^{-2}$	FALSE
Q18	**Q19**	**$1.93x10^{-7}$**	**$8.33x10^{-3}$**	**TRUE**	**4**	**$4.17x10^{-3}$**	**TRUE**
	Q20	**$6.61x10^{-4}$**	**$8.33x10^{-3}$**	**TRUE**	**8**	**$6.25x10^{-3}$**	**TRUE**
	Q21	$4.71x10^{-1}$	$8.33x10^{-3}$	FALSE	15	$5.00x10^{-2}$	FALSE
	Q22	**$2.32x10^{-4}$**	**$8.33x10^{-3}$**	**TRUE**	**7**	**$5.56x10^{-3}$**	**TRUE**
Q19	**Q20**	**$8.67x10^{-17}$**	**$8.33x10^{-3}$**	**TRUE**	**1**	**$3.33x10^{-3}$**	**TRUE**
	Q21	**$1.64x10^{-8}$**	**$8.33x10^{-3}$**	**TRUE**	**3**	**$3.85x10^{-3}$**	**TRUE**
	Q22	$7.25x10^{-2}$	$8.33x10^{-3}$	FALSE	12	$1.25x10^{-2}$	FALSE
Q20	Q21	$9.97x10^{-3}$	$8.33x10^{-3}$	FALSE	10	$8.33x10^{-3}$	FALSE
	Q22	**$2.78x10^{-12}$**	**$8.33x10^{-3}$**	**TRUE**	**2**	**$3.57x10^{-3}$**	**TRUE**
Q21	**Q22**	**$2.34x10^{-5}$**	**$8.33x10^{-3}$**	**TRUE**	**6**	**$5.00x10^{-3}$**	**TRUE**

Technological factor

The single factor ANOVA in Microsoft Excel is also used here for five questions under the Legal factor and received result as shown in Table 3-19. Result shows that average values have no big difference and considered as equal. P value ($4.98x10^{-46}$) is very small and <0.05. It says that there are significant differences within the group and also F (15.15) >F-critical (1.59) therefore, doing T-test and post-hoc tests are required to identify the significance of each question.

Table 3-19: ANOVA: Single factor results for Technological factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Q41	93	338	3.63	3.89
Q42	93	617	6.63	5.36
Q43	93	384	4.13	6.31
Q44	93	465	5.00	8.91
Q45	93	512	5.51	9.84
Q46	93	498	5.35	5.71
Q47	93	424	4.56	4.79
Q48	93	563	6.05	7.01
Q51	93	609	6.55	2.29
Q52	93	511	5.49	6.62
Q53	93	376	4.04	5.48
Q55	93	271	2.91	8.82
Q56	93	554	5.96	6.09
Q57	93	486	5.23	2.92
Q58	93	512	5.51	4.25
Q59	93	567	6.10	4.61
Q60	93	525	5.65	4.54
Q61	93	542	5.83	5.34
Q62	93	521	5.60	6.85
Q63	93	540	5.81	6.01

ANOVA

Source of variation	*SS*	*df*	*MS*	*F*	*P-value*	*F critical*
Between Groups	1664	19	87.60	15.15	4.98×10^{-46}	1.59
Within Groups	10638	1840	5.78			
Total	**12302**	**1859**				

Table 3-20 also shows that the results of *P(T<=t)* value by doing 190 T-test to compare the twenty questions with each other, Bonferroni α value had taken by dividing the 0.05 by 20 and it was 0.0025and then checked whether P-value <Bα value under the *"True/ False"* column. The P value ranked from 1 to 190 and calculated Hα value and checked whether significant difference is there or not by referring to second *"True/ False (P< Hα)"*column.

Q41 asked regarding competitiveness in Technology development related to rubber industry. Q42 asked about effect of new technology on rubber product industry. Q43 asked whether organisation depends on third parties for technological support/solutions. Q44 asked about the effectiveness of rate of change of modern technology on rubber industry. Q45 asked about the satisfaction level with research and development activities compared to the competitors. Q46 asked about application of new technologies to eliminate bottleneck. Q47 asked application of new technologies to improve the productivity. Q48 asked about the impact level of new technology related to the quality and pricing of products. Q51 asked about view of being competitive in the market that develops your products. Q52 asked regarding the facilities for the development of technology in organisation. Q53 asked about availability of qualified technologist in the organisation. Q55 asked about turnover rate of technologist in the organisation. Q56 asked that satisfaction level of the performance of established institutions to develop rubber industry knowledge. Q57 asked that the company budget allocation for technical training, Q58 asked about the technical training for technologists in the organisation. Q59 asked about availability of standard training evaluation procedures. Q60 asked about availability of foreign technical training in the organisation. Q61 asked about the availability of proper techniques to absorb international technology. Q62 asked regarding the availability of good resources for reference materials. Q63 asked about availability of mechanism to access the latest technology in the world. By comparing Q41 with other nineteen questions, we can decide Q41 has no significant difference with Q43, Q47, Q53, and Q55 but has significant difference with other fifteen questions according to the results of the Table 3-20. By comparing Q33 with other eighteen questions, we can decide Q42 has significant difference with Q43, Q44, Q46, Q47, Q53, Q55 and Q57 but has no significant difference with other eleven questions. Likewise, we can decide other seventeen questions as follow:

Q43 has no significant difference with Q44, Q45, Q46, Q47, Q53, Q55, and Q57 but it has significant difference with other ten questions. Q44 has significant difference with Q51 and Q55 but has no significant difference with other fourteen questions. Q45 has significant difference with Q53 and Q55 but has no significant difference with other thirteen questions. Q46 has significant difference with Q51, Q53 and Q55 but has no significant difference with other eleven questions. Q47 has significant difference with Q48, Q51, Q55, Q56, Q59, Q61 and Q63 but has no significant difference with other six

questions. Q48 has significant difference with Q53 and Q55 but has no significant difference with other ten questions. Q51 has significant difference with Q53, Q55, Q57 and Q58 but has no significant difference with other seven questions. Q52 has significant difference with Q53 and Q55 but it has no significant difference with other eight questions.

Q53 has no significant difference with Q55 but has significant difference with other eight questions. Q55 has significant difference with other Q56, Q57, Q58, Q59, Q60, Q61, Q62, and Q63 and it is the lowest value. Q56 has no significant difference with all compared questions from Q57 to Q63. Q57 has no significant difference with all compared questions from Q58 to Q63. Q58 has no significant difference with all compared questions from Q59 to Q63. Q59 has no significant difference with compared other four questions. Q60 has no significant difference with compared other three questions. Q61 has no significant difference with other two and Q62 has no significant difference with Q63. Therefore, by considering all these decisions, Q42, Q45, Q48, Q51, Q52, Q56, Q58, Q59, Q60, Q61, Q62, and Q63 are the major questions. Second major questions are Q44, Q46, and Q57and third major one is Q47, and lasts are Q41, Q43, Q53, and Q55.

Table 3-20: T-test used with Bonferroni and Holm method for Technological questions

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q41	**Q42**	**$1.06x10^{-17}$**	**$2.50x10^{-3}$**	**TRUE**	**3**	**$2.66x10^{-4}$**	**TRUE**
	Q43	$1.37x10^{-1}$	$2.50x10^{-3}$	FALSE	125	$7.58x10^{-4}$	FALSE
	Q44	**$3.05x10^{-4}$**	**$2.50x10^{-3}$**	**TRUE**	**68**	**$4.07x10^{-4}$**	**TRUE**
	Q45	**$2.40x10^{-6}$**	**$2.50x10^{-3}$**	**TRUE**	**45**	**$3.42x10^{-4}$**	**TRUE**
	Q46	**$2.52x10^{-7}$**	**$2.50x10^{-3}$**	**TRUE**	**39**	**$3.29x10^{-4}$**	**TRUE**
	Q47	$2.82x10^{-3}$	$2.50x10^{-3}$	FALSE	82	$4.59x10^{-4}$	FALSE
	Q48	**$3.14x10^{-11}$**	**$2.50x10^{-3}$**	**TRUE**	**18**	**$2.89x10^{-4}$**	**TRUE**
	Q51	**$7.76x10^{-23}$**	**$2.50x10^{-3}$**	**TRUE**	**1**	**2.63x-10^{-4}**	**TRUE**
	Q52	**$1.07x10^{-7}$**	**$2.50x10^{-3}$**	**TRUE**	**36**	**$3.23x10^{-4}$**	**TRUE**
	Q53	$1.99x10^{-1}$	$2.50x10^{-3}$	FALSE	135	$8.93x10^{-4}$	FALSE
	Q55	$5.28x10^{-2}$	$2.50x10^{-3}$	FALSE	110	$6.17x10^{-4}$	FALSE
	Q56	**$2.74x10^{-11}$**	**$2.50x10^{-3}$**	**TRUE**	**16**	**$2.86x10^{-4}$**	**TRUE**
	Q57	**$1.86x10^{-8}$**	**$2.50x10^{-3}$**	**TRUE**	**30**	**$3.11x10^{-4}$**	**TRUE**
	Q58	**$1.88x10^{-9}$**	**$2.50x10^{-3}$**	**TRUE**	**26**	**$3.03x10^{-4}$**	**TRUE**
	Q59	**$5.57x10^{-14}$**	**$2.50x10^{-3}$**	**TRUE**	**6**	**$2.70x10^{-4}$**	**TRUE**
	Q60	**$2.72x10^{-10}$**	**$2.50x10^{-3}$**	**TRUE**	**21**	**$2.94x10^{-4}$**	**TRUE**
	Q61	**$5.66x10^{-11}$**	**$2.50x10^{-3}$**	**TRUE**	**19**	**$2.91x10^{-4}$**	**TRUE**
	Q62	**$2.97x10^{-8}$**	**$2.50x10^{-3}$**	**TRUE**	**31**	**$3.13x10^{-4}$**	**TRUE**
	Q63	**$3.07x10^{-10}$**	**$2.50x10^{-3}$**	**TRUE**	**22**	**$2.96x10^{-4}$**	**TRUE**
Q42	**Q43**	**$3.09x10^{-11}$**	**$2.50x10^{-3}$**	**TRUE**	**17**	**$2.87x10^{-4}$**	**TRUE**
	Q44	**$4.66x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**57**	**$3.73x10^{-4}$**	**TRUE**
	Q45	$5.79x10^{-3}$	$2.50x10^{-3}$	FALSE	90	$4.95x40^{-4}$	FALSE
	Q46	**$2.76x10^{-4}$**	**$2.50x10^{-3}$**	**TRUE**	**67**	**$4.03x10^{-4}$**	**TRUE**
	Q47	**$2.38x10^{-9}$**	**$2.50x10^{-3}$**	**TRUE**	**27**	**$3.05x10^{-4}$**	**TRUE**
	Q48	$1.13x10^{-1}$	$2.50x10^{-3}$	FALSE	120	$7.04x10^{-4}$	FALSE
	Q51	$7.65x10^{-1}$	$2.50x10^{-3}$	FALSE	179	$4.17x10^{-3}$	FALSE
	Q52	$1.76x10^{-3}$	$2.50x10^{-3}$	TRUE	78	$4.42x10^{-4}$	FALSE
	Q53	**$1.55x10^{-12}$**	**$2.50x10^{-3}$**	**TRUE**	**10**	**$2.76x10^{-4}$**	**TRUE**
	Q55	**$1.55x10^{-12}$**	**$2.50x10^{-3}$**	**TRUE**	**11**	**$2.78x10^{-4}$**	**TRUE**
	Q56	$5.51x10^{-2}$	$2.50x10^{-3}$	FALSE	111	$6.25x10^{-4}$	FALSE

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q42	**Q57**	**$4.65x10^{-6}$**	**$2.50x10^{-3}$**	**TRUE**	**49**	**$3.52x10^{-4}$**	**TRUE**
	Q58	$5.62x10^{-4}$	$2.50x10^{-3}$	TRUE	71	$4.17x10^{-4}$	FALSE
	Q59	$1.02x10^{-1}$	$2.50x10^{-3}$	FALSE	119	$6.94x10^{-4}$	FALSE
	Q60	$2.78x10^{-3}$	$2.50x10^{-3}$	FALSE	81	$4.55x10^{-4}$	FALSE
	Q61	$1.85x10^{-2}$	$2.50x10^{-3}$	FALSE	99	$5.43x10^{-4}$	FALSE
	Q62	$4.90x10^{-3}$	$2.50x10^{-3}$	FALSE	89	$4.90x10^{-4}$	FALSE
	Q63	$1.89x10^{-2}$	$2.50x10^{-3}$	FALSE	100	$5.49x10^{-4}$	FALSE
Q43	Q44	$3.26x10^{-2}$	$2.50x10^{-3}$	FALSE	105	$5.81x10^{-4}$	FALSE
	Q45	$1.15x10^{-3}$	$2.50x10^{-3}$	TRUE	77	$4.39x10^{-4}$	FALSE
	Q46	$7.99x10^{-4}$	$2.50x10^{-3}$	TRUE	74	$4.27x10^{-4}$	FALSE
	Q47	$2.15x10^{-1}$	$2.50x10^{-3}$	FALSE	138	$9.43x10^{-4}$	FALSE
	Q48	**$8.95x10^{-7}$**	**$2.50x10^{-3}$**	**TRUE**	**41**	**$3.33x10^{-4}$**	**TRUE**
	Q51	**$1.77x10^{-13}$**	**$2.50x10^{-3}$**	**TRUE**	**7**	**2.72x-10^{-4}**	**TRUE**
	Q52	**$3.27x10^{-4}$**	**$2.50x10^{-3}$**	**TRUE**	**69**	**$4.10x10^{-4}$**	**TRUE**
	Q53	$8.09x10^{-1}$	$2.50x10^{-3}$	FALSE	183	$6.25x10^{-3}$	FALSE
	Q55	$2.95x10^{-3}$	$2.50x10^{-3}$	FALSE	84	$4.67x10^{-4}$	FALSE
	Q56	**$1.29x10^{-6}$**	**$2.50x10^{-3}$**	**TRUE**	**43**	**$3.38x10^{-4}$**	**TRUE**
	Q57	$6.21x10^{-4}$	$2.50x10^{-3}$	TRUE	72	$4.20x10^{-4}$	FALSE
	Q58	**$6.59x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**59**	**$3.79x10^{-4}$**	**TRUE**
	Q59	**$3.79x10^{-8}$**	**$2.50x10^{-3}$**	**TRUE**	**34**	**$3.18x10^{-4}$**	**TRUE**
	Q60	**$1.55x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**53**	**$3.62x10^{-4}$**	**TRUE**
	Q61	**$3.27x10^{-6}$**	**$2.50x10^{-3}$**	**TRUE**	**47**	**$3.47x10^{-4}$**	**TRUE**
	Q62	**$1.27x10^{-4}$**	**$2.50x10^{-3}$**	**TRUE**	**64**	**$3.94x10^{-4}$**	**TRUE**
	Q63	**$7.53x10^{-6}$**	**$2.50x10^{-3}$**	**TRUE**	**50**	**$3.55x10^{-4}$**	**TRUE**
Q44	Q45	$2.62x10^{-1}$	$2.50x10^{-3}$	FALSE	144	$1.06x10^{-3}$	FALSE
	Q46	$3.72x10^{-1}$	$2.50x10^{-3}$	FALSE	152	$1.28x10^{-3}$	FALSE
	Q47	$2.52x10^{-1}$	$2.50x10^{-3}$	FALSE	143	$1.04x10^{-3}$	FALSE
	Q48	$1.17x10^{-2}$	$2.50x10^{-3}$	FALSE	92	$5.05x10^{-4}$	FALSE
	Q51	**$1.42x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**52**	**$3.60x10^{-4}$**	**TRUE**
	Q52	$2.28x10^{-1}$	$2.50x10^{-3}$	FALSE	139	$9.62x10^{-4}$	FALSE
	Q53	$1.59x10^{-2}$	$2.50x10^{-3}$	FALSE	96	$5.26x10^{-4}$	FALSE
	Q55	**$3.62x10^{-6}$**	**$2.50x10^{-3}$**	**TRUE**	**48**	**$3.50x10^{-4}$**	**TRUE**

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q44	Q56	$1.82x10^{-2}$	$2.50x10^{-3}$	FALSE	98	$5.38x10^{-4}$	FALSE
	Q57	$5.27x10^{-1}$	$2.50x10^{-3}$	FALSE	163	$1.79x10^{-3}$	FALSE
	Q58	$1.81x10^{-1}$	$2.50x10^{-3}$	FALSE	133	$8.62x10^{-4}$	FALSE
	Q59	$4.50x10^{-3}$	$2.50x10^{-3}$	FALSE	88	$4.85x10^{-4}$	FALSE
	Q60	$9.15x10^{-2}$	$2.50x10^{-3}$	FALSE	116	$6.67x10^{-4}$	FALSE
	Q61	$3.58x10^{-2}$	$2.50x10^{-3}$	FALSE	106	$5.88x10^{-4}$	FALSE
	Q62	$1.45x10^{-1}$	$2.50x10^{-3}$	FALSE	127	$7.81x10^{-4}$	FALSE
	Q63	$4.55x10^{-2}$	$2.50x10^{-3}$	FALSE	108	$6.02x10^{-4}$	FALSE
Q45	Q46	$7.13x10^{-1}$	$2.50x10^{-3}$	FALSE	176	$3.33x10^{-3}$	FALSE
	Q47	$1.81x10^{-2}$	$2.50x10^{-3}$	FALSE	97	$5.32x10^{-4}$	FALSE
	Q48	$1.99x10^{-1}$	$2.50x10^{-3}$	FALSE	134	$8.77x10^{-4}$	FALSE
	Q51	$4.35x10^{-3}$	$2.50x10^{-3}$	FALSE	86	$4.76x10^{-4}$	FALSE
	Q52	$9.80x10^{-1}$	$2.50x10^{-3}$	FALSE	189	$2.50x10^{-2}$	FALSE
	Q53	**$3.06x10^{-8}$**	**$2.50x10^{-3}$**	**TRUE**	**32**	**$3.14x10^{-4}$**	**TRUE**
	Q55	**$3.06x10^{-8}$**	**$2.50x10^{-3}$**	**TRUE**	**33**	**$3.16x10^{-4}$**	**TRUE**
	Q56	$2.77x10^{-1}$	$2.50x10^{-3}$	FALSE	145	$1.09x10^{-3}$	FALSE
	Q57	$4.51x10^{-1}$	$2.50x10^{-3}$	FALSE	159	$1.56x10^{-3}$	FALSE
	Q58	$1.00x10^{-0}$	$2.50x10^{-3}$	FALSE	190	$5.00x10^{-2}$	FALSE
	Q59	$1.35x10^{-1}$	$2.50x10^{-3}$	FALSE	124	$7.46x10^{-4}$	FALSE
	Q60	$7.23x10^{-1}$	$2.50x10^{-3}$	FALSE	178	$3.85x10^{-3}$	FALSE
	Q61	$4.26x10^{-1}$	$2.50x10^{-3}$	FALSE	158	$1.52x10^{-3}$	FALSE
	Q62	$8.20x10^{-1}$	$2.50x10^{-3}$	FALSE	184	$7.14x10^{-3}$	FALSE
	Q63	$4.67x10^{-1}$	$2.50x10^{-3}$	FALSE	160	$1.61x10^{-3}$	FALSE
Q46	Q47	$1.89x10^{-2}$	$2.50x10^{-3}$	FALSE	101	$5.56x10^{-4}$	FALSE
	Q48	$6.03x10^{-2}$	$2.50x10^{-3}$	FALSE	113	$6.41x10^{-4}$	FALSE
	Q51	**$7.01x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**60**	**$3.82x10^{-4}$**	**TRUE**
	Q52	$7.02x10^{-1}$	$2.50x10^{-3}$	FALSE	175	$3.13x10^{-3}$	FALSE
	Q53	**$2.10x10^{-4}$**	**$2.50x10^{-3}$**	**TRUE**	**66**	**$4.00x10^{-4}$**	**TRUE**
	Q55	**$4.12x10^{-9}$**	**$2.50x10^{-3}$**	**TRUE**	**29**	**$3.09x10^{-4}$**	**TRUE**
	Q56	$9.26x10^{-2}$	$2.50x10^{-3}$	FALSE	117	$6.76x10^{-4}$	FALSE
	Q57	$6.72x10^{-1}$	$2.50x10^{-3}$	FALSE	172	$2.63x10^{-3}$	FALSE
	Q58	$6.46x10^{-1}$	$2.50x10^{-3}$	FALSE	169	$2.27x10^{-3}$	FALSE
	Q59	$2.71x10^{-2}$	$2.50x10^{-3}$	FALSE	104	$5.75x10^{-4}$	FALSE

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q46	Q60	$3.83x10^{-1}$	$2.50x10^{-3}$	FALSE	153	$1.32x10^{-3}$	FALSE
	Q61	$1.72x10^{-1}$	$2.50x10^{-3}$	FALSE	131	$8.33x10^{-4}$	FALSE
	Q62	$5.02x10^{-1}$	$2.50x10^{-3}$	FALSE	161	$1.67x10^{-3}$	FALSE
	Q63	$2.05x10^{-1}$	$2.50x10^{-3}$	FALSE	136	$9.09x10^{-4}$	FALSE
Q47	**Q48**	**$4.22x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**56**	**$3.70x10^{-4}$**	**TRUE**
	Q51	**$1.43x10^{-11}$**	**$2.50x10^{-3}$**	**TRUE**	**15**	**$2.84x10^{-4}$**	**TRUE**
	Q52	$8.26x10^{-3}$	$2.50x10^{-3}$	FALSE	91	$5.00x10^{-4}$	FALSE
	Q53	$1.18x10^{-1}$	$2.50x10^{-3}$	FALSE	122	$7.25x10^{-4}$	FALSE
	Q55	**$2.76x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**54**	**$3.65x10^{-4}$**	**TRUE**
	Q56	**$6.51x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**58**	**$3.76x10^{-4}$**	**TRUE**
	Q57	$2.17x10^{-2}$	$2.50x10^{-3}$	FALSE	103	$5.68x10^{-4}$	FALSE
	Q58	$2.76x10^{-3}$	$2.50x10^{-3}$	FALSE	80	$4.50x10^{-4}$	FALSE
	Q59	**$2.79x10^{-6}$**	**$2.50x10^{-3}$**	**TRUE**	**46**	**$3.45x10^{-4}$**	**TRUE**
	Q60	$7.47x10^{-4}$	$2.50x10^{-3}$	TRUE	73	$4.24x10^{-4}$	FALSE
Q47	**Q61**	**$1.67x10^{-4}$**	**$2.50x10^{-3}$**	**TRUE**	**65**	**$3.97x10^{-4}$**	**TRUE**
	Q62	$3.62x10^{-3}$	$2.50x10^{-3}$	FALSE	85	$4.72x10^{-4}$	FALSE
	Q63	**$3.29x10^{-4}$**	**$2.50x10^{-3}$**	**TRUE**	**70**	**$4.13x10^{-4}$**	**TRUE**
Q48	Q51	$1.20x10^{-1}$	$2.50x10^{-3}$	FALSE	123	$7.35x10^{-4}$	FALSE
	Q52	$1.46x10^{-1}$	$2.50x10^{-3}$	FALSE	128	$7.94x10^{-4}$	FALSE
	Q53	**$1.33x10^{-7}$**	**$2.50x10^{-3}$**	**TRUE**	**37**	**$3.25x10^{-4}$**	**TRUE**
	Q55	**$1.37x10^{-12}$**	**$2.50x10^{-3}$**	**TRUE**	**8**	**$2.73x10^{-4}$**	**TRUE**
	Q56	$7.97x10^{-1}$	$2.50x10^{-3}$	FALSE	182	$5.56x10^{-3}$	FALSE
	Q57	$1.21x10^{-2}$	$2.50x10^{-3}$	FALSE	93	$5.10x10^{-4}$	FALSE
	Q58	$1.17x10^{-1}$	$2.50x10^{-3}$	FALSE	121	$7.14x10^{-4}$	FALSE
	Q59	$9.03x10^{-1}$	$2.50x10^{-3}$	FALSE	186	$1.00x10^{-2}$	FALSE
	Q60	$2.48x10^{-1}$	$2.50x10^{-3}$	FALSE	142	$1.02x10^{-3}$	FALSE
	Q61	$5.36x10^{-1}$	$2.50x10^{-3}$	FALSE	165	$1.92x10^{-3}$	FALSE
	Q62	$2.44x10^{-1}$	$2.50x10^{-3}$	FALSE	140	$9.80x10^{-4}$	FALSE
	Q63	$5.09x10^{-1}$	$2.50x10^{-3}$	FALSE	162	$1.72x10^{-3}$	FALSE
Q51	Q52	$8.17x10^{-4}$	$2.50x10^{-3}$	TRUE	75	$4.31x10^{-4}$	FALSE
	Q53	**$2.25x10^{-15}$**	**$2.50x10^{-3}$**	**TRUE**	**4**	**$2.67x10^{-4}$**	**TRUE**

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q51	**Q55**	**$1.51x10^{-20}$**	**$2.50x10^{-3}$**	**TRUE**	**2**	**$2.65x10^{-4}$**	**TRUE**
	Q56	$5.03x10^{-2}$	$2.50x10^{-3}$	FALSE	109	$6.10x10^{-4}$	FALSE
	Q57	**$8.17x10^{-8}$**	**$2.50x10^{-3}$**	**TRUE**	**35**	**$3.21x10^{-4}$**	**TRUE**
	Q58	**$1.20x10^{-4}$**	**$2.50x10^{-3}$**	**TRUE**	**63**	**$3.91x10^{-4}$**	**TRUE**
	Q59	$9.91x10^{-2}$	$2.50x10^{-3}$	FALSE	118	$6.85x10^{-4}$	FALSE
	Q60	$1.04x10^{-3}$	$2.50x10^{-3}$	TRUE	76	$4.35x10^{-4}$	FALSE
	Q61	$1.28x10^{-2}$	$2.50x10^{-3}$	FALSE	94	$5.15x10^{-4}$	FALSE
	Q62	$2.91x10^{-3}$	$2.50x10^{-3}$	FALSE	83	$4.63x10^{-4}$	FALSE
	Q63	$1.39x10^{-2}$	$2.50x10^{-3}$	FALSE	95	$5.21x10^{-4}$	FALSE
Q52	**Q53**	**$8.33x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**61**	**$3.85x10^{-4}$**	**TRUE**
	Q55	**$1.79x10^{-9}$**	**$2.50x10^{-3}$**	**TRUE**	**25**	**$3.01x10^{-4}$**	**TRUE**
	Q56	$2.13x10^{-1}$	$2.50x10^{-3}$	FALSE	137	$9.26x10^{-4}$	FALSE
	Q57	$4.02x10^{-1}$	$2.50x10^{-3}$	FALSE	156	$1.43x10^{-3}$	FALSE
	Q58	$9.75x10^{-1}$	$2.50x10^{-3}$	FALSE	188	$1.67x10^{-2}$	FALSE
	Q59	$8.48x10^{-2}$	$2.50x10^{-3}$	FALSE	115	$6.58x10^{-4}$	FALSE
	Q60	$6.64x10^{-1}$	$2.50x10^{-3}$	FALSE	171	$2.50x10^{-3}$	FALSE
	Q61	$3.54x10^{-1}$	$2.50x10^{-3}$	FALSE	149	$1.19x10^{-3}$	FALSE
	Q62	$7.78x10^{-1}$	$2.50x10^{-3}$	FALSE	180	$4.55x10^{-3}$	FALSE
	Q63	$3.99x10^{-1}$	$2.50x10^{-3}$	FALSE	155	$1.39x10^{-3}$	FALSE
Q53	Q55	$4.45x10^{-3}$	$2.50x10^{-3}$	FALSE	87	$4.81x10^{-4}$	FALSE
	Q56	**$1.78x10^{-7}$**	**$2.50x10^{-3}$**	**TRUE**	**38**	**$3.27x10^{-4}$**	**TRUE**
	Q57	**$1.17x10^{-4}$**	**$2.50x10^{-3}$**	**TRUE**	**62**	**$3.88x10^{-4}$**	**TRUE**
	Q58	**$1.10x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**51**	**$3.57x10^{-4}$**	**TRUE**
	Q59	**$3.00x10^{-9}$**	**$2.50x10^{-3}$**	**TRUE**	**28**	**$3.07x10^{-4}$**	**TRUE**
	Q60	**$2.26x10^{-6}$**	**$2.50x10^{-3}$**	**TRUE**	**44**	**$3.40x10^{-4}$**	**TRUE**
	Q61	**$4.50x10^{-7}$**	**$2.50x10^{-3}$**	**TRUE**	**40**	**$3.31x10^{-4}$**	**TRUE**
	Q62	**$2.97x10^{-5}$**	**$2.50x10^{-3}$**	**TRUE**	**55**	**$3.68x10^{-4}$**	**TRUE**
	Q63	**$1.22x10^{-6}$**	**$2.50x10^{-3}$**	**TRUE**	**42**	**$3.36x10^{-4}$**	**TRUE**
Q55	**Q56**	**$1.45x10^{-12}$**	**$2.50x10^{-3}$**	**TRUE**	**9**	**$2.75x10^{-4}$**	**TRUE**
	Q57	**$7.00x10^{-10}$**	**$2.50x10^{-3}$**	**TRUE**	**24**	**$2.99x10^{-4}$**	**TRUE**
	Q58	**$7.58x10^{-11}$**	**$2.50x10^{-3}$**	**TRUE**	**20**	**$2.92x10^{-4}$**	**TRUE**
	Q59	**$1.37x10^{-14}$**	**$2.50x10^{-3}$**	**TRUE**	**5**	**$2.69x10^{-4}$**	**TRUE**
	Q60	**$1.43x10^{-11}$**	**$2.50x10^{-3}$**	**TRUE**	**14**	**$2.82x10^{-4}$**	**TRUE**

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q55	**Q61**	**$3.16x10^{-12}$**	**$2.50x10^{-3}$**	**TRUE**	**12**	**$2.79x10^{-4}$**	**TRUE**
	Q62	**$5.62x10^{-10}$**	**$2.50x10^{-3}$**	**TRUE**	**23**	**$2.98x10^{-4}$**	**TRUE**
	Q63	**$1.15x10^{-11}$**	**$2.50x10^{-3}$**	**TRUE**	**13**	**$2.81x10^{-4}$**	**TRUE**
Q56	Q57	$1.98x10^{-2}$	$2.50x10^{-3}$	FALSE	102	$5.62x10^{-4}$	FALSE
	Q58	$1.77x10^{-13}$	$2.50x10^{-3}$	FALSE	132	$8.47x10^{-4}$	FALSE
	Q59	$6.81x10^{-1}$	$2.50x10^{-3}$	FALSE	174	$2.94x10^{-3}$	FALSE
	Q60	$3.57x10^{-1}$	$2.50x10^{-3}$	FALSE	150	$1.22x10^{-3}$	FALSE
	Q61	$7.13x10^{-1}$	$2.50x10^{-3}$	FALSE	177	$3.57x10^{-3}$	FALSE
	Q62	$3.43x10^{-1}$	$2.50x10^{-3}$	FALSE	148	$1.16x10^{-3}$	FALSE
	Q63	$6.77x-10^{-1}$	$2.50x10^{-3}$	FALSE	173	$2.78x10^{-3}$	FALSE
Q57	Q58	$3.15x10^{-1}$	$2.50x10^{-3}$	FALSE	146	$1.11x10^{-3}$	FALSE
	Q59	$2.53x10^{-3}$	$2.50x10^{-3}$	FALSE	79	$4.46x10^{-4}$	FALSE
	Q60	$1.40x10^{-1}$	$2.50x10^{-3}$	FALSE	126	$7.69x10^{-4}$	FALSE
	Q61	$4.47x10^{-2}$	$2.50x10^{-3}$	FALSE	107	$5.95x10^{-4}$	FALSE
	Q62	$2.47x10^{-1}$	$2.50x10^{-3}$	FALSE	141	$1.00x10^{-3}$	FALSE
	Q63	$6.24x10^{-2}$	$2.50x10^{-3}$	FALSE	114	$6.49x10^{-4}$	FALSE
Q58	Q59	$5.69x10^{-2}$	$2.50x10^{-3}$	FALSE	112	$6.33x10^{-4}$	FALSE
	Q60	$6.50x10^{-1}$	$2.50x10^{-3}$	FALSE	170	$2.38x10^{-3}$	FALSE
	Q61	$3.16x10^{-1}$	$2.50x10^{-3}$	FALSE	147	$1.14x10^{-3}$	FALSE
	Q62	$7.80x10^{-1}$	$2.50x10^{-3}$	FALSE	181	$5.00x10^{-3}$	FALSE
	Q63	$3.66x10^{-1}$	$2.50x10^{-3}$	FALSE	151	$1.25x10^{-3}$	FALSE
Q59	Q60	$1.52x10^{-1}$	$2.50x10^{-3}$	FALSE	129	$8.06x10^{-4}$	FALSE
	Q61	$4.12x10^{-1}$	$2.50x10^{-3}$	FALSE	157	$1.47x10^{-3}$	FALSE
	Q62	$1.61x10^{-1}$	$2.50x10^{-3}$	FALSE	130	$8.20x10^{-4}$	FALSE
	Q63	$3.91x10^{-1}$	$2.50x10^{-3}$	FALSE	154	$1.35x10^{-3}$	FALSE
Q60	Q61	$5.76x10^{-1}$	$2.50x10^{-3}$	FALSE	166	$2.00x10^{-3}$	FALSE
	Q62	$9.02x10^{-1}$	$2.50x10^{-3}$	FALSE	185	$8.33x10^{-3}$	FALSE
	Q63	$6.32x10^{-1}$	$2.50x10^{-3}$	FALSE	168	$2.17x10^{-3}$	FALSE
Q61	Q62	$5.43x10^{-1}$	$2.50x10^{-3}$	FALSE	164	$1.85x10^{-3}$	FALSE
	Q63	$9.51x10^{-1}$	$2.50x10^{-3}$	FALSE	187	$1.25x10^{-2}$	FALSE
Q62	Q63	$5.83x10^{-1}$	$2.50x10^{-3}$	FALSE	167	$2.08x10^{-3}$	FALSE

Legal factor

The single factor ANOVA in Microsoft Excel is also used here for five questions under the Legal factor and received result as shown in Table 3-21. Result shows that average values have no big difference and considered as equal. P value ($2.94x10^{-4}$) is very small and <0.05. It says that there are significant differences within the group and also F>F-critical therefore doing T-test and Post-hoc tests are required to identify the significance of each question.

Table 3-21: ANOVA: Single factor results for Legal factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Q25	93	554	5.96	5.39
Q26	93	511	5.49	7.49
Q27	93	447	4.81	6.14
Q28	93	559	6.01	2.68
Q29	93	451	4.85	7.24

ANOVA

Source of variation	*SS*	*df*	*MS*	*F*	*P-value*	*F- critical*
Between groups	125	4	31.27	5.402	$2.94x10^{-4}$	2.39
Within groups	2662	460	5.79			
Total	**2787**	**464**				

Also the Table 3-22 shows that the results of *P(T<=t)* value by doing 10 T-tests to compare the five questions with each other, Bonferroni α value had taken by dividing the 0.05 by 5 and it was 0.01 and then checked whether P value <Bα value under the *"True/ False"* column. The P value ranked from 1 to 10 and it was calculated Hα value and checked whether significant difference is there or not by referring *"True/ False (P< Hα)"* column.

Q25 asked about effect of employment issues on rubber industry. Q26 asked about imports and export issues related to rubber industry. Q27 asked about the customer complains related to rubber industry. Q28 asked health and safety issues related to rubber industry. Q29 asked regarding the effectiveness of compliance issues in rubber industry. By comparing Q25 with other four questions, we can decide that it has no significant

difference with Q26, and Q28 but has significant difference with Q27 and Q29. By comparing Q26 with other three questions, we can decide Q26 has no significant difference with other three. Likewise, we can decide Q27 has no significant difference with Q29 but has significant difference with Q28. Q28 has significant difference with Q29. Therefore, by considering all these decisions, Q25 and Q28 are the major questions. Second major question is Q26 and lasts are Q27, and Q29.

Table 3-22: T-test used with Bonferroni and Holm method for Legal questions

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q25	Q26	$2.15x10^{-1}$	$1.00x10^{-2}$	FALSE	8	$1.67x10^{-2}$	FALSE
	Q27	**$1.29x10^{-3}$**	**$1.00x10^{-2}$**	**TRUE**	**3**	**$6.30x10^{-3}$**	**TRUE**
	Q28	$8.55x10^{-1}$	$1.00x10^{-2}$	FALSE	9	$2.50x10^{-2}$	FALSE
	Q29	**$3.02x10^{-3}$**	**$1.00x10^{-2}$**	**TRUE**	**4**	**$7.10x10^{-3}$**	**TRUE**
Q26	Q27	$7.38x10^{-2}$	$1.00x10^{-2}$	FALSE	5	$8.30x10^{-3}$	FALSE
	Q28	$1.20x10^{-1}$	$1.00x10^{-2}$	FALSE	7	$1.25x10^{-2}$	FALSE
	Q29	$1.06x10^{-1}$	$1.00x10^{-2}$	FALSE	6	$1.00x10^{-2}$	FALSE
Q27	**Q28**	**$1.30x10^{-4}$**	**$1.00x10^{-2}$**	**TRUE**	**1**	**$5.00x10^{-3}$**	**TRUE**
	Q29	$9.09x10^{-1}$	$1.00x10^{-2}$	FALSE	10	$5.00x10^{-2}$	FALSE
Q28	**Q29**	**$4.80x10^{-4}$**	**$1.00x10^{-2}$**	**TRUE**	**2**	**$5.60x10^{-3}$**	**TRUE**

Environmental factor

The single factor ANOVA in Microsoft Excel is also used here for five questions under the legal factor and received result as shown in Table 3-23. It also shows the sum of the value, average value, and variance for each question under the summary together with source of variation, Sum of Squares (SS), degree of freedom, Mean Square (MS), F-value, P-Value and F-critical value under the ANOVA in the table. Result shows that average values have no big difference and considered as equal. P-value ($1.3x10^{-54}$) is very small and <0.05. It says that there are significant differences within the group and also F>F-critical therefore, doing T-test and Post-hoc tests is required to identify the significance of each question.

Table 3-23: ANOVA: Single factor results for Environmental factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Q32	93	605	6.51	2.32
Q33	93	529	5.69	6.80
Q34	93	609	6.55	7.51
Q35	93	451	4.85	7.39
Q36	93	547	5.88	3.84
Q37	93	231	2.48	6.75
Q38	93	186	2.00	7.20

ANOVA

Source of variation	*SS*	*df*	*MS*	*F*	*P-value*	*F- critical*
Between groups	1963	6	327.25	54.78	$1.3x10^{-54}$	2.11
Within groups	3847	644	5.97			
Total	**5810**	**650**				

Table 3-24 also shows that the results of *P(T<=t)* value by doing 21 T-tests to compare the seven questions with each other, Bonferroni α value had taken by dividing the 0.05 by 7 and it was around 0.0071 and then checked whether P value < Bα value under the *"True/ False"* column. The P value ranked from 1 to 21 and it was calculated Hα value and checked whether significant difference is there or not by referring to second *"True/ False (P< Hα)"* column.

Q32 asked about Environmental restrictions related to rubber industry. Q33 asked about Weather condition reduces the productivity of rubber industry. Q34 asked about application of standard methods for disposal of waste material in rubber industry. Q35 asked about Ecological consequences related to rubber industry. Q36 asked about Environmental issues related to rubber industry. Q37 asked about effectiveness of the Environmental regulations to narrow down product range. Q38 asked regarding change of organisation location due to lack of resources. By comparing Q32 with other six questions, we can decide Q32 has no significant difference with Q33, Q34, and Q36 but has significant difference with Q35, Q37, and Q38. By comparing Q33 with other five questions, we can decide Q33 has no significant difference with Q34, Q35, and Q36 but

Q33 has significant difference with Q37, and Q38. Likewise, we can decide Q34 has no significant difference with Q36 and it is highest value but Q34 has significant difference with Q35, Q37, and Q38. Q35 has significant difference with other three. Q36 has significant difference with other two. Q37 has no significant difference with Q38. Therefore, by considering all these decisions, Q32, Q33, Q34, and Q36 are the major questions. Second major question is Q35 and lasts are Q37, and Q38.

Table 3-24: T-test used with Bonferroni and Holm method for Environmental questions

Question No.	*Compared Question Nos.*	*P(T<=t) two-tail*	*Bonferroni α value (Bα)*	*True/ False (P<Bα)*	*Rank*	*Holm α value (Hα)*	*True/ False (P< Hα)*
Q32	Q33	$9.82x10^{-3}$	$7.14x10^{-3}$	FALSE	14	$6.25x10^{-3}$	FALSE
	Q34	$8.95x10^{-1}$	$7.14x10^{-3}$	FALSE	21	$5.00x10^{-2}$	FALSE
	Q35	**$7.48x10^{-7}$**	**$7.14x10^{-3}$**	**TRUE**	**11**	**$4.55x10^{-3}$**	**TRUE**
	Q36	$1.64x10^{-2}$	$7.14x10^{-3}$	FALSE	15	$7.14x10^{-3}$	FALSE
	Q37	**$1.81x10^{-27}$**	**$7.14x10^{-3}$**	**TRUE**	**2**	**$2.50x10^{-3}$**	**TRUE**
	Q38	**$4.76x10^{-31}$**	**$7.14x10^{-3}$**	**TRUE**	**1**	**$2.38x10^{-3}$**	**TRUE**
Q33	Q34	$2.96x10^{-2}$	$7.14x10^{-3}$	FALSE	16	$8.33x10^{-3}$	FALSE
	Q35	$3.31x10^{-2}$	$7.14x10^{-3}$	FALSE	17	$1.00x10^{-2}$	FALSE
	Q36	$5.68x10^{-1}$	$7.14x10^{-3}$	FALSE	20	$2.50x10^{-2}$	FALSE
	Q37	**$1.23x10^{-14}$**	**$7.14x10^{-3}$**	**TRUE**	**8**	**$3.57x10^{-3}$**	**TRUE**
	Q38	**$1.10x10^{-17}$**	**$7.14x10^{-3}$**	**TRUE**	**7**	**$3.33x10^{-3}$**	**TRUE**
Q34	**Q35**	**$3.47x10^{-5}$**	**$7.14x10^{-3}$**	**TRUE**	**12**	**$5.00x10^{-3}$**	**TRUE**
	Q36	$5.80x10^{-2}$	$7.14x10^{-3}$	FALSE	18	$1.25x10^{-2}$	FALSE
	Q37	**$3.70x10^{-20}$**	**$7.14x10^{-3}$**	**TRUE**	**5**	**$2.94x10^{-3}$**	**TRUE**
	Q38	**$3.15x10^{-23}$**	**$7.14x10^{-3}$**	**TRUE**	**3**	**$2.63x10^{-3}$**	**TRUE**
Q35	**Q36**	**$3.38x10^{-3}$**	**$7.14x10^{-3}$**	**TRUE**	**13**	**$5.56x10^{-3}$**	**TRUE**
	Q37	**$7.29x10^{-9}$**	**$7.14x10^{-3}$**	**TRUE**	**10**	**$4.17x10^{-3}$**	**TRUE**
	Q38	**$1.53x10^{-11}$**	**$7.14x10^{-3}$**	**TRUE**	**9**	**$3.85x10^{-3}$**	**TRUE**
Q36	**Q37**	**$2.90x10^{-19}$**	**$7.14x10^{-3}$**	**TRUE**	**6**	**$3.13x10^{-3}$**	**TRUE**
	Q38	**$9.97x10^{-23}$**	**$7.14x10^{-3}$**	**TRUE**	**4**	**$2.78x10^{-3}$**	**TRUE**
Q37	Q38	$2.13x10^{-1}$	$7.14x10^{-3}$	FALSE	19	$1.67x10^{-2}$	FALSE

Correlations of each factors

Correlation analysis was used to check whether there were possible connections among PESTLE factors and to understand relationship between each two factors. By summarizing all the data for each question, it had been calculated mean values under each factor and gathered mean values. Under the political factor, the minimum is 3.56 and maximum mean value is 6.47 and under Economic factor minimum is 4.32 and maximum is 7.06. Under Social factor, the minimum is 2.84 and maximum is 6.48. Under Technology factor, the minimum is 2.91 and maximum is 6.63. Under Legal factor, the minimum is 4.81 and maximum is 6.01. Under Environment factor, the minimum is 2.00 and maximum is 6.55.

The correlations of each factor were calculated by using Microsoft Excel and it has shown in Table 3-25. The strength level of relationships was considered as follows by considering the correlation coefficient as r [15]:

Positive	Negative
0< r < 0.19 - very weak relationship	-0.19< r <0 - very weak relationship
0.2< r < 0.39 - weak relationship	-0.39 < r < -0.2 - weak relationship
0.4< r <0.59 - medium relationship	-0.59 < r <-0.4- medium relationship
0.6< r < 0.79 - strong relationship	-0.79 <r < -0.6 - strong relationship
0.8< r < 1- very strong relationship	-1 < r <-0.8 - very strong relationship

Considering these correlations, it can be seen one relationship is very weak, namely the Social and Environmental factors. There is only one relationship that has very strong relationship between two factors, namely Economic and Technological factors and also another two strong relationships were there, namely Political and Legal factors, and Economic and Environment factors. Other relationships are medium and weak. All relationships are as shown in Table 3-25.

Table 3-25: Correlations of each factor

	Political	*Economic*	*Social*	*Legal*	*Environmental*	*Technological*
Political	1					
Economic	-0.5957 (Medium)	1				
Social	-0.3229 (Medium)	-0.4426 (Medium)	1			
Legal	0.6919 (Strong)	-0.3158 (Medium)	-0.5077 (Medium)	1		
Environmental	0.3326 (Medium)	-0.6310 (Strong)	-0.0183 (Very Weak)	-0.4330 (Medium)	1	
Technological	-0.1076 (Weak)	0.8668 (Very Strong)	-0.3755 (Medium)	-0.1336 (Weak)	-0.1286 (Weak)	1

To obtain graphical representation for very strong and strong relationships, it was obtained the scattered chart and made the trend line to get linear correlations. Figure 3-3 shows the linear correlation between Economic and Technological factors. It shows that, when Economic factor is increasing, the Technological factor is also increasing with 0.959 gradients showing the very strong relationship (Correlation coefficient r = 0.8668).

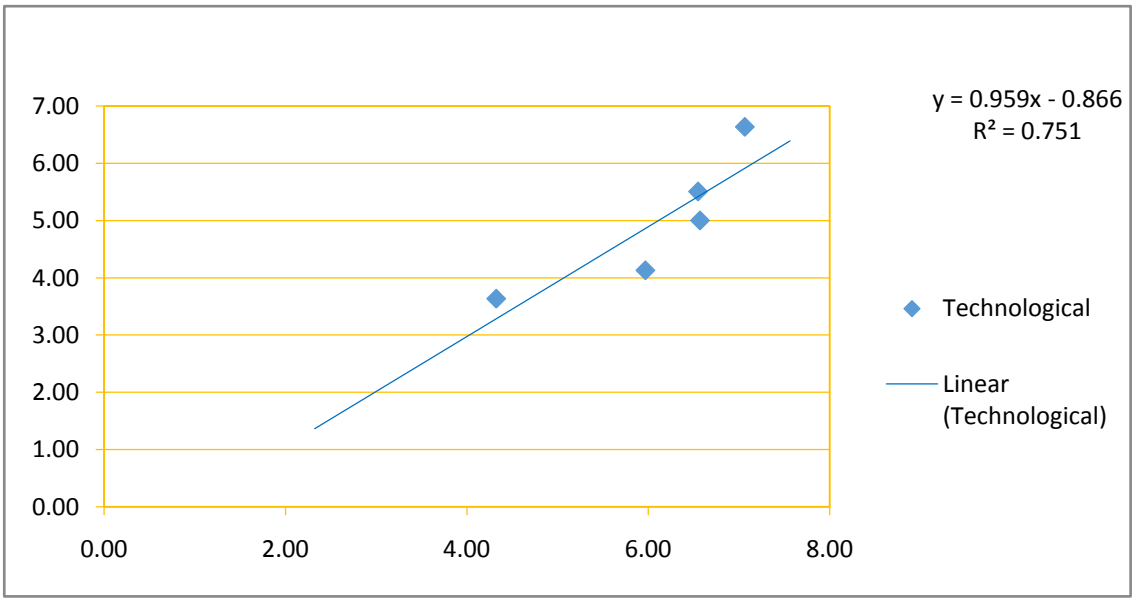


Figure 3-3: Linear correlation between Economic and Technology factors

Figure 3-4 shows the linear correlation between Political and Legal factors. It also shows that when political factor is increasing, the Legal factor is also increasing with 0.386 gradients, showing the strong relationship (Correlation coefficient r = 0.6919).

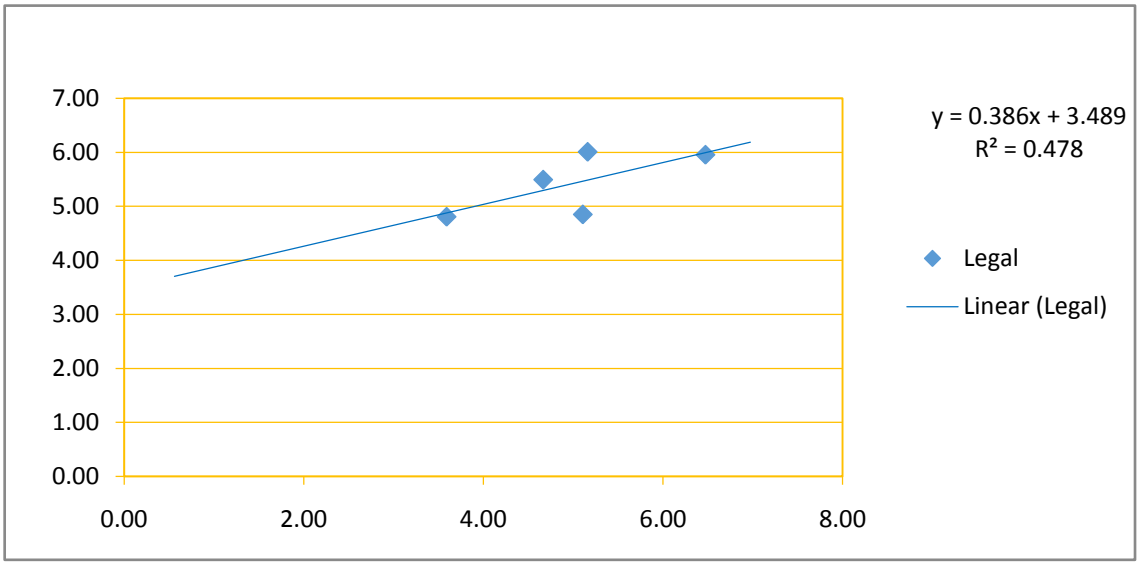


Figure 3-4: Linear correlation between Political and Legal factors

Figure 3-5 shows the linear correlation between Economic and Environmental factors. It shows that when Economic factor is increasing, the Environmental factor is decreasing with 0.412 gradients, showing the strong relationship (Correlation coefficient r = 0.6310).

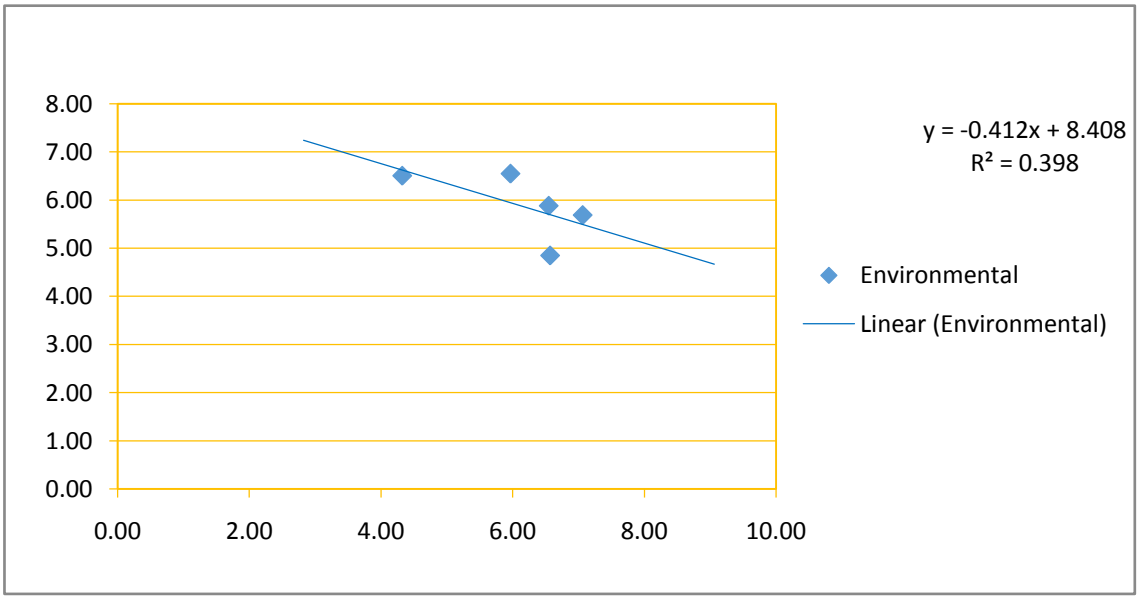


Figure 3-5: Linear correlation between Economic and Environmental factors

Summary of barriers

Finally, by considering all quantitative analysis, it was identified that the major barriers and medium barriers for each factor as follows. Under the Political factor it was able to identify one major barrier and three medium barriers. Table 3-26 shows the barriers and number of respondents.

Table 3-26: Identified barriers under Political factor

No of Barriers	Identified Barriers	Status of Barriers		No of Respondents
1	Impact of trade policies or international legislations on rubber product Industry	Major		92
2	Insufficient budget allocation of Government for development of rubber industry		Medium	92
3	Effect of export restrictions on the rubber industry		Medium	76
4	Political impact on raw rubber prices fluctuation		Medium	75

Under the economic factor, one major barrier and two medium barriers were identified. Table 3-27 shows the barriers and number of respondents.

Table 3-27: Identified barriers under Economic factor

No of Barriers	Identified Barriers	Status of Barriers		No of Respondents
1	Impact of globalization on market share in rubber industry	Major		92
2	Impact of cost of living on rubber industry		Medium	91
3	Effect of exchange rates on rubber industry		Medium	85

Under social factor, two major barriers and one medium barrier were identified. Table 3-28 shows the barriers and number of respondents.

Table 3-28: Identified barriers under Social factor

No of Barriers	Identified Barriers	Status of Barriers		No of Respondents
1	Impact of life style of the people on rubber industry	Major		89
2	Impact of social attitudes on rubber industry as the educational levels improve	Major		87
3	Effect of change of consumer's opinions related to product		Medium	70

There are twelve major barriers and one medium barrier which were identified through the Technological factors according to the results. It was clarified that most important barriers are Technological barriers. Identified barriers and number of respondents are as shown in Table 3-29.

Table 3-29: Identified barriers under Technological factor

No of Barriers	Identified Barriers	Status of Barriers		No of Respondents
1	Lack of mechanism to access the latest technology in the world	Major		93
2	Lack of Research and Development activities compared to the competitors	Major		93
3	Insufficient facilities for the development of technology in the organization	Major		93
4	Unsatisfactory performance of established institutions to develop rubber industry knowledge	Major		93

No of Barriers	Identified Barriers	Status of Barriers		No of Respondents
5	Lack of technical trainings for technologists	Major		93
6	Lack of proper techniques to absorb international technology	Major		93
7	Lack of foreign technical training for technologists	Major		93
8	Lack of good resources for reference materials	Major		93
9	Lack of standard training evaluation procedures	Major		93
10	lack of competitiveness in the market	Major		92
11	Affect of new technology on rubber industry	Major		86
12	Impact of new technology related to the quality and pricing of products	Major		81
13	Lack of application of new technologies to eliminate bottleneck		Medium	93

Under Technological factor, there were separate questions without nine point scale and all 93 samples given the answers to all these three questions. First one was asked about the availability of Patent or License relevant to their products but received around 50% for both YES and NO answers and it indicated the technology level of rubber industry. It was asked regarding the minimum educational level of technologist as second one and out of 93 samples 53% answers are Diploma levels and 47% answers B.Sc. degree level and it was implied that there are shortage of qualified technologists in the industry. No one answered the minimum educational level as M.Sc., PhD or other levels. As a third one, it was asked average rate of value addition of their product, 69% of them were mentioned as 0-500% and 21% as 501 -1000% and 10% as 1001-2000%. This also implies that the technological status of Sri Lankan rubber industry.

Under the Legal factor, it was identified two major barriers and one medium barrier. Table 3-30 shows the barriers and number of respondents.

Table 3-30: Identified barriers under Legal factor

No of Barriers	Identified Barriers	Status of Barriers		No of Respondents
1	Effect of health and safety issues related to rubber industry	Major		92
2	Affect of employment issues related to rubber industry	Major		85
3	Effect of imports and export issues related to rubber Industry		Medium	82

Under Environment factor, four major barriers were identified. Table 3-31 shows the barriers and number of respondents.

Table 3-31: Identified barriers under Environment factor

No of Barriers	Identified Barriers	Status of Barriers		No of Respondents
1	Effect of environmental restrictions related to rubber Industry	Major		92
2	Effect of environmental issues related to rubber industry	Major		89
3	Unavailability of standard methods for disposal of waste material in rubber industry	Major		81
4	Effect of weather condition on productivity of rubber industry	Major		81

3.4.3. Identification of solutions

At the beginning, it was needed to mention that 68 samples were given the answers to these questions which were asked about the solution to the barriers at the end of the each factor. Others had not answers to those questions due to their busy schedules. Lots of suggestions were proposed by the industrial people and, by checking those suggestions deeply, it is found that there were suitable solutions for the relevant barriers.

It was proposed thirty suggestions for the Political factor and finally three solutions were identified. Table 3-32 shows the identified solutions and number of respondents.

Table 3-32: Identified solutions under Political factor

No of Solutions	Identified Solutions	No of respondents
1	Create the national policy for the rubber industry	59
2	Need to make free trade alliance with other countries	55
3	Need sufficient budget allocation from the Government	55

It was proposed thirty six suggestions for Economic factor and finally six solutions were identified. Table 3-33 shows the identified solutions and number of respondents.

Table 3-33: Identified solutions under Economic factor

No of Solutions	Identified Solutions	No of respondents
1	Free trade agreement with developed countries	60
2	Exchange rate should be maintain in lowest level	58
3	Good plan to structure the government taxes and subsidies to motivate the rubber plantation	56
4	Diplomatic steps to mitigate foreign restrictions	54

No of Solutions	Identified Solutions	No of respondents
5	Need to increase the wages for rubber industry proportionate to the cost of living.	48
6	Improve infrastructure and housing for rubber tapping peoples.	46

It was proposed thirty-one suggestions for Social factor and finally four solutions were identified. Table 3-34 shows the identified solutions and number of respondents.

Table 3-34: Identified solutions under Social factor

No of Solutions	*Identified Solutions*	*No of respondents*
1	Improve facilities of employees who are working in rubber related industry	51
2	Awareness programme for industrial people to improve the quality of the products	50
3	More promotional activities to encourage the young generation to absorb to the rubber industry	48
4	Fair salary should be given to employee to maintain life standard	46

It was proposed forty-three suggestions for Technological factor and finally eleven solutions were identified. Table 3-35 shows the identified solutions and number of respondents.

Table 3-35: Identified solutions under Technological factor

No of Solutions	Identified Solutions	No of respondents
1	Need free technology alliance with developed countries	60

No of Solutions	Identified Solutions	No of respondents
2	Need to increase budget allocation for R&D activities	56
3	Govt. should provide facilities for Reverse Engineering	56
4	Need management support for technological aspects.	48
5	Organizing advance training programs about the new technological methods	48
6	Need to increase infrastructure facilities and qualified technologist	48
7	Need to implement online reference facilities for rubber sector	48
8	Encourage the target oriented R & D activities to achieve optimum quality and pricing.	47
9	Increase foreign training programs	47
10	Implement of standard training evaluation procedure within the organisation	46
11	Need to use latest technology to be competitive in the market	46

It was proposed twenty two suggestions for Legal factor and finally three solutions were identified. Table 3-36 shows the identified solutions and number of respondents.

Table 3-36: Identified solutions under Legal factor

No of Solutions	Identified Solutions	No of respondents
1	Free trade alliance with develop countries.	60
2	Promote to follow (Occupational Safety and Health Standards) OSHS for rubber industry	52

No of Solutions	Identified Solutions	No of respondents
3	Awareness programmes for employees to avoid any issues	48

It was proposed thirty four suggestions for Environmental factor and finally four solutions were identified. Table 3-37 shows the identified solutions and number of respondents.

Table 3-37: Identified solutions under Environmental factor

No of Solutions	Identified Solutions	No of respondents
1	Establish centralize waste management system for particular area	52
2	Need to obtain Environmental management system ISO 14001	50
3	Introduce the new techniques and technologies for field.	48
4	Increase more industrial zones for rubber industry	47

3.5. Discussion

This study was done to find out the present situations, barriers, difficulties, issues of the rubber product industry and to find out solutions for those identified barriers. It was important to identify the available barriers in rubber industry to clear the path way of development of Sri Lankan economy. Therefore, a questionnaire (Appendix 1) was made to distribute through the rubber industry. The survey was mainly expected to explore the barriers of rubber industry and the selective manufacturers in various industries were participated. The survey material was comprehensive and covered a broad range of aspects having potential effects on the rubber industry.

During the distribution of questionnaires by handing over the printed hard copy, most of them were reluctant to fill questionnaires at the time of handing over and requested to come in another day on which they were promised to complete the questionnaires. It was difficult to collect the questionnaire from industrial experts due to their busy work schedules. Some industry head peoples did not like to give their data and discourage their crew to attend this survey. Emailing the questionnaires was easy but getting reply was most difficult as discussed in [14]. Some industry peoples did not send the filled questionnaires so I had to go to meet them and collect the questionnaires. Some industry people willingly attended to this survey but some are very poorly but at the end of this work, it could be collected a number of considerable samples (93 questionnaires) with valuable data to analyse. Although the questionnaire included some space for suggestion, barriers and solutions under each factor, some of the people did not suggest any things for barriers and solutions which were not mentioned in the questionnaire but some experts have mentioned valuable ideas under those questions. All gathered information and data are attached with this report under the Appendix 2.

It was suggested several barriers which were not in the questionnaire. When considering the Political factor, it was proposed fourteen barriers and under the Economic factor twenty nine barriers. It was proposed sixteen barriers under the Social factor. Sixteen barriers were proposed under Technological factor and also seven and nine teen barriers were proposed under Legal and Environmental factors respectively and the data are attached with this report under the Appendix 2.

According to the PESTLE analysis, it was found that three factors are most effective for the rubber industry; they were Economic, Legal and Technological factors and these

factors received higher ratings than the other three. According to the quantitative analysis, the important barriers under each factor and the significance level of each barrier were found by following ANOVA and student T-test with the Non-parametric tests to reduce the error when taking the decisions. Finally it was observed the linear co-relations among the six factors and identified the significance level.

After analysing all the data, it was identified four barriers under the political factor and three solutions. Those barriers are; Impact of trade policies or international legislations, effect of export restrictions, insufficient budget allocation of government for development of rubber industry, political impact on raw rubber prices fluctuation. As identified solutions, it is suggested to create the national policy for the rubber industry due to the government's political relationships are changing with the time, therefore the export market will depend on its nature of the relationships. It was also proposed to make free trade alliance with other countries. This is to reduce export and import restriction for rubber industry. As a third one, it was proposed that government should increase the budget allocation for development of rubber industry because of presently allocated budget is not sufficient for that.

For the Economic factor, it was identified three barriers and six solutions as follows: Impact of globalisation on market share, effect of exchange rates, and impact of cost of living all of which are related to rubber industry are the identified barriers. Identified solutions are requirement of Good plan to structure the government taxes and subsidies to motivate the rubber plantation. This can be used to minimize the globalisation effect by increasing rubber production and control the import and export. As the second one, it was proposed that the requirement of diplomatic steps to mitigate foreign restrictions. This can be used to keep globalisation effect in minimum level. Free trade agreement with developed countries was proposed as third solution. This also helps to reduce the globalisation effect. It was proposed to maintain exchange rate in lowest level to reduce floating of rupee value compared to the US dollar unless it effects the export income and raw material cost. As the fifth one, it was proposed to improve the infrastructure and housing for rubber tapping peoples unless peoples will leave the industry due to high cost of living. Increasing the salaries or giving allowances proportionate to the cost of living was proposed as the sixth solution due to above reason.

For the Social factor, three barriers and four solutions were identified. The barriers are; effect of change of consumers' opinions related to product, impact of social attitudes on rubber industry as the educational levels improve, and impact of life style of the people on rubber industry. Identified solutions are to implement awareness programme for industrial people to improve the quality of the products because product quality is very important with the competitive market unless consumers' opinions will change. More promotional activities to encourage the young generation to be absorbed to the rubber industry were proposed as second solution. It was also proposed to improve facilities of employees who are working in rubber related industry because educated young generation do not like to work with the rubber industry due to heavy work and attitude, but they like to work with light work with clean suits. It was proposed that fair salary should be given to employees to maintain lifestyle as a forth solution due to high cost of living.

For the Technological factor it was identified thirteen barriers and eleven solutions. Identified barriers are; Effect of new technology on rubber industry, lack of research and development activities compared to the competitors, lack of application of new technologies to eliminate bottleneck, impact of new technology related to the quality and pricing of products, effect of lack of competitiveness in the market, insufficient facilities for the development of technology in the organisation, unsatisfactory performance of established institutions to develop rubber industry knowledge, lack of technical trainings for technologists, lack of standard training evaluation procedures, lack of foreign technical training for technologists, lack of proper techniques to absorb international technology, lack of good resources for reference materials, lack of mechanism to access the latest technology in the world. Identified eleven solutions include proposal to organised advance training programs about the new technological methods, because most of the companies still using old technology for manufacturing process and need to adapt to the new technology. Requirement of free technology alliance with developed countries was proposed as the second one. It is needed to be updated with the latest technology. As the third one, it was proposed to increase budget allocation for R&D then it will help to improve technology within the organisation. Requirement of management support for technological aspects was proposed as forth solution and it will help to develop the organisation. It was proposed to encourage the target oriented R&D activities to achieve

optimum quality and pricing because customer satisfaction is most important thing in the marketing of products. It was proposed to use the latest technology to be competitive in the market then it will help to develop the product. It was proposed to increase infrastructure facilities and qualified technologists in established institutions to develop rubber industry knowledge because establish institutions has lack of facilities and qualified technologists to perform well. It was proposed to implement standard training evaluation procedure within the organisation. This will help to retain qualified technologist within the organisation. It was proposed to increase foreign training program as next solution, and this will help to transfer technology from foreign countries. It was proposed that government should provide facilities for reverse engineering due to the high cost of modern machinery. As the last solution, it was proposed to implement online reference facilities for rubber sector although presently having reference facilities with some institutions but those are difficult to access. In addition to that, three evidences were identified under this section and those are implying that technology status of Sri Lanka is not in good situation. Availability of patent or license relevant to products is one of the key indicators of technology development and the other one is education level of technologists and the third one is average rate of value addition of product.

Under the Legal factor, three barriers and three solutions were identified. It was proposed that effect of employment issues, effect of imports and export issues, effect of health and safety issues, all of which are related to rubber industry as three identified barriers. As the first solution, it was proposed to make awareness programme for employees to avoid any issues. Transparent work will help to avoid any issues. It was proposed to go for free trade alliance with develop countries as the second solution. This will help to minimize import and export issues. As the third one, it was proposed to follow OSHS for rubber industry and this will help to avoid lot of health and safety issue in rubber industry.

For the environment factor, four barriers and four solutions were identified. It was proposed that effect of environmental restrictions, effect of weather condition on productivity, unavailability of standard methods for disposal of waste material, and effect of environmental issues, all of which are related to rubber industry as identified barriers. As the first solution, it was proposed to increase more industrial zones for rubber industry. It will help to minimise environment restriction by moving rubber industry to industrial zones. It was proposed to introduce the new techniques and technologies for

field as the second solution and this will lead the industry to keep productivity without big changes with weather conditions. It was proposed to establish centralised waste management system for particular areas and this will avoid the waste material disposal problem from rubber industry. It was proposed to obtain environmental management system (ISO 14001) as the forth solution because a lot of environmental issues can avoid by obtaining ISO14001.

After discussing all results from this survey, it is important to mention the methodological limitations occurring from this industrial survey. Due to this very long questionnaire and time consuming, a lot of people did not like to attend to this and fill the blanks and give suggestions, so the data collection method was very difficult. Some industry people did not like to express their ideas and details to the outsiders. Accordingly, the industrial survey and data analysis were probably the most sophisticated and time-consuming processes in this research project. One general limitation attributed to survey research is individual responses to questions that lead to the arithmetic manipulation of figures, creating frequencies, averages and rates that represent "average replies", ratios or proportions that carry no real significance on their own, and rather mystify reality. The second important concern in this survey research has been the problems related to validity and reliability of results. The inconsistency of collected data can be attributed either to the dynamic and genuine variability or fleeting occurrence of the phenomenon observed or to the lack of truth or consistency in the replies given.

CHAPTER 4

4 Conclusion

It seems that Sri Lankan rubber industries are going to face a huge set back in the near future mainly due to technological, economical and legal barriers and that will affect the Sri Lankan economy because rubber is one of the main export products. According to the results of the survey, the reasons behind the decline of the Sri Lankan rubber industry were clarified. The survey was conducted through the PESTLE analysis method and the aim of that was to identify the impact of those factors on rubber industry.

By using quantitative and qualitative analysis, it was identified one major barrier and three medium barriers, and three solutions for those barriers by analysing the gathered data under the Political factor. Those are shown in Table 4-1.

Table 4-1: Identified barriers and proposed solutions under Political factor

Identified Barriers	*Status of Barriers*		*Proposed Solutions*
Impact of trade policies or International legislations on rubber product industry	Major		Need to make free trade alliance with other countries
Insufficient budget allocation of Government for development of rubber industry		Medium	Need sufficient budget allocation from the government
Affect of export restrictions on the rubber Industry		Medium	Need to make free trade alliance with other countries
Political impact on raw rubber prices fluctuation		Medium	Create the national policy for the rubber industry

It was identified one major barrier and two medium barriers, and six solutions for those barriers under Economic factor. Those are shown in Table 4-2.

Table 4-2: Identified barriers and proposed solutions under Economic factor

Identified Barriers	*Status of Barriers*		*Proposed Solutions*
Impact of globalization on market share in rubber industry	Major		Good plan to structure the government taxes and subsidies to motivate the rubber plantation
			Diplomatic steps to mitigate foreign restrictions
			Free trade agreement with developed countries
Impact of cost of living on rubber industry		Medium	Improve infrastructure and housing for tapping peoples.
			Need to increase the wages for rubber industry proportionate to the cost of living.
Effect of exchange rates on rubber industry		Medium	Exchange rate shall be maintain in lowest level

It was identified two major barriers and one medium barrier, and four solutions for those barriers under the Social factor. Those are shown in Table 4-3.

Table 4-3: Identified barriers and proposed solutions under Social factor

Identified Barriers	*Status of Barriers*		*Proposed Solutions*
Impact of life style of the people on rubber industry	Major		Improve facilities of employees who are working in rubber related industry
			Fair salary should be given to employee to maintain life standard

Identified Barriers	*Status of Barriers*		*Proposed Solutions*
Impact of social attitudes on rubber industry as the educational levels improve	Major		More promotional activities to encourage the young generation to absorb to the rubber industry
Effect of change of consumer's opinions related to product		Medium	Awareness programme for industrial people to improve the quality of the products

Under the Technological factor, it was identified twelve major barriers, and one medium barrier with eleven solutions for those barriers. Those are shown in Table 4-4.

Table 4-4: Identified barriers and proposed solutions under Technological factor

Identified Barriers	*Status of Barriers*		*Proposed Solutions*
Lack of mechanism to access the latest technology in the world	Major		Need free technology alliance with developed countries
Lack of research and development activities compared to the competitors	Major		Need to increase budget allocation for R&D activities
Insufficient facilities for the development of technology in the organization	Major		Need management support for technological aspects.
Unsatisfactory performance of established institutions to develop rubber industry knowledge	Major		Need to increase infrastructure facilities and qualified technologist
Lack of technical trainings for technologists	Major		Organising advance training programs about the new technological methods
Lack of proper techniques to absorb international technology	Major		Govt should provide facilities for Reverse Engineering

Identified Barriers	*Status of Barriers*		*Proposed Solutions*
Lack of foreign technical training for technologists	Major		Increase foreign training programs
Lack of good resources for reference materials	Major		Need to implement online reference facilities for rubber sector
Lack of standard training evaluation procedures	Major		Implement of standard training evaluation procedure within the organisation
Lack of competitiveness in the market	Major		Need to use latest technology to be competitive in the market
Affect of new technology on rubber industry	Major		Organizing advance training programs about the new technological methods
Impact of new technology related to the quality and pricing of products	Major		Encourage the target oriented R & D activities to achieve optimum quality and pricing.
Lack of application of new technologies to eliminate bottleneck		Medium	Organising advance training programs about the new technological methods

It was identified two major barriers, and one medium barrier, and three solutions for those barriers under Legal factor. Those are shown in Table 4-5.

Table 4-5: Identified barriers and proposed solutions under Legal factor

Identified Barriers	*Status of Barriers*		*Proposed Solutions*
Effect of health and safety issues related to rubber industry	Major		Promote to follow (Occupational Safety and Health Standards) OSHS for rubber industry

Identified Barriers	*Status of Barriers*		*Proposed Solutions*
Affect of employment issues related to rubber industry	Major		Awareness programmes for employees to avoid any issues
Effect of imports and export issues related to rubber industry		Medium	Free trade alliance with develop countries.

It was identified four major barriers, and four solutions for those barriers under the Environment factor. Those are shown in Table 4-6.

Table 4-6: Identified barriers and proposed solutions under Environmental factor

Identified Barriers	*Status of Barriers*		*Proposed Solutions*
Effect of environmental restrictions related to rubber industry	Major		Establish centralise waste management system for particular area
Effect of environmental issues related to rubber industry	Major		Increase more industrial zones for rubber industry
Unavailability of standard methods for disposal of waste material in rubber industry	Major		Need to obtain Environmental management system ISO 14001
Effect of weather condition on productivity of rubber industry	Major		Introduce the new techniques and technologies for field.

By summarising all the barriers and solutions, it was identified thirty barriers for rubber industry. In order to the qualitative analysis, it was concluded that there are thirty one solutions for the above mentioned barriers. In addition to that identified three evidences, those implies that the technology status of the Sri Lankan rubber industry is lagging behind the world technology. This survey was successfully completed and achieved the above mention objective by identifying barriers and solutions for rubber industry. It is

important to stress here that the technology development is very important in Sri Lankan rubber industry. Improving the academic facilities and technology development in rubber industry will be the survival of Sri Lankan rubber industry.

By extending this survey, it is important to carry out a survey to identify barriers and solutions in small scale rubber industry especially for SMEs as a future work.

References

[1] "Rubber Industry of Sri Lanka", Crttradefair2017.com, 2017. [Online]. Available: https://www.crttradefair2017.com/rubber.php. [Accessed: 09- Oct- 2017].

[2] P. C. Warnasooriya. "Technology Status Assessment in Sri Lankan Raw Rubber Industry Estate Sector", MBA, University of Moratuwa, 2003.

[3] Ministry of Enterprise Development and Investment Promotion, Ministry of Industrial Development, Ministry of Plantation Industries, Federation of Chambers of Commerce and Industry of Sri Lanka, Small and Medium Enterprise Developers and Export Development Board., "Country Study on Sri Lanka using Global Value Chain Analysis:", The industrial rubber and electronic products sectors, 2011.

[4] Ministry of Plantation Industries, "Sri Lanka Rubber Industry Master Plan 2017 – 2026 A National Agenda For Rubber Industry Development", Sri Lanka Rubber Secretariat, 2016.

[5] Statistical Information on Plantation Crops 2015, Rubber sector. Ministry of Plantation Industries, 2017, pp. 73-145.

[6] W.M.G Seneviratne, V.H.L Rodrigo, G.P.W.P.P Seneviratne and S Siriwardene, Rubber Research Institute of Sri Lanka Annual Review 2015, Rubber Research Institute of Sri Lanka, 2016.

[7] L.M.K. Tillekeratne, A. Nugawela and W. M.G. Seneviratne, Hand Book of Rubber Processing, 2nd ed. Rubber Research Institute of Sri Lanka, 2016.

[8] J. K S Sankalpa, W. Wijesuriya and P. W Jeewanthi, Export performance of rubber products manufacturing sector in Sri Lanka, Rubber Research Institute of Sri Lanka, 2013.

[9] A. Mazurkiewicz, and B. Poteralska, (2017). Technology Transfer Barriers and Challenges Faced by R&D Organisations, Procedia Engineering, 182, pp.457-465.

[10] W. Jung, "Barriers to technology transfer and their elimination", The Journal of Technology Transfer, vol. 4, no. 2, pp. 15-25, 1980.

[11] K. Yazdani, K.Y Rashvanlouei, K Ismail. Ranking of Technology Transfer Barriers in Developing Countries; Case Study of Iran's Biotechnology Industry. Proceedings of the 2011 IEEE International Conference on Industrial Engineering and Engineering Management 2011; 1602–1606.

[12] R. Banerjee and M. Kolhatkar, "Barriers to foreign trade for the Rubber Industry", International Journal of Engineering Technology Science and Research IJETSR, vol. 2, no. 10, pp. 12-17, 2015.

[13] Developed by the Sri Lanka Rubber Cluster, "A Competitiveness Strategy for Sri Lanka's Rubber Industry", Pdf.usaid.gov, 2002. [Online]. Available: http://pdf.usaid.gov/pdf_docs/Pnadt758.pdf. [Accessed: 17- Sep- 2016].

[14] N. Schillewaert and P. Meulemeester, "Comparing response distributions of offline and online data collection methods", International Journal of Market Research, vol. 47, no. 2, pp. 163-178, 2005.

[15] "Pearson's correlation", Statstutor.ac.uk, 2017. [Online]. Available: http://www.statstutor.ac.uk/resources/uploaded/pearsons.pdf. [Accessed: 11- Dec- 2017].

Appendix 1

UNIVERSITY OF MORATUWA

Master of Engineering in Manufacturing Systems Engineering

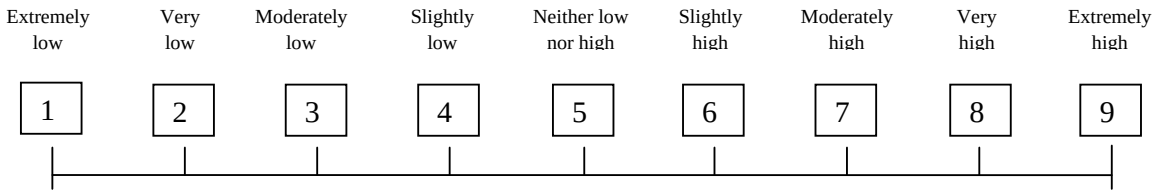
Questionnaire for Assessment of Barrier effects on Rubber Products Industry

I would like to thank you for participating in this Survey. The information will be collected by myself will be used to enhance the academic knowledge of my Masters of Manufacturing Systems Engineering Programme at The University of Moratuwa and shall not be used for any other purpose and all answers that you provide in this survey will be treat as confidential.

This Survey will take about only 30 minutes of your valuable time.

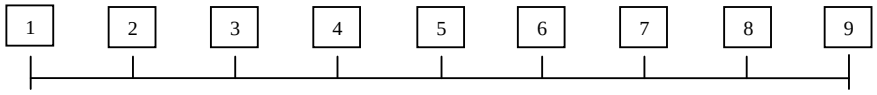
Company Name:…… Designation:……

When you are answering, please follow the under mentioned ranking method and mark your value on the scale one to nine

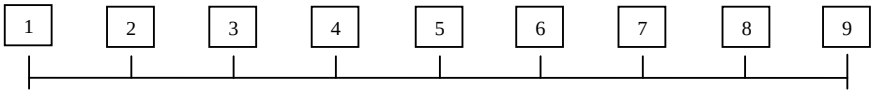


POLITICAL

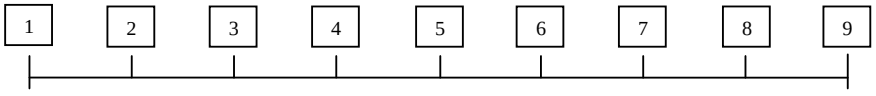
1. Are there any Trade Policies or International legislations creating any impact on your Rubber product Industry? Yes ☐ NO ☐. If yes, mark the rating in below scale.



2. Do you need any amendments or changes to the existing regulations related to Rubber Industry? Yes ☐ NO ☐. If yes, mark the requirement level.

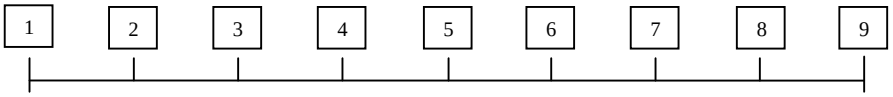


3. Are there new legislations passed during last year relevant to Rubber product industry? Yes ☐ NO☐ . If yes, mark the impact level of new legislation.

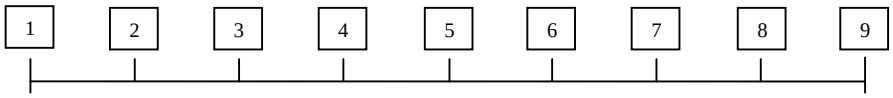


4. Are there any export restrictions which affect the rubber Industry? Yes ☐ NO ☐ .

   If yes, mark the effectiveness on the scale.

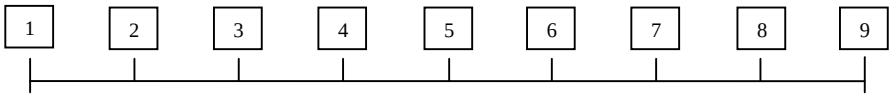


5. Are you satisfied with the government budget allocation for development of your Rubber Industry? Yes ☐ NO ☐ . Please mark the rating on the scale.



6. Is there any political impact on raw rubber prices fluctuation? Yes ☐ NO ☐.

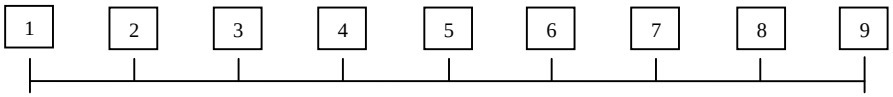
   if yes, marks the impact level on the scale.



7. Is there any government taxation which is not fair for your rubber industry?

   Yes ☐ NO ☐ . If yes, mention the details and mark the effectiveness on the scale.

   ……..



8. Have you any other Political barriers? Yes ☐ NO ☐. If yes, pleases mention below.

   ……

   ……

   ……

9. Give five suggestions to overcome the above mentioned barriers.

   ……

   ……

   ……

   ……

   ……

   ……

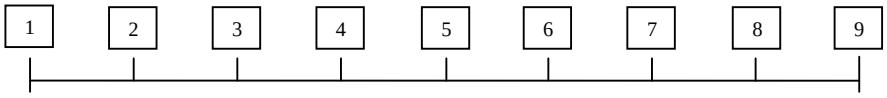
   ……

   ……

ECONOMIC

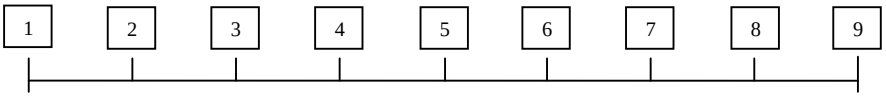
10. Have you observed any economic improvements in rubber industry since 2010?

    Yes ☐ NO ☐. Please mark the rating on the scale.



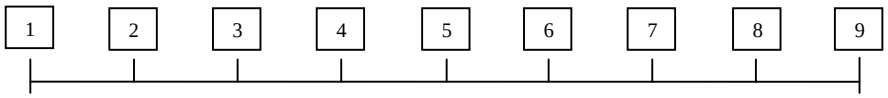
11. Has globalization created any impact on market share in Rubber Industry?

    Yes ☐ NO ☐ . If yes, mark the impact level on the scale.



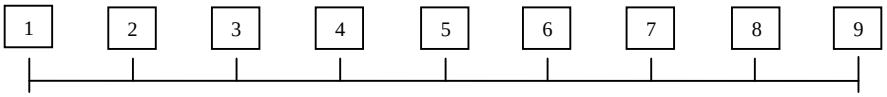
12. Does the prevailing Interest rate affect your Rubber Industry? Yes☐ NO ☐.

    If yes, mark the effectiveness on the scale.



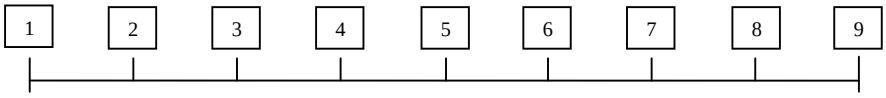
13. Do the exchange rates affect your Rubber Industry? Yes ☐ NO ☐.

    If yes, mark the effectiveness on the scale.



14. Do you think that cost of living has an impact in Rubber Industry? Yes ☐ NO☐.

    If yes, mark the impact level on the scale.



15. Have you any other economic barriers? Yes ☐ NO☐. If yes, pleases mention below.

    ……

    ……

    ……

16. Give five suggestions to overcome the above mentioned barriers.

.....

.....

.....

.....

.....

.....

.....

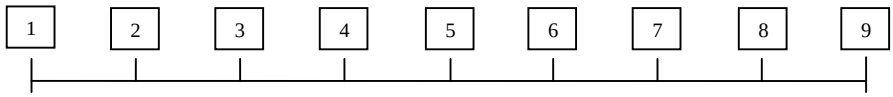
.....

.....

SOCIAL

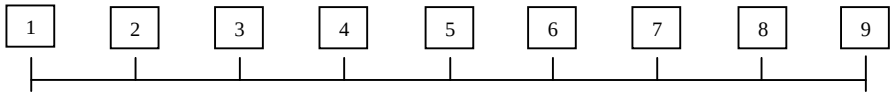
17. Is there any effect of change of consumers opinions related to your product?

Yes ☐ NO☐ . If yes, mark the rating on the scale.



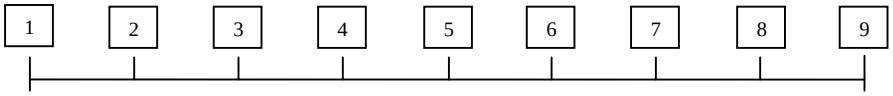
18. Do you have an impact as per the demographic in your rubber industry? Yes ☐ NO ☐.

If yes, mark the impact level on the scale.



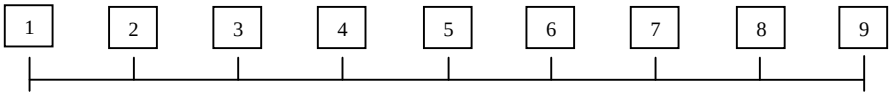
19. Do the social attitudes impacts on Rubber Industry as the educational levels improve?

Yes ☐ NO ☐. If yes, mark the impact level on scale.

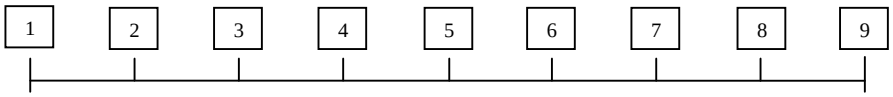


20. Do the ethics and different religions create any impact on rubber Industry?

Yes ☐ NO ☐. If yes, give the rating.

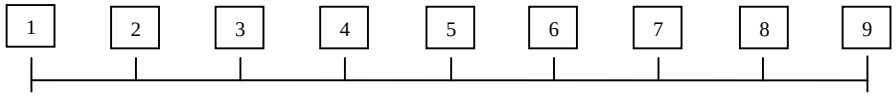


21. Have you experienced any changes of purchasing habits of Customers related to your products? Yes ☐ NO ☐. If yes, give the rating.



22. Does the life style of the people create an impact in rubber Industry? Yes☐ NO ☐.

If yes, give the rating.



23. Have you any other Social barriers? Yes ☐ NO ☐ If yes, pleases mention below.

……

……

……

24. Give five suggestions to overcome the above mentioned barriers.

……

……

……

……

……

……

……

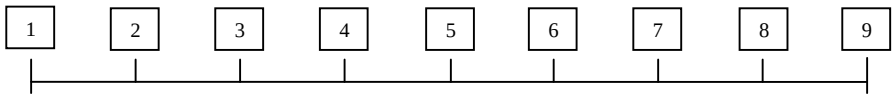
……

……

LEGAL

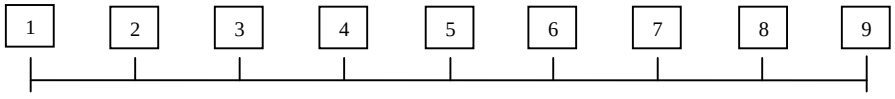
25. Are there any employment issues affecting your rubber industry? Yes ☐ NO ☐.

If yes, mark the impact level on scale.



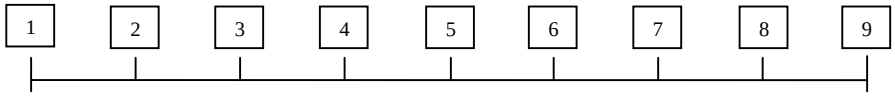
26. Are there any imports and export issues related to your rubber Industry? Yes☐ NO ☐.

If yes, mark your rating.



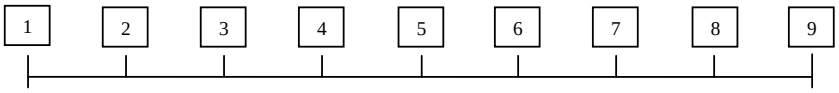
27. Are there any Customer complains related to your rubber industry? Yes ☐ NO ☐.

If yes, give your rating.



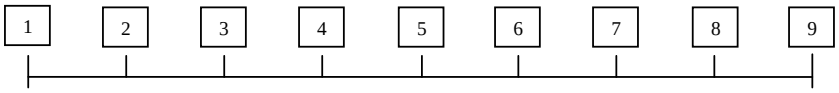
28. Are there any Health and Safety issues related to your rubber industry? Yes ☐ NO ☐.

If yes, mark your rating.



29. Are there any compliance issues affecting your rubber industry? Yes ☐ NO ☐ .

If yes, mark your rating.



30. Have you any other Legal barriers? Yes ☐ NO ☐. If yes, pleases mention below.

……

……

……

31. Give five suggestions to overcome the above mentioned barriers.

……

……

……

……

……

……

……

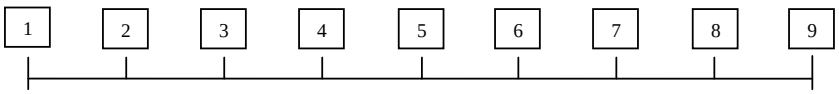
……

……

ENVIRONMENTAL

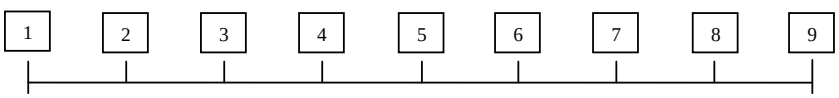
32. Do you have any environmental restrictions related to your Rubber Industry?

Yes ☐ NO ☐. If yes, marks your rating.



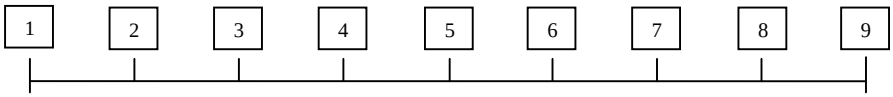
33. Does the weather condition reduce the Productivity of your Rubber Industry?

Yes ☐ NO ☐. If yes, marks your rating.



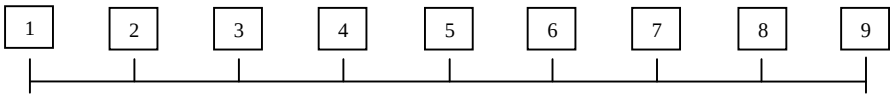
34. Have you applied any standard methods for disposal of waste material in your industry?

Yes ☐ NO ☐. Please mark your rating on the scale.



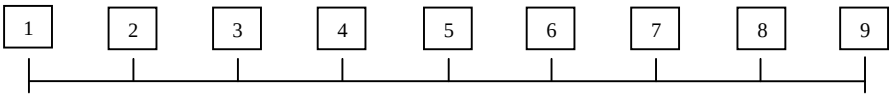
35. Do you face any ecological consequences related to your rubber industry? Yes ☐ NO ☐

If yes, marks your rating.



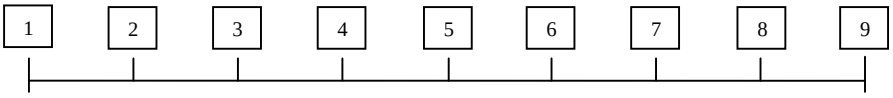
36. Are there any environmental issues to be addressed related to your Rubber Industry?

Yes ☐ NO ☐. If yes, marks your rating.



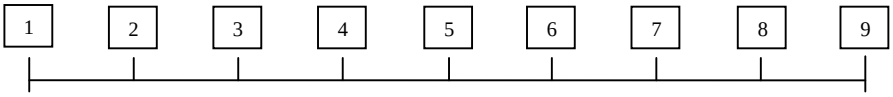
37. Have the environmental regulations effected to narrow down your product range?

Yes ☐ NO ☐. If yes, give your rating.



38. Have you been forced to change your location due to lack of resources? Yes ☐ NO ☐.

If yes, give your rating.



39. Have you any other environmental barriers? Yes ☐ NO ☐.

If yes, pleases mention below.

……

……

……

40. Give five suggestions to overcome the above mention barriers.

……

……

……

……

……

……

……

……

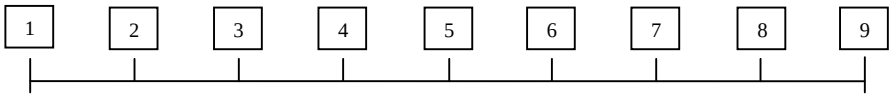
……

……

TECHNOLOGICAL

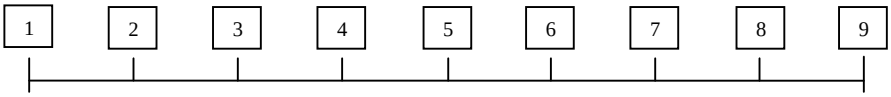
41. Are you competitive in Technology Development related to your Rubber Industry?

Yes ☐ NO ☐. Please mark your rating on the scale.



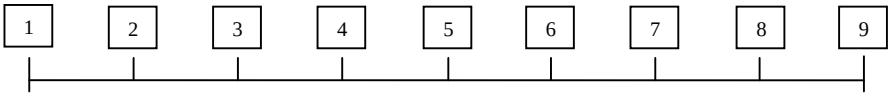
42. Does the new technology affect your business? Yes ☐ NO ☐.

If yes, give your rating.



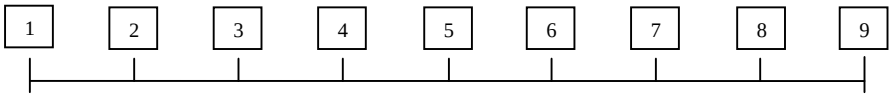
43. Do you depend on 3rd parties for technological support/solutions? Yes ☐ NO ☐.

If yes, give your rating.



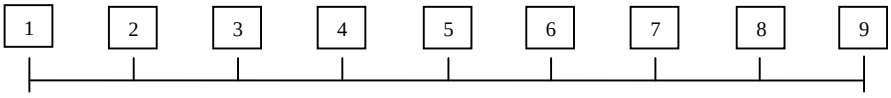
44. Does the rate of change of modern technology affect your Rubber Industry?

Yes ☐ NO ☐. If yes, give your rating.



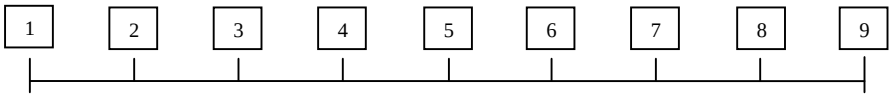
45. Are you satisfied with your Research and Development activities compared to the

Competitors? Yes ☐ NO ☐. Please mark your rating on the scale.



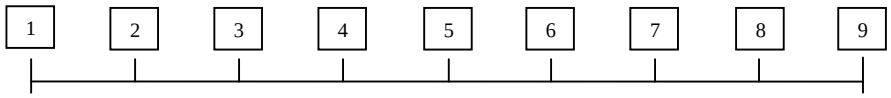
46. Do you apply new technologies to eliminate bottleneck? Yes ☐ NO ☐.

Please mark your rating on the scale.

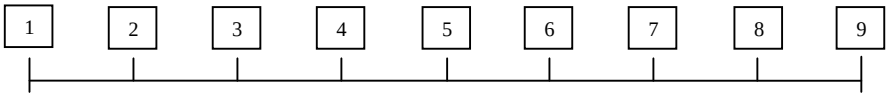


47. Do you apply new technologies to improve your productivity? Yes ☐ NO ☐.

Please mark your rating on the scale.



48. Does the new technology has an impact related to the Quality and pricing of your products? Yes ☐ NO ☐. If yes, give your rating.

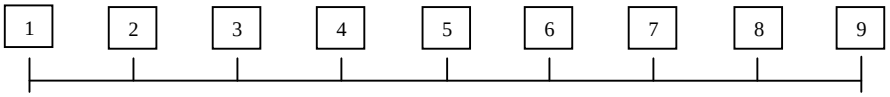


49. Do you have any Patent or Licence relevant to your products? Yes ☐ NO ☐

50. Do you have Knowledge Management Systems (KMS) in your company? Yes ☐ NO ☐

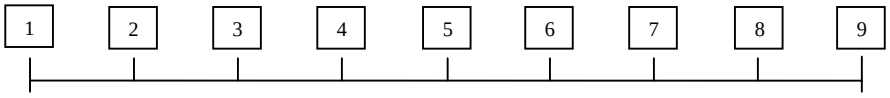
51. Do you think that being competitive in the market develops your products?

Yes ☐ NO ☐. Please mark your rating on the scale.



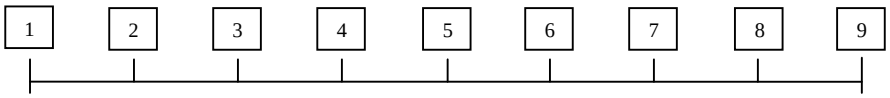
52. Do you have enough facilities for the development of technology in your organization?

Yes ☐ NO ☐. Please mark your rating on the scale.



53. Does your organization consist of qualified technologist? Yes ☐ NO ☐.

Please mark your rating on the scale.

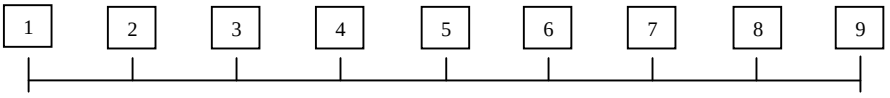


54. What are minimum education levels of technologist in your organization?

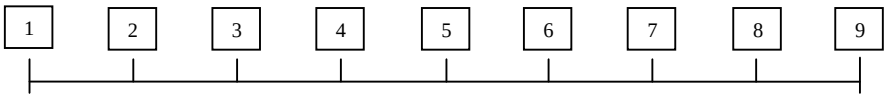
1. Diploma 2. B.Sc Degree. 3. Master Degree 4 PhD 5. Other

55. Does your organization have turnover of higher technologist? Yes ☐ NO ☐.

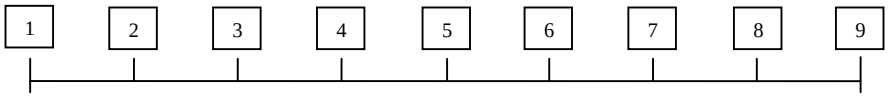
If yes, give your rating.



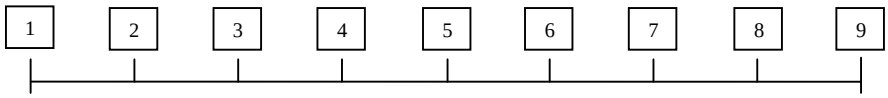
56. Are you satisfied with the performance of established institutions to develop Rubber Industry knowledge? Yes ☐ NO☐. Please mark your rating on the scale.



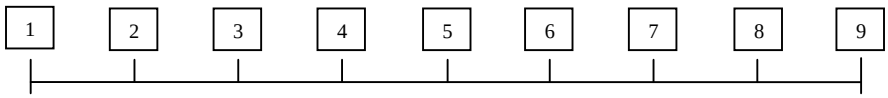
57. Does your company provide sufficient budget allocation for technical training? Yes ☐ NO ☐. Please mark your rating on the scale.



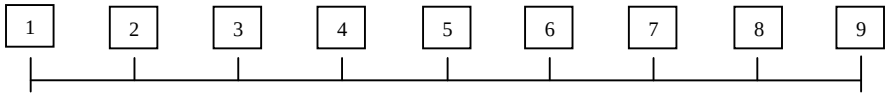
58. Does your organization conduct technical training for technologists? Yes ☐ NO ☐. Please mark your rating on the scale.



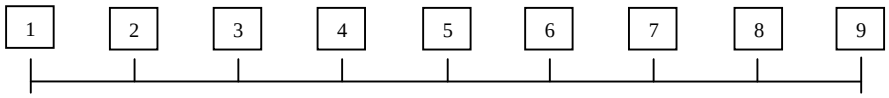
59. Does your organization have Standard Training evaluation procedures? Yes ☐ NO ☐. Please mark your rating on the scale.



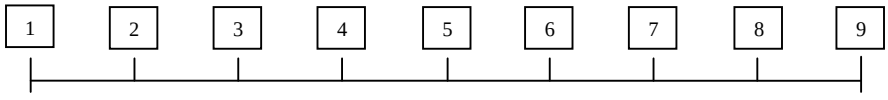
60. Does your organization provide any foreign Technical Training to your Staff? Yes ☐ NO ☐. Please mark your rating on the scale.



61. Does your organization have proper techniques to absorb international technology? Yes ☐ NO ☐. Please mark your rating on the scale.

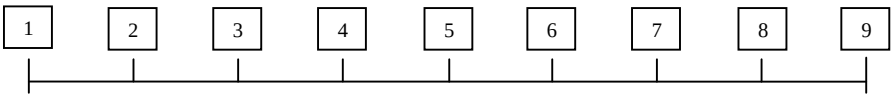


62. Do you have good resources for reference materials? Yes ☐ NO ☐. Please mark your rating on the scale.



63. Do you have mechanism to access the latest technology in the world? Yes ☐ NO ☐.

Please mark your rating on the scale.



64. What is the average rate of value addition of your product?

1. 0-500%
2. 501-1000%
3. 1001-2000%

65. Have you any other technological barriers? Yes ☐ NO ☐.

If yes, pleases mention below.

……

……

……

66. Give five suggestions to overcome the above mentioned barriers.

……..

……..

……..

……..

……..

……..

……..

……..

……..

Appendix 2

Survey data for Political, Economic and Social factors

	Political							*Economic*					*Social*					
	Question No.							*Question No.*					*Question No.*					
Sample No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*10*	*11*	*12*	*13*	*14*	*17*	*18*	*19*	*20*	*21*	*22*
1	9	7	9	9	9	6	6	2	9	8	8	9	6	7	9	0	0	8
2	7	6	6	6	7	6	6	4	7	7	7	7	7	6	6	6	7	6
3	7	6	6	6	7	6	6	4	6	6	6	6	6	6	6	6	6	6
4	7	6	6	6	7	6	6	4	7	7	7	7	7	6	6	6	7	6
5	7	6	7	0	4	0	0	9	9	9	9	5	9	6	8	5	8	8
6	7	6	6	6	9	6	6	4	7	7	7	7	7	6	6	6	7	6
7	8	7	7	0	9	8	0	4	8	7	5	5	0	8	7	8	8	8
8	8	8	0	9	9	9	5	1	9	9	9	9	9	8	9	0	0	8
9	9	7	0	6	3	6	5	9	9	6	7	7	7	6	7	0	0	6
10	6	7	6	8	3	7	7	5	7	6	8	9	6	6	8	6	6	9
11	4	4	4	4	7	4	4	4	4	5	7	6	0	0	6	0	0	7
12	9	9	7	5	6	9	2	5	9	9	9	9	0	0	8	7	0	9
13	4	0	0	0	4	0	0	3	4	3	0	6	0	0	6	0	4	5
14	5	6	6	5	3	6	0	4	6	5	6	5	6	6	0	0	6	0
15	6	0	4	3	6	4	4	4	6	7	4	7	6	6	7	0	5	7
16	5	7	0	3	4	0	0	5	6	6	6	6	6	3	7	0	0	4
17	5	7	0	3	4	0	0	5	7	5	5	6	6	2	6	0	0	3
18	7	0	0	7	3	7	0	3	8	8	7	8	8	7	8	8	8	7
19	6	0	6	0	3	6	5	4	7	5	6	8	7	6	7	0	0	7
20	6	4	6	7	6	0	0	9	9	8	9	9	0	6	6	5	9	9
21	7	4	7	0	7	5	0	5	8	7	5	5	0	0	4	0	8	8
22	8	5	0	7	7	0	6	4	9	8	8	9	6	7	0	6	0	8
23	5	4	0	5	7	6	6	5	9	6	7	7	7	6	7	0	5	6
24	8	6	6	6	6	6	6	3	7	6	6	6	6	8	9	7	3	6
25	6	4	4	4	7	6	6	4	8	7	6	7	7	8	7	0	3	6
26	7	5	4	5	8	0	0	9	9	8	9	9	9	0	8	0	9	9
27	5	5	0	0	5	5	0	5	9	7	5	5	7	8	7	5	8	8
28	6	4	6	5	5	6	6	4	9	8	9	9	6	6	8	0	0	8
29	8	6	6	6	7	6	0	5	7	7	7	7	0	4	7	6	7	6
30	7	5	6	4	7	6	6	3	6	6	8	6	7	8	9	5	6	5
31	6	6	6	6	7	6	0	4	7	6	7	7	7	8	7	0	4	3
32	6	4	0	6	4	6	7	3	4	3	9	6	6	3	8	5	0	3
33	6	0	0	7	4	7	7	2	8	6	8	7	8	7	7	0	7	8
34	6	0	6	5	8	5	0	2	9	8	9	9	7	8	5	0	9	9

	Political							*Economic*					*Social*					
	Question No.							*Question No.*					*Question No.*					
Sample No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*10*	*11*	*12*	*13*	*14*	*17*	*18*	*19*	*20*	*21*	*22*
35	7	0	7	0	6	5	0	4	9	7	5	7	9	8	8	5	8	8
36	6	5	0	6	4	6	5	3	7	3	0	7	7	0	7	0	0	4
37	8	4	0	6	7	0	4	4	8	7	9	9	7	5	9	5	6	5
38	8	6	6	6	7	6	6	4	9	6	7	9	6	5	7	0	4	3
39	6	0	4	6	4	6	0	9	9	3	8	7	6	3	8	0	6	3
40	9	8	7	6	4	6	5	5	4	3	7	9	7	6	5	0	7	4
41	5	7	0	5	5	0	0	4	9	8	9	7	9	8	3	0	8	9
42	7	0	6	0	6	7	0	5	8	7	5	5	7	8	7	6	8	8
43	8	6	6	6	4	6	5	3	9	7	0	7	6	3	9	0	0	4
44	6	5	7	6	4	6	7	4	7	6	9	7	6	8	7	5	5	4
45	4	0	0	6	4	7	0	3	8	7	7	9	7	8	8	0	3	4
46	5	4	0	6	4	0	8	9	9	9	8	6	9	3	7	0	3	4
47	8	6	6	6	4	7	7	5	9	3	9	6	7	8	7	6	0	4
48	7	5	4	0	6	0	0	4	8	7	7	5	0	8	9	0	6	5
49	5	4	7	6	4	6	5	5	4	6	8	6	7	3	7	5	4	3
50	5	5	0	6	4	6	7	3	4	7	7	7	9	5	8	0	0	3
51	6	6	6	6	4	0	0	4	4	9	9	7	7	5	5	0	0	4
52	6	7	0	6	4	6	0	3	4	3	0	9	0	4	3	0	0	4
53	8	0	4	6	4	6	7	3	4	3	0	6	7	0	3	0	0	4
54	8	0	0	7	9	8	0	4	7	8	9	9	6	6	6	0	7	6
55	9	5	0	6	9	0	0	2	6	0	5	6	8	0	7	0	5	5
56	6	4	3	7	6	0	3	9	5	4	4	7	0	0	3	0	2	0
57	6	0	0	6	4	3	0	9	7	7	7	8	7	6	7	0	6	0
58	6	9	0	6	4	8	0	4	7	6	7	6	0	0	6	0	0	6
59	7	0	4	5	8	0	0	2	9	8	9	9	6	6	7	9	9	9
60	5	6	0	6	4	6	7	3	4	3	7	6	0	4	5	0	0	4
61	6	5	5	9	6	7	0	2	9	8	8	6	7	6	7	5	9	9
62	7	4	0	6	4	7	7	3	4	3	7	6	6	0	8	3	0	4
63	5	6	0	6	4	6	0	4	7	6	9	6	0	7	0	3	0	6
64	0	5	5	0	0	5	5	9	9	6	4	4	2	0	5	0	0	4
65	6	8	6	6	4	6	7	3	4	7	9	6	6	3	6	6	5	4
66	8	6	4	0	5	6	0	4	8	6	7	5	0	8	0	5	3	8
67	7	5	0	8	8	5	5	9	9	7	8	6	0	0	7	0	3	9
68	8	6	0	6	4	6	7	5	4	9	7	6	7	3	5	7	6	5
69	6	7	6	0	4	5	8	4	7	6	9	6	0	0	6	6	4	3

	Political							*Economic*					*Social*					
	Question No.							*Question No.*					*Question No.*					
Sample No.	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*10*	*11*	*12*	*13*	*14*	*17*	*18*	*19*	*20*	*21*	*22*
70	5	5	4	8	4	7	0	5	7	6	9	6	5	0	6	0	0	3
71	5	5	4	6	4	6	7	3	4	3	7	6	6	3	7	7	0	4
72	6	4	0	8	6	7	5	2	9	8	8	5	4	3	8	0	9	9
73	8	4	6	0	5	4	0	4	8	7	7	5	0	0	9	0	8	8
74	5	6	0	6	4	6	7	9	4	3	9	6	9	0	7	0	0	4
75	7	5	5	7	3	8	6	3	8	5	7	5	7	5	8	6	6	7
76	7	5	6	7	3	8	6	3	8	5	5	7	7	5	8	6	6	7
77	8	5	6	9	2	9	5	3	8	7	8	0	9	5	8	6	5	9
78	8	5	6	8	3	8	5	3	8	5	8	0	8	6	8	6	5	8
79	7	5	6	9	5	7	0	2	9	8	9	5	0	0	7	5	6	9
80	8	0	4	0	5	8	5	5	8	5	5	5	7	8	8	8	6	8
81	5	5	4	8	4	5	0	5	7	6	7	6	7	4	7	0	0	6
82	6	0	0	6	4	6	7	4	4	3	0	6	7	0	8	6	0	4
83	5	4	6	6	4	6	7	5	8	3	0	5	8	9	8	0	5	6
84	8	6	0	0	5	0	0	3	5	7	5	5	0	8	6	6	3	7
85	5	0	8	8	4	6	7	5	7	6	7	5	6	3	7	0	0	6
86	7	9	0	6	4	8	0	5	7	6	5	6	0	0	6	5	0	6
87	7	8	8	9	4	6	8	4	9	5	7	7	8	8	7	8	9	9
88	8	8	0	8	4	6	7	5	4	3	5	6	0	0	8	6	7	8
89	6	7	8	0	5	8	0	3	8	7	5	5	9	0	0	0	6	8
90	8	9	5	8	4	6	7	3	8	3	0	6	6	3	9	7	6	4
91	5	0	0	0	3	0	0	4	0	0	7	8	0	5	6	0	0	0
92	7	8	8	9	8	8	8	2	9	8	9	9	0	0	9	9	9	9
93	4	6	0	6	4	0	7	2	8	5	7	8	5	5	0	0	5	7

Survey data for Technological factor

	Technological																			
	Question No.																			
Sample No.	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*51*	*52*	*53*	*55*	*56*	*57*	*58*	*59*	*60*	*61*	*62*	*63*
1	9	9	6	8	9	4	4	7	6	9	3	0	9	4	3	4	2	4	5	4
2	4	6	4	6	2	4	4	6	6	6	2	0	4	6	6	6	7	4	4	4
3	4	7	4	6	2	4	4	6	6	5	3	0	4	6	6	6	7	4	4	4
4	4	6	4	6	2	3	2	6	6	7	2	0	4	6	6	6	7	7	4	4
5	1	9	0	8	3	3	3	6	8	3	3	7	9	3	2	9	3	3	3	3
6	4	8	4	7	2	3	4	6	6	7	2	0	3	6	6	6	7	7	4	4
7	5	8	4	3	9	5	2	9	9	9	4	0	9	7	7	7	3	7	9	9
8	2	8	0	0	9	2	2	8	0	9	4	0	9	2	4	9	9	9	9	2
9	4	7	8	7	3	3	3	7	6	4	3	7	4	3	3	3	3	3	4	4
10	2	8	4	5	9	2	3	7	9	7	1	5	8	5	6	7	8	8	9	6
11	6	6	6	0	9	9	6	6	7	9	9	0	5	4	9	9	8	9	9	9
12	2	8	6	8	3	3	3	8	5	2	2	5	3	9	5	9	5	3	9	3
13	9	0	0	0	5	9	4	6	7	3	4	0	4	3	4	5	3	6	3	4
14	6	3	7	3	9	7	8	0	6	7	4	4	5	6	6	5	6	9	5	9
15	2	8	3	8	4	6	6	6	4	7	3	4	7	7	6	9	8	9	4	9
16	5	6	4	5	6	9	6	6	6	5	3	0	4	4	7	6	6	4	3	8
17	6	5	2	6	7	9	6	5	7	4	3	3	5	4	6	6	6	4	4	9
18	1	7	7	7	1	2	2	7	7	2	2	7	3	2	2	2	1	3	4	3
19	2	8	6	0	2	2	2	8	7	4	7	0	6	4	5	5	4	4	4	6
20	4	9	9	9	9	6	9	9	9	1	3	7	1	5	6	9	4	9	1	9
21	1	8	4	3	9	5	2	9	9	9	2	5	9	7	7	7	3	7	9	9
22	4	9	4	8	9	4	4	7	6	9	3	0	9	4	3	4	2	4	5	4
23	5	6	0	6	2	4	4	6	6	6	2	5	4	6	6	6	7	4	4	4
24	2	7	4	6	2	4	4	6	6	5	3	0	9	6	6	6	7	4	4	4
25	4	6	4	6	2	3	2	6	6	7	2	0	4	6	6	6	7	7	4	4
26	4	9	0	9	9	6	2	0	6	1	9	7	8	5	6	2	4	9	1	2
27	1	8	4	3	9	5	2	6	4	5	4	5	5	7	7	5	3	7	9	4
28	4	9	6	8	9	4	3	6	6	4	3	0	9	4	3	4	2	4	5	6
29	5	6	4	6	2	4	3	5	6	2	2	5	4	6	6	6	7	4	4	4
30	2	7	4	6	2	4	4	6	6	4	3	0	4	6	6	6	7	4	4	4
31	4	6	4	6	2	3	2	6	6	7	2	0	4	6	4	2	7	7	4	4
32	6	6	6	0	9	9	6	6	7	9	9	0	5	4	3	5	8	9	9	9
33	2	8	7	7	5	4	4	7	7	9	3	6	4	9	9	4	6	3	4	3
34	5	9	4	9	2	6	2	0	6	4	2	0	1	5	6	6	4	9	1	9

Sample No.	Technological																			
	Question No.																			
	41	42	43	44	45	46	47	48	51	52	53	55	56	57	58	59	60	61	62	63
35	4	8	0	3	2	5	2	6	4	2	3	7	9	7	7	2	3	7	6	2
36	1	6	4	8	3	9	3	6	6	4	2	5	9	4	4	5	8	9	5	4
37	4	6	4	6	2	4	3	5	6	6	3	0	4	6	3	6	7	4	4	6
38	5	7	0	6	2	4	4	6	6	5	2	5	8	6	6	6	5	4	3	4
39	2	6	6	6	2	9	2	6	7	5	2	0	5	4	9	6	3	4	4	9
40	4	6	4	8	2	9	2	6	7	4	3	0	5	4	4	2	6	4	3	2
41	5	9	0	7	3	3	3	9	9	2	2	0	1	5	3	5	4	3	5	4
42	4	8	4	3	2	3	3	9	9	4	3	7	9	7	7	7	3	4	4	6
43	1	9	4	0	2	5	6	8	7	9	2	5	5	4	9	6	5	9	6	9
44	4	8	0	8	2	2	6	0	7	9	2	0	5	4	9	2	3	9	4	2
45	5	8	6	6	3	3	6	6	6	5	3	5	5	4	4	5	6	4	3	4
46	2	8	6	6	2	3	6	6	4	4	2	0	9	4	3	6	8	4	5	6
47	4	7	4	6	9	5	6	5	6	2	2	7	4	4	9	8	5	3	4	9
48	5	8	0	8	9	2	2	9	9	5	3	5	8	7	7	5	3	4	3	2
49	6	6	4	7	9	3	6	6	7	4	2	0	5	4	9	9	6	4	6	4
50	6	6	4	0	9	2	6	6	7	2	3	5	5	4	9	6	5	4	5	6
51	6	6	0	0	9	9	6	6	7	4	2	0	5	4	4	8	3	3	4	2
52	6	6	6	0	9	9	6	6	7	9	6	0	5	4	3	5	6	4	3	4
53	6	6	6	0	9	9	6	6	7	9	5	0	5	4	9	9	8	9	4	6
54	3	7	2	6	4	4	3	6	7	4	3	6	9	4	4	5	4	4	9	5
55	1	8	0	0	5	5	3	0	7	3	3	0	5	4	4	3	6	6	4	6
56	8	2	0	4	4	9	9	5	3	9	4	0	6	5	4	8	4	6	6	9
57	3	7	5	7	3	4	4	6	7	4	3	7	9	3	3	3	3	4	3	3
58	5	0	5	0	9	9	5	0	5	5	5	0	9	5	5	5	5	5	5	5
59	4	9	5	9	9	6	9	9	9	1	2	0	9	5	4	9	4	9	1	9
60	6	6	6	0	9	9	2	6	6	9	3	7	4	4	3	6	8	9	9	2
61	5	9	9	9	9	6	2	9	4	1	2	5	8	5	6	2	4	9	8	4
62	4	6	6	0	9	9	3	8	6	9	3	0	5	4	4	5	8	9	9	6
63	5	0	5	0	9	9	3	0	5	5	2	5	9	5	3	5	5	5	5	5
64	1	7	1	3	2	5	2	8	6	2	3	0	9	1	2	3	3	1	7	3
65	6	6	4	0	9	9	6	7	7	5	5	6	5	4	4	6	8	9	9	9
66	5	8	0	3	2	5	2	9	6	4	4	0	9	2	3	2	3	7	9	9
67	4	9	4	8	2	3	2	9	4	2	5	7	1	3	6	5	8	4	1	9
68	1	6	4	6	3	5	2	6	6	4	2	5	5	5	4	9	5	4	8	9
69	4	0	0	6	2	5	3	0	5	5	8	0	9	4	3	6	8	3	5	5

Sample No.	*Technological*																			
	Question No.																			
	41	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*51*	*52*	*53*	*55*	*56*	*57*	*58*	*59*	*60*	*61*	*62*	*63*
70	5	0	4	6	9	2	3	0	5	5	2	5	9	5	5	2	6	4	8	5
71	2	6	0	8	2	5	6	7	6	9	3	5	5	8	4	8	8	8	5	8
72	4	9	4	7	2	2	9	6	8	1	8	7	1	5	3	9	4	4	8	8
73	4	8	4	3	3	3	7	6	6	9	4	5	9	7	7	7	3	3	9	6
74	1	6	0	0	5	3	6	6	7	9	9	0	5	8	4	9	5	4	9	2
75	2	6	5	4	6	7	7	7	7	7	7	5	7	7	8	8	9	8	6	7
76	2	7	5	4	6	7	7	7	7	7	7	5	7	7	8	6	9	8	7	7
77	1	8	5	7	9	8	7	9	8	7	7	5	8	8	8	7	9	9	8	8
78	1	8	5	7	8	8	7	9	8	8	8	5	7	8	8	7	9	9	8	8
79	1	9	4	6	3	6	9	9	6	8	8	8	1	8	6	9	8	8	1	4
80	1	8	8	8	5	3	7	9	8	9	5	0	9	7	7	7	6	7	9	6
81	4	0	5	7	9	6	5	0	6	5	8	5	9	5	5	5	5	5	8	5
82	2	6	6	8	9	5	6	6	7	9	8	0	8	8	8	9	8	8	9	8
83	2	6	6	6	2	5	6	6	7	9	9	0	5	4	8	9	8	4	9	8
84	4	8	8	6	5	5	7	9	9	9	4	6	9	7	7	7	8	8	9	6
85	1	6	6	6	3	6	6	6	7	7	8	0	5	8	8	9	8	4	9	9
86	2	0	6	5	8	9	5	0	5	5	5	3	9	5	3	5	5	8	5	5
87	2	9	9	7	8	6	8	9	9	5	9	5	5	5	8	9	8	4	1	9
88	2	6	6	0	9	9	6	8	7	7	5	0	5	4	8	7	8	8	9	9
89	4	8	4	3	9	5	2	9	9	5	4	5	5	7	4	7	3	4	9	9
90	2	6	6	0	9	9	6	8	7	6	9	0	5	4	3	9	8	9	9	9
91	2	7	0	7	9	9	9	0	8	3	2	9	5	9	9	7	8	7	9	9
92	9	9	9	9	9	6	9	9	9	1	9	0	1	5	6	9	4	9	1	9
93	2	7	8	7	7	4	3	8	8	4	3	7	8	7	4	9	4	4	9	4

Survey data for Legal and Environmental factors

	Legal					*Environmental*						
	Question No.					*Question No.*						
Sample No.	*25*	*26*	*27*	*28*	*29*	*32*	*33*	*34*	*35*	*36*	*37*	*38*
1	8	8	4	6	6	4	5	7	8	6	0	0
2	9	7	7	6	7	7	8	9	4	6	4	6
3	8	6	6	6	7	6	7	9	4	8	4	6
4	9	7	7	6	6	7	8	9	4	6	4	6
5	8	6	7	6	6	6	7	7	8	7	0	0
6	9	7	7	6	6	7	8	9	4	6	4	6
7	6	7	2	8	7	9	7	0	0	8	0	0
8	0	0	5	6	8	8	8	9	0	8	0	0
9	7	7	6	7	7	7	6	7	6	7	0	0
10	7	6	2	6	9	8	3	0	5	6	0	0
11	7	6	0	7	6	7	6	0	5	7	0	0
12	8	7	5	6	7	7	9	7	8	7	0	0
13	0	0	3	2	0	5	0	6	0	2	0	0
14	6	6	3	6	6	6	5	7	6	6	5	0
15	6	6	6	6	7	8	7	7	4	6	3	4
16	5	3	6	6	0	7	5	7	5	6	0	0
17	4	2	7	6	0	6	6	7	6	5	0	0
18	7	7	8	8	7	8	8	8	7	7	7	8
19	5	0	5	7	0	6	0	8	5	6	0	0
20	6	0	0	7	0	8	8	8	8	8	5	0
21	6	6	2	6	7	9	7	0	0	8	0	0
22	0	6	4	2	6	4	5	7	8	6	0	0
23	6	3	7	6	7	7	0	9	4	7	0	6
24	6	2	6	6	0	6	5	9	4	2	0	6
25	5	0	7	6	6	7	7	9	4	6	0	6
26	4	6	0	7	7	8	5	9	4	6	5	0
27	6	6	2	6	0	9	0	7	8	6	0	0
28	8	3	4	2	6	4	5	9	4	5	0	0
29	9	2	7	6	7	7	7	0	0	6	5	6
30	8	7	6	6	7	6	5	9	4	8	3	6
31	9	7	7	6	6	7	8	7	4	6	0	6
32	8	8	5	6	5	6	5	7	6	6	5	0
33	0	9	9	6	0	7	8	6	6	0	6	0
34	6	0	7	7	0	8	8	8	4	8	5	3

	Legal					*Environmental*						
	Question No.					*Question No.*						
Sample No.	*25*	*26*	*27*	*28*	*29*	*32*	*33*	*34*	*35*	*36*	*37*	*38*
35	0	6	6	7	7	9	7	0	4	8	0	3
36	6	6	7	6	5	6	5	7	8	7	0	0
37	6	3	7	2	7	7	6	9	4	2	0	6
38	5	2	7	8	0	6	0	9	0	6	5	6
39	4	0	2	6	6	6	5	7	6	6	3	0
40	8	6	5	6	7	6	7	7	6	6	0	0
41	6	6	0	7	0	8	5	9	8	5	5	5
42	0	3	7	7	7	9	7	7	0	8	0	0
43	6	2	6	6	5	6	5	9	6	6	5	5
44	6	7	7	8	5	6	5	0	4	5	0	0
45	5	6	7	6	5	6	6	9	4	0	0	4
46	4	6	7	6	5	6	6	7	8	6	4	0
47	8	5	2	7	5	6	8	8	4	2	3	0
48	0	7	8	6	7	5	6	8	0	6	0	0
49	6	7	5	2	5	6	9	7	6	5	5	0
50	6	8	5	6	5	6	0	7	6	0	5	0
51	5	8	5	6	5	6	8	7	6	6	5	4
52	4	8	5	6	5	6	5	7	6	6	4	0
53	8	8	5	6	5	6	5	7	6	6	5	0
54	8	0	5	3	6	7	3	5	5	4	0	0
55	2	0	0	0	6	0	0	7	0	4	0	0
56	3	2	2	4	3	2	0	0	0	5	3	0
57	6	6	6	5	1	1	6	5	5	7	0	0
58	7	5	5	5	6	6	5	5	5	5	0	0
59	0	9	0	7	0	8	8	8	8	8	0	0
60	6	8	5	6	8	6	5	7	6	6	0	0
61	6	9	0	2	0	8	8	8	8	8	5	0
62	5	8	8	6	5	6	5	7	6	6	3	6
63	4	5	5	5	6	6	5	5	5	5	0	0
64	9	4	1	6	6	7	0	9	0	0	3	0
65	8	8	5	7	5	7	8	7	6	6	0	3
66	6	0	3	6	7	5	7	0	0	8	0	0
67	6	6	6	2	0	6	8	8	4	8	4	0
68	8	6	5	6	8	6	6	7	8	6	3	0
69	7	3	3	5	6	6	3	7	8	5	0	3

	Legal					*Environmental*						
	Question No.					*Question No.*						
Sample No.	*25*	*26*	*27*	*28*	*29*	*32*	*33*	*34*	*35*	*36*	*37*	*38*
70	7	7	5	8	6	6	8	5	4	5	0	0
71	8	7	2	6	5	7	9	7	0	6	7	5
72	6	9	5	7	0	5	0	7	8	8	0	6
73	6	7	2	8	7	6	7	8	0	7	4	0
74	8	8	5	6	5	6	5	5	6	2	3	0
75	6	8	7	7	6	7	7	8	6	7	7	5
76	6	8	7	7	6	7	7	8	7	6	7	6
77	6	9	8	9	6	9	8	9	8	7	8	6
78	6	9	8	9	6	9	8	9	8	7	8	5
79	6	7	0	7	0	7	6	8	4	8	4	0
80	8	2	8	8	7	5	9	0	0	8	6	6
81	7	7	5	8	6	6	0	8	8	5	0	5
82	8	0	8	6	8	6	8	7	4	7	4	0
83	8	6	5	6	5	7	5	8	8	2	0	0
84	6	6	7	8	7	8	7	0	8	6	6	5
85	8	7	7	6	8	8	5	8	0	6	0	0
86	7	8	5	5	6	6	6	8	8	6	6	0
87	8	7	0	7	0	7	8	8	8	5	5	0
88	6	5	5	8	5	7	6	7	6	6	5	5
89	6	7	7	5	7	6	9	0	0	8	0	5
90	8	8	5	6	5	6	0	7	6	6	5	0
91	5	6	0	8	0	7	6	6	5	7	0	0
92	6	9	0	7	0	8	8	8	8	8	5	0
93	8	8	5	6	5	8	9	7	8	9	6	7

Survey data for Technological factor without nine point scale

	Technological			
	Question No.			
Sample No.	*49*	*50*	*54*	*64*
1	No	Yes	B.Sc. Degree	0-500
2	No	Yes	B.Sc. Degree	0-500
3	No	Yes	B.Sc. Degree	0-500
4	No	Yes	B.Sc. Degree	0-500
5	No	Yes	Diploma	0-500
6	No	Yes	B.Sc. Degree	0-500
7	No	Yes	B.Sc. Degree	0-500
8	Yes	No	B.Sc. Degree	0-500
9	Yes	No	Diploma	0-500
10	Yes	No	Diploma	0-500
11	No	No	Diploma	0-500
12	Yes	Yes	B.Sc. Degree	0-500
13	Yes	Yes	Diploma	501-1000
14	No	Yes	Diploma	0-500
15	Yes	No	Diploma	0-500
16	Yes	Yes	Diploma	1001-2000
17	Yes	Yes	Diploma	1001-2000
18	Yes	Yes	Diploma	0-500
19	Yes	No	Diploma	501-1000
20	No	No	B.Sc. Degree	0-500
21	No	Yes	B.Sc. Degree	0-500
22	No	No	B.Sc. Degree	0-500
23	No	Yes	B.Sc. Degree	0-500
24	Yes	No	Diploma	501-1000
25	No	Yes	Diploma	0-500
26	Yes	No	B.Sc. Degree	0-500
27	No	No	B.Sc. Degree	0-500
28	No	Yes	Diploma	501-1000
29	No	Yes	B.Sc. Degree	0-500
30	No	No	B.Sc. Degree	0-500
31	Yes	Yes	B.Sc. Degree	0-500
32	Yes	No	Diploma	0-500
33	No	No	B.Sc. Degree	0-500
34	Yes	Yes	Diploma	0-500

	Technological			
	Question No.			
Sample No.	*49*	*50*	*54*	*64*
35	Yes	No	B.Sc. Degree	1001-2000
36	No	Yes	Diploma	0-500
37	Yes	Yes	B.Sc. Degree	0-500
38	Yes	No	Diploma	0-500
39	No	Yes	B.Sc. Degree	0-500
40	Yes	Yes	Diploma	501-1000
41	No	No	B.Sc. Degree	0-500
42	Yes	Yes	Diploma	1001-2000
43	No	Yes	B.Sc. Degree	0-500
44	Yes	Yes	Diploma	0-500
45	Yes	No	Diploma	0-500
46	Yes	Yes	B.Sc. Degree	501-1000
47	No	Yes	B.Sc. Degree	1001-2000
48	Yes	No	Diploma	0-500
49	Yes	Yes	B.Sc. Degree	0-500
50	Yes	Yes	Diploma	501-1000
51	No	Yes	B.Sc. Degree	0-500
52	Yes	No	Diploma	0-500
53	No	Yes	B.Sc. Degree	0-500
54	No	Yes	B.Sc. Degree	501-1000
55	No	Yes	B.Sc. Degree	501-1000
56	No	Yes	Diploma	0-500
57	Yes	Yes	B.Sc. Degree	501-1000
58	No	No	B.Sc. Degree	0-500
59	Yes	Yes	Diploma	0-500
60	Yes	No	B.Sc. Degree	501-1000
61	No	Yes	B.Sc. Degree	0-500
62	No	Yes	Diploma	0-500
63	No	No	Diploma	0-500
64	Yes	Yes	B.Sc. Degree	1001-2000
65	Yes	Yes	Diploma	0-500
66	No	No	B.Sc. Degree	0-500
67	No	Yes	Diploma	0-500
68	No	Yes	Diploma	0-500
69	No	Yes	B.Sc. Degree	0-500

	Technological			
	Question No.			
Sample No.	*49*	*50*	*54*	*64*
70	Yes	Yes	Diploma	1001-2000
71	Yes	No	Diploma	0-500
72	Yes	Yes	B.Sc. Degree	501-1000
73	No	Yes	B.Sc. Degree	0-500
74	Yes	Yes	Diploma	1001-2000
75	Yes	No	Diploma	501-1000
76	Yes	No	Diploma	501-1000
77	Yes	No	Diploma	501-1000
78	Yes	No	Diploma	501-1000
79	No	Yes	Diploma	0-500
80	No	No	Diploma	501-1000
81	No	Yes	B.Sc. Degree	0-500
82	Yes	No	Diploma	501-1000
83	No	Yes	Diploma	0-500
84	No	No	B.Sc. Degree	0-500
85	Yes	Yes	Diploma	0-500
86	Yes	Yes	Diploma	1001-2000
87	No	Yes	B.Sc. Degree	0-500
88	Yes	Yes	Diploma	501-1000
89	No	No	Diploma	0-500
90	Yes	Yes	B.Sc. Degree	501-1000
91	No	No	Diploma	0-500
92	Yes	No	B.Sc. Degree	0-500
93	Yes	Yes	Diploma	0-500

Survey date for proposed barriers

Political factor	
No.	*Question No. 8*
1	No clear policies for the Industry
2	No clear procedures for starting new business
3	Dragging of implementation of rubber master plan
4	No supportive structure over core issues
5	Authorities always willing to punish, not to guide
6	Government's political relationships are changing with the time therefore the export market will depend its nature of the relationships
9	Over politicization
10	Generally motivation of small scale industry, rubber planters and some sponsorship is not enough
11	
12	Taxes on import raw materials to be reduced
13	Government can interfere in finding new export markets
14	Import of aw rubber controlled by Tax

Economic factor	
No.	*Question No. 15*
1	Lack of focus on sustainability
2	Poor focus for the authorities on SME (small and medium-sized enterprises) sector
3	Lack of natural rubber, high cost and low productivity
4	Cost of labour increased
5	Difficult to find large scale investors
6	High interest rate for credits
7	Change taxing policy within short period
8	Reduce taxes
9	Decline in the prices of NR
10	Import of rubber
11	Decline the prices of NR with the reduction of crude oil price
12	Fluctuation of natural rubber price
13	High fluctuation rate for rubber in global market as it is a primary products
14	Majority of foreign investments in Sri Lanka were not confined to sea countries. Only like Korea, Taiwan and Indonesia
15	
16	Sri Lankan rupee was allowed to devalue gradually over time as a floating currency

Economic factor	
No.	*Question No. 15*
17	High tax schemes
18	Less rubber plantation and cost effectiveness
19	Income of employee in rubber industry
20	Workers who tapping is the owner of rubber plantation
21	Government must provide high budget to improve the educational level of industry
22	Taxes of raw materials
23	Trade union issue
24	Lack of resources
25	labour issues
26	lack of skill labour
27	Initial capital for SME sector
28	Lack of market research ability for SME sector
29	Inactive scheme for more value added product to large rubber product companies

Social factor	
No.	*Question No. 23*
1	People has bad mind-set that this industry is very difficult to
2	start and continue with good revenue
3	Long term effect on health
4	Devaluation of employees in rubber sector
5	Adhere in traditional techniques
6	Small rubber land % minimized due to urbanization
7	Shortage of skill rubber tappers
8	Labours are not willing to work in the plantation
9	People don’t like to work in rubber plantation sector because they think that it was a low grade work
10	
11	Urbanisation
12	Unawareness of safety of rubber products and production methods
13	Economy and environmental impact on society from the industry
14	Disposal barriers like waste
15	Social issue
16	EPL barriers

Technological factor	
No.	*Question No. 65*
1	Lack of expert in rubber technology
2	Weak in product and mould design
3	Lack of advanced testing facilities for rubber industry
4	Need attitude change
5	Required more adept labour force
6	Development of infrastructure transport, IT, technology
7	High cost of introducing new technology
8	Difficult to make machines for tapping rubber
9	Should find new rubber clones
10	New technological applications do not go to the small investors
11	Lack of technological resources and other facilities
12	High initial cost for new technologies
13	Low testing and research centres
14	Low testing methods and technicians
15	Take some time to update latest technology
16	Lack of experienced technologists

Legal factor	
No.	*Question No. 30*
1	Lack of expert in rubber technology
2	Lack of scientific regulations on noise level
3	Long procedure to getting approval
4	Delay in providing services by authorized institutes
5	Some rules and regulations implementing is difficult
6	Lack of interfering for some legal barriers by government
7	In Sri Lanka the government does not impose any rules and regulations as well as no requirements of license for the import and export of rubber. But the government imposes the duty on import on synthetic rubber and related import materials.

Environment factor	
No.	*Question No. 39*
1	Rubber waste problem
2	Poor waste management system
3	Few expertise provide facilities against environmental issues
4	Environment pollution due to value addition operation
5	Limited lands for growing NR
6	Production of NR heavily depend on weather condition
7	Environmental pollution due to value addition operation
8	Lack of environmental testing facilities and technologies in Sri Lanka
9	Some government rules and regulations must be practicable for some environment issues from industries
11	The technology used by most of raw rubber manufacturers is old and this results in low productivity and environmental damages witch people to do not tolerate any longer
14	When releasing chemicals, waste water and smoke to environment, people create problems
16	Rubber product may consume more time for the degradation process than that of other products
17	
18	Environmental issue increases the cost of raw material
19	Extremely difficult to achieve international standard limits

Appendix 3

Suggestion to overcome the barriers

Political factor	
No.	*Question No. 9*
1	Create the national policy for the rubber industry
2	One-Stop-Shop for starting of new business
3	Speed up the implementation of rubber master plan
4	Branding of products
5	Support from the government for R&D
6	Capacity building of technologists
7	Educate government officers about importance of any kind of production
8	Establish government body which provides guidance to overcome industrial issues
9	Tax release benefits relevant to amount of export
10	Frequent change in tax policies
11	Master plan should be implemented for long term development
12	Government should encourage to develop rubber cultivation
13	Introduction /Research for new hybrid plantation
14	Protect the employer from unions
15	Making economic agreement with foreign countries provide subsidies
16	Strict the import policy of rubber products
17	Stable and strong political relationship should build by any government
18	Go for free trade alliance
19	Lower the restrictions to import RSS for BOI companies
20	Help to reduce environmental impact (Financially/Technologically/Legally)
21	Reduce cost of electricity
22	Maintain stable exchange rate
23	Government must give help to develop small scale manufactures to increase the productivity
24	It is important to provide some loan facilities to small manufactures with the lowest interest rate
25	Knowledge transfer needed
26	Cultivation of NR should be improved if possible on north area of the country
27	Taxation of imports rubber and crude rubber should be reviewed regularly with reference to local availability of rubber and local demand
28	Our Rubber products purchasing countries should be made aware on the exact subsidy and CESS programs

Economic factor	
No.	*Question No. 16*
1	Circular production and manufacturing supply chain
2	Create data base on SME sector
3	Technology and capacity building implementation of master plan
4	Good plan to structure the government taxes and subsidies to motivate the rubber plantation
5	Law loan interest for the industry new comers
6	Reduce taxes for exporters
7	Good strategic plan to attract foreign investors
8	Awareness programme about the potential of the industry
9	Introduce some benefits for large scale investors
10	Increase liquidity of money by reducing interest rate
11	Attractive benefits for foreign customers
12	Diplomatic steps to mitigate foreign restrictions
13	Adhere taxing policy without frequent changes
14	Life standard of employee who are working in rubber cultivation sector should be improved
15	New technology should be introduce
16	Government support for small rubber holders
17	Given fixed price for NR
18	Increase importer tariff and non-tariff barriers
19	Increase the import tax of raw rubber and rubber products
22	Implement cost reduction practice in all phases of rubber processing and incorporate ISO, MRP, IQA, JIT, MIS tools
23	Natural rubber market should be demanded than the artificial products and introducing some procedures for fix rates
24	Government should minimize taxes to rubber industries
25	Influence the small scale rubber plant owners to increase the production of rubber by giving financial support and latest technology
26	Free trade agreement with Europe, US, and UK
27	Improve infrastructure and housing for tapping peoples
28	Enhance rubber tile and rubber mats industries for export market
29	Increase budget level to improve the knowledge
30	Need support for each small and large scale industry
31	Exchanged rate shall be in lowest level
32	Implement skill development programme for training labours/operators on rubber machineries
33	Provide interest free loan scheme
34	Assistance from EDB or relevant Government Organization
35	Policy decision at political level

Social factor	
No.	*Question No. 24*
1	Change the attitude of child and review the education syllabus starting from school level
2	More promotional activities to encourage the young generation to be absorbed to the rubber industry
3	Introduce special incentive or salary scale for the employees in the rubber plantation
4	Awareness programme for the potential and industrial development of the existing industry
5	Loan for the new investors to motivate starting industry
6	Preside on personal protective equipment
7	Primary education monitored to industrial sector
8	Give privilege for personnel who value rubber industry
9	Inculcate people that the best weapon is quality
10	Social attitude should be changed
11	Fair salary should be given to employee to maintain life standard
12	Enhance quality of life standard through developing infrastructure
13	Need to start rubber tapping training programme
14	Enhance quality of life through developing infrastructure
15	Promote corporate governance practices
16	Promote fair trade
17	Give some subsidies for rubber planters by government
18	Establish new rubber plantations
19	Can give brief introduction or awareness programme to the society
20	Improve skill education
21	Improve communication in between society and industry
22	Help to improve lifestyle and infrastructure
23	Motivate to invest to reduce environmental impact
24	Improve facilities of employees who are working at rubber related industry
25	Need to improve technology factor in rubber related industry
26	Social attitude should be changed
27	Improve knowledge to start small scale products
28	Continually monitor and encourage people
29	Introduce the social policy
30	Awareness programme and training
31	Education

Technological factor	
No.	*Question No. 66*
1	Develop plastic and rubber institute to polymer university level
2	Implement master plan suggestions for technology improvement
3	Allocate technical polymer experts in SLINTEC (Sri Lanka Institute of Nanotechnology)
4	Upgrade the rubber research institute for world excellent centre
5	Transparency of all works
6	Training programme with regard to attitude change
7	Privilege for workers who are interested for knowledge
8	More budget allocation
9	Automation of production processes
10	Improved quality of parts and end products for significant cost saving
11	Give technical assistant to the investors
12	Establish training programme for personnel who engaged in rubber processing
13	Organising advance training programs about the new technological methods
14	Implementing long term development predictions
15	Introducing, implementing and improving a procedure of internal research and development areas
16	Recruit new ones with high technological knowledge for some areas
17	Provide great support by the management for technological aspects
18	Implement new institute like PRI by government
19	Start courses in vocational training institute about the rubber technology then we can train school levers about this technology
20	Increase training programs with other countries
21	Rubber plantation training in Malaysia, and Vietnam.
22	Technical support agreement with develop countries (at least for rubber industry)
23	Obtain new investment with high technical background
24	Improve the technology of knowledge transfer
25	Increase budget allocation for education
26	Increase budget allocation for testing and training
27	Enhance the levels of patents and encourage patent holders
28	Increase the salary of the people
29	Limited testing are available at small size rubber factory so advance testing locations for rubber materials developments would be useful
30	Implement of continuous human resource development plan
31	Human resource development to be move focused on emerging fields
32	Improvement of quality of training
33	Encourage the target oriented R&D activities, move towards to innovations
34	Encourage of private-public-partnership programmes and collaborate research on identified technological fields

Legal factor	
No.	*Question No. 31*
1	Revision of carbon rule and regulation
2	Noise level clarification for industrial zones (BOI has around 65 but IDB has low value than domestic area)
3	Simplify to getting authority for industries
4	Authority personnel in one premises
5	Establish government team who provides supportive guidance to overcome issues
6	Incentive programmes that provide service on time
7	Create a link between universities and industries to develop process and products
8	Rating system for service providing institutes
9	Rubber cultivation should be legally protected
10	Need to reduce tax
11	Some rules and regulations should be upgrade as fit to modern way
12	Some of rules and regulations should practicable when it is implementing
13	High contribution of government for overcoming the issues
14	Introducing new rules and regulations for the industry because although some government sectors implementing some rules and regulations most of those are not enacted
15	Stimulated procedures should introduce by the government.
16	Improve safety level and introduce new technology
17	Increase salary and allowances
18	Reduce tax related to export and import
19	Improve more industrial zones
20	Increase the knowledge of the people

Environmental factor	
No.	*Question No. 40*
1	Develop an awareness on eco metrics nano-technology, etc., for sustainability
2	Encourage the greener product concept
3	Effective waste material management
4	Improve the waste management technology
5	It is required to find out a method to dispose or reused the waste rubber
6	Establish centralize waste management system for particular area
7	Establish service providing unit that provides assistance to solve issues in production/process
8	Provide PPE in a reasonable price
9	Rating mechanism for factories referring supplied system to minimize environmental issue
10	Expand rubber cultivation to non-traditional areas
11	Higher degree of environment friendliness through natural forest cover provided by rubber plantation and substantial carbon sequestering
12	provide technical exposure to small scale manufactures
13	Expanding NR cultivation to non-traditional areas
14	Develop high yield tapping and replanting standards
15	Promote cleaner production and green technologies in manufacturing units
16	Removing the obsolete techniques and technologies and introduce new techniques and technologies for field
17	Introducing new degree programs at university level for industrial environmental filed
18	Government rules and regulations must be updated
19	Removing some political barriers from the field
20	Introducing and give priority for new environmental and safety projects and activities as industries and government
21	Implement new environment polices
22	Implement systems like cleaner production
23	Develop techniques or materials to increase the degradation process of used rubber products
24	Recycling methods has to be developed or implement
25	Tax reduction for environment friendly investment or enhancement
26	Awareness programme must be conducted to avoid environmental issue
27	Get ISO14001 and OSHAS
28	Reduce the taxes to import raw materials
29	Improve standard disposal system
30	Improve industrial zones
31	Supply of technical know-how on waste disposal at a subsidies rate
32	Development of practical waste Re-use or recycling methods through R&D work
33	Increase awareness of the people on real level of impact of waste from rubber industry