

# **Factors Influencing Inventory Risk Perception of Automobile Spare Parts Providers in Sri Lanka**

**G.L.R. Prasanna Perera**  
**159214D**

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Master of Business Administration in Supply Chain Management

Department of Transport and Logistics Management

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Sri Lanka

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Varuna Adikariwattage (PhD)

## **ABSTRACT**

Universally, automotive industry has been accepted as a major driver of growth of a nation's economy and is a significant contribution to the global economy. With the emerging trends in the global supply chain concept, upstream supply chain flows such as production, raw materials, assembly parts need to be placed on time as to ensure the delivery of finished products to the market on time. When referring the incremental growth rates of vehicle production during past 20 years, automotive aftermarket is considered to be the secondary market of the automotive industry. But, when this comes to Sri Lanka, automobile spare parts inventory controlling has been faced with numerous challenges which are raised mainly due to the unpredictable nature of the business industry. Since demand for the automobile spare parts is a derived demand which arise mainly from the growth of the automobiles market; inventory management has to be done with an extra attention by analyzing the main driver for proper inventory controlling of the particular business sector. Hence, this research is focused on exploring the most critical parameters affecting to risk perception of inventory controlling of the automobile industry in Sri Lanka and is expected to identify the major factors and its sub causes for failures of not having an effective inventory controlling system at the companies in Sri Lanka. This study is carried out based on the questionnaire analysis and likert scale has been used to provide a quantitative rating for the questions. Based on the research findings which were derived by the Rotated Components matrix by running SPSS software; 06 main factors such as Market Analysis and Market Development, Human Resource management, Supply Chain Integration, Product portfolio Management, Inventory Management System, Management Involvement were identified and these factors are the main drivers for raising the issues in inventory management of spare parts industry which have to be closely address the companies to overcome issues. As per the question by question analysis, it is revealed that the existing inventory controlling procedures are not in a satisfactory level which has to be re-aligned their inventory controlling with the new drivers derived from the study. Hence, suitable recommendations are made for automobile spare parts companies to take corrective actions in the weaker areas and maintain an effective inventory levels at their companies beyond their customer's expectations.

**KEY WORDS: Automobile market, Likert Scale Analysis, Market development, Supply Chain Integration, Inventory controlling.**

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## **CHAPTER ONE - INTRODUCTION**

### **1.1 History of the automotive industry**

The automotive industry began in the 1890s with hundreds of manufacturers that pioneered the horseless carriage. For many decades, the United States led the world in total automobile production. In 1929, before the Great Depression, the world had 32,028,500 automobiles in use, and the U.S. automobile industry produced over 90% of them. At that time the U.S. had one car per 4.87 persons. After World War II, the U.S. produced about 75 percent of world's auto production. In 1980, the U.S. was overtaken by Japan and became world's leader again in 1994. In 2006, Japan narrowly passed the U.S. in production and held this rank until 2009, when China took the top spot with 13.8 million units. With 19.3 million units manufactured in 2012, China almost doubled the U.S. production, with 10.3 million units, while Japan was in third place with 9.9 million units. From 1970 (140 models) over 1998 (260 models) to 2012 (684 models), the number of automobile models in the U.S. has grown exponentially.

Around the world, there were about 806 million cars and light trucks on the road in 2007, consuming over 980 billion liters (980,000,000 m<sup>3</sup>) of gasoline and diesel fuel yearly. The automobile is a primary mode of transportation for many developed economies. In the developed countries, the automotive industry has slowed down. It is also expected that this trend will continue, especially as the younger generations of people (in highly urbanized countries) no longer want to own a car anymore, and prefer other modes of transport. Other potentially powerful automotive markets are Iran and Indonesia. Emerging auto markets already buy more cars than established markets. According to a J.D. Power study, emerging markets accounted for 51 percent of the global light-vehicle sales in 2010. The study, performed in 2010 expected this trend to accelerate. However, more recent reports (2012) confirmed the opposite; namely that the automotive industry was slowing down even in BRIC (Brazil, Russia, India and China) countries. In the United States, vehicle sales peaked in 2000, at 17.8 million units.

## 1.2 World motor vehicles production

With the positive outlook of the automobile industry in the globe; it has been recorded with incremental growth rates of vehicle production during past 20 years which is further illustrates as follows. As per with that; it is considered that auto parts and equipment companies also should regularly review and need to adjust their business priorities and inventory practices as to cope up with the increasing demand of the automobile market without incurring any shortage or unnecessary surplus of spare parts at their inventories.

Table: 01 Growth Rate changes of World Motor Vehicles Production

<b>Year</b>	<b>Production</b>	<b>Change %</b>
<b>1998</b>	52,987,000	-2.70%
<b>1999</b>	56,258,892	6.20%
<b>2000</b>	58,374,162	3.80%
<b>2001</b>	56,304,925	-3.50%
<b>2002</b>	58,994,318	4.80%
<b>2003</b>	60,663,225	2.80%
<b>2004</b>	64,496,220	6.30%
<b>2005</b>	66,482,439	3.10%
<b>2006</b>	69,222,975	4.10%
<b>2007</b>	73,266,061	5.80%
<b>2008</b>	70,520,493	-3.70%
<b>2009</b>	61,791,868	-12.40%
<b>2010</b>	77,857,705	26.00%
<b>2011</b>	79,989,155	3.10%
<b>2012</b>	84,141,209	5.30%
<b>2013</b>	87,300,115	3.70%
<b>2014</b>	89,747,430	2.60%
<b>2015</b>	90,086,346	0.40%
<b>2016</b>	94,976,569	4.50%

*Source: OICA report (2016)*

### 1.2.1 Top 10 motor vehicles producing countries 2016

When referring the online statistics (2016); motor vehicle production in the globe has been spread among different countries as follows. As per with that; the top leading manufacturing position still be with China by recording around 28 Millions of vehicles per annum. Also, United State, Japan and Germany also holding with competitive positions of 02<sup>nd</sup>, 03<sup>rd</sup> and 04<sup>th</sup> world ranking; and this has induced the demand for the automobile spare parts industry the in global and local markets which is comprehensively studied in the research.

Table 02: Global Giants in Motor Vehicle Production

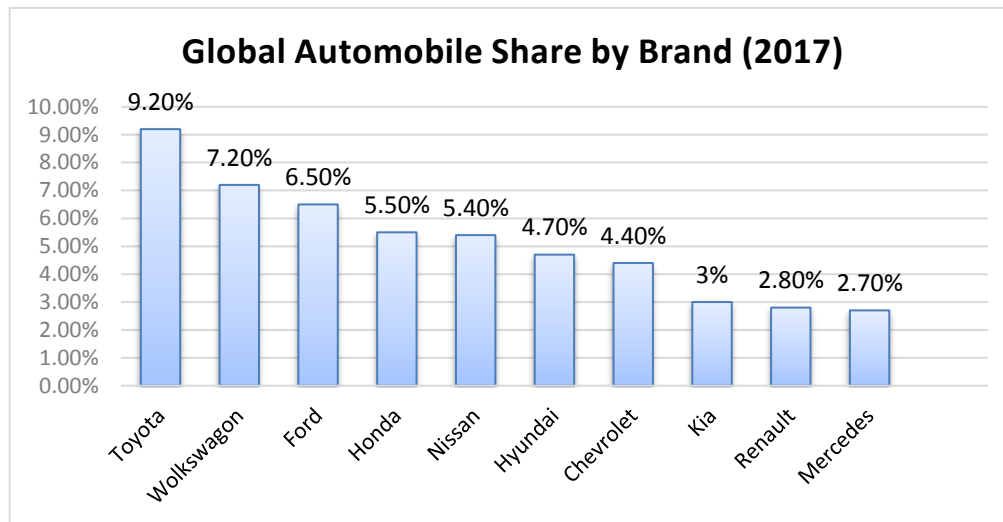
Country	Motor vehicle production (units)
China	28,118,794
United States	12,198,137
Japan	9,204,590
Germany	6,062,562
India	4,488,965
South Korea	4,228,509
Mexico	3,597,462
Spain	2,885,922
Canada	2,370,271
Brazil	2,156,356

*Source: OICA report (2016)*

### 1.2.2 Global Automotive Market share in 2017, by brand

As per statista (2017); world leading car manufacturing brands based on the sales revenues can be illustrates as follows. According to that; the top ranking position was topped by Toyota, owned by Japan's Toyota Motor Corporation, and followed by Germany's Volkswagen in 02<sup>nd</sup> place and Ford in 3<sup>rd</sup> Place.

Figure 01: Global Brand Share in Automobile Industry



With the growing trends towards the environmental friendly concepts of the society; it has been created number of new challenges in automobile manufacturing industry during past few years. Thus, markets trends of shifting to the lighter materials, shifting to the electric and hybrid vehicles and alternative powertrains are made revolutions in the industry which revealed by above statistics recorded in 2017. With these different automobile brands available in the market; demand for the spare parts also get fluctuated which is being one of the major challenge in controlling an effective spare part inventories at the spare part providing companies in the world.

### 1.2.3 Automotive Parts Sector Definitions

Automotive parts (vehicle spare parts) are defined as either Original Equipment (OE), or aftermarket parts. Original equipment parts that are used in the assembly of a new motor vehicle (automobile, light truck, or truck) or are purchased by the manufacturer for its service network are referred to as Original Equipment Service (OES) parts. Suppliers of OE parts are broken into three levels. The first level is "Tier 1" suppliers who sell finished components directly to the vehicle manufacturer. The next level is "Tier 2" suppliers who sell parts and materials for the finished components to the Tier 1 suppliers. The third level is "Tier 3" suppliers who supply raw materials to any of the above suppliers or directly to vehicle assemblers. There is often overlap between the tiers. Original equipment production accounts for an estimated two-thirds to three-fourths of the total automotive parts production.



#### **1.2.4 Automotive spare parts market**

The automotive aftermarket is the secondary market of the automotive industry, concerned with the manufacturing, remanufacturing, distribution, retailing, and installation of all vehicle parts, chemicals, equipment, and accessories, after the sale of the automobile by the original equipment manufacturer (OEM) to the consumer. The parts, accessories, etc. for sale may or may not be manufactured by the OEM. According to a report by the International Trade Administration in the Department of Commerce, "Aftermarket parts are divided into two categories: replacement parts and accessories. Replacement parts are automotive parts built or remanufactured to replace OE parts as they become worn or damaged. Accessories are parts made for comfort, convenience, performance, safety, or customization, and are designed for add-on after the original sale of the motor vehicle.

The aftermarket encompasses parts for replacement, collision, appearance, and performance, including electric propulsion. The aftermarket provides a wide variety of parts of varying qualities and prices for nearly all vehicle makes and models.

Consumers have the option of repairing their vehicles themselves or can take the vehicle to a professional repair facility. The aftermarket helps keep vehicles on the road by providing consumers the choice of where they want their vehicles serviced, maintained, or customized.

A spare part, spare, service part, repair part, or replacement part, is an interchangeable part that is kept in an inventory and used for the repair or replacement of failed units. Spare parts are an important feature of logistics engineering and supply chain management, often comprising dedicated spare parts management systems.

Further to elaborate, in logistics, spare parts can be broadly classified into two groups, repairable and consumables.

#### **1.2.5 Repairable**

Repairable parts are parts that are deemed worthy of repair, usually by virtue of economic consideration of their repair cost. Rather than bear the cost of completely replacing a finished product, repairable typically are designed to enable more affordable maintenance by being more modular. This allows components to be more

easily removed, repaired, and replaced, enabling cheaper replacement. Spare parts that are needed to support condemnation of repairable parts are known as replenishment spares.

A routable pool is a pool of repairable spare parts inventory set aside to allow for multiple repairs to be accomplished simultaneously. This can be used to minimize stock out conditions for repairable items.

### **1.2.6 Consumables**

Parts that are not repairable are considered consumable parts. Consumable parts are usually scrapped, or "condemned", when they are found to have failed. Since no attempt at repair is made, for a fixed mean time between failures (MTBF), replacement rates for consumption of consumables are higher than an equivalent item treated as a repairable part. Because of this, consumables tend to be lower cost items.

Because consumables are lower cost and higher volume, economies of scale can be found by ordering in large lot sizes, a so-called Economic order quantity.

### **1.2.7 Automotive spare parts market in Sri Lanka**

As an island economy with persistent balance of payment issues Sri Lanka lives within an export or perish environment. This situation is further compounded by insurmountable increases in the world oil prices threatening every aspect of the economy. The current account deficit is managed by worker remittances, an unsustainable resource.

Considering the geographical location of Sri Lanka, its proximity to South India and the concessions already available in the Sri Lanka /India FTA which has been in successful operation for quite some time, industry analysts clearly see a major export opportunity for Sri Lanka, to make a significant contribution to much needed foreign exchange earnings as well as the creation of employment. Export led growth policy of the successive governments since 1977 has paid rich dividends through rapid economic growth. According to a recent World Bank study off-shoring or the process whereby one company delegate's responsibility for performing a function or series of tasks to

another company based in another country is now confined not only for goods but also for services.

The World Bank estimates off-shoring now represents a US\$100 billion market and is growing at a rate of 30 per cent annually. Sri Lanka possesses ideal attributes for a good off-shoring base due to its highly skilled labour force, good managerial support services in engineering, legal and financial services and an efficient port operation.

There is a very clear business case for all the stakeholders in the automotive trade /industry to pursue this idea and find niches in the Indian market. Growth of industries, development of infrastructure and increasing middle class purchasing power will necessarily create a demand for more automobiles to be produced in India.

Sri Lanka has all the potential to build capacity to meet excess Indian demand. Now that the project has received the blessings of the first citizen of Sri Lanka it is up to the private motor trade and government's investment promotion arm BOI to get together and build a successful feeder industry.

### **1.2.8 Vehicle Population in Sri Lanka**

When analyzing the vehicle industry in Sri Lanka; The Ceylon Chamber of Commerce Statistics (2017) has revealed that Sri Lanka has reached 6.8 Millions of vehicle population in 2016 in which the vehicle breakdown can be further illustrates with years as follows. Even though the Sri Lanka is treated to be as a third world country; which still in the middle income level; automobile industry is still growing at a precedent rate over the years. Thus, automobile spare parts industry also becoming a growing industry in Sri Lanka where the inventory management of spare part providers have to be well deployed by each provider as to cater for this ever growing vehicle market in an efficient manner.

Table 03: Vehicle Population in Sri Lanka

<i>Year</i>	2012	2013	2014	2015	2016
<i>Motor Cars</i>	499,714	528,094	566,874	672,502	717,674
<i>Motor Tricycle</i>	766,784	850,457	929,495	1,059,042	1,115,987
<i>Motor Cycles</i>	2,546,447	2,715,727	2,988,612	3,359,501	3,699,630
<i>Buses</i>	91,623	93,428	97,279	101,419	104,104
<i>Dual purpose vehicles</i>	280,143	304,746	325,545	365,001	391,888
<i>Motor Lorries</i>	323,776	329,648	334,769	341,911	349,474
<i>Land Vehicles-Tractors</i>	315,520	326,292	333,362	343,339	353,624
<i>Land Vehicles-Trailers</i>	53,020	55,286	57,298	59,426	63,088
<b><i>Total</i></b>	<b>4,877,027</b>	<b>5,203,678</b>	<b>5,633,234</b>	<b>6,302,141</b>	<b>6,795,469</b>

***Source: The Ceylon Chamber of Commerce records (2017)***

### **1.3 Background of the study**

With the emerging market trends in the global and local business setup; inventory environment has changed and very recently, introduction of new technology, management philosophies, economic situation and the customization of products, have led to exist more complex parameters affecting the automobile spare parts inventory levels. When this comes to Sri Lanka; automobile spare parts inventory controlling has been faced with numerous challenges which are raised mainly due to the unpredictable nature of the business industry. Since demand for the automobile spare parts is a derived demand which arise mainly from the growth of the automobiles market; inventory management has to be done with an extra attention by analyzing the main driver for proper inventory controlling in automobile spare part industry.

Therefore, it is important to understand which variables that are inventory drivers in spare parts industry. Having a good inventory management is no longer a competitive advantage if is not effectively managed by the companies. Therefore, it is very much critical to have an effective inventory management system in each company; by being sensitive to the intra and extra risk drivers which impact over their inventory levels over time. Thus, the study is explored few key drivers for proper inventory management in automobile spare parts industry which have to be overlooked and closely attained by the companies for their wellbeing and the survival of the industry at last.

### **1.4 Problem Statement**

When referring the Sri Lankan context; it is found that the growth of the automobile industry is getting vary over the years which cannot be predicted due to complexity of the business environment. Even though the government annual budget set some control over the price variation in the automobile industry; it is very rare to have stability across the industry. Thus, large no of small scale, medium scale and large scale enterprises who spread across the spare parts industry are severe affected by the inventory controlling issues which finally affect to the performance of the business set ups.

As per the industry records, many of spare parts providers are keeping lot of automobile spare parts in their stocks for sales. But they could not have enough information to sale out those individual parts in the right time. Therefore it was always

found that an excess amount of spares, more than necessary requirement in inventory. Since improper inventory controlling of large excess and shortages have been severely affected to the total industry by reducing the customer service level at large; this research is mainly focusing on to find out the factors which are influencing over inventory risk perception of automobile spare parts companies in Sri Lanka and finally provide the recommendation to mitigate such issues.

### **1.5 Objective of the study**

The objectives of the research are;

- (i) To examine the factors that influence the risk perception of inventory controlling in automobile spare parts companies in Sri Lanka.
- (ii) To recommend strategies for the automobile spare parts providers; which can acquire and adopt to enhance the inventory controlling of automobile spare parts in Sri Lankan context.

### **1.6 Scope of the research**

There are large numbers of automobile spare parts providing companies spread across the industry in Sri Lanka and they operate under small, medium and large scale business setups. Since, the industry is severely affected by the dynamics and trends in the local and global business environment; it is important to address inventory issues pertaining to all scale business set ups in Sri Lanka. But, since the population of the study which is the total no of automobile spare parts providers are quite a high number; the scope of the study has been narrowed down to 37 most resilient companies who operates in Gampaha and Colombo Districts. Thus, based on the selected sample, main drivers for proper inventory controlling have been analyzed and finally draw the conclusion for the population of the study as well.

### **1.7 Limitation of the study**

- \* Insufficient of time framework.
- \* The information, which was needed, could not be made public by the organization.
- \* The scope of the study has been narrow down to the Sri Lankan leading automobile Industry only.
- \* There are limited resources and literatures were available on this research area which made difficulty in getting aid for the research reference.

## **1.8 Chapter breakdown**

This thesis consists of five main chapters in order to achieve the ultimate objective of the research.

**Chapter 1** gives an overview about the background of the study area with the brief introduction to automobile spare parts industry in Sri Lanka. The need for the research, research problem and objectives are identified. Scope and the limitations of the research are focused. Through the chapter 1, reader will understand the basic idea of the research and the importance of the research.

**Chapter 2** was structured to establish the theoretical framework for the research and identify the suitable inventory management system. This chapter is the basis for identifying the analyzing method and the methodology. This consist the previous literature reviews and their findings with relevance to this research.

**Chapter 3** explains the methodology used to reach the research findings. This will explain the research design, data gathering methods used population, sample design and the analysis method. A comprehensive idea about designing of the questionnaires can be gained after reading this chapter and the analysis methods has been explained in detail.

**Chapter 4** was structured to present research findings. Basically it includes descriptive analysis of the influencing factors of automobile trade relates to spare parts providers.

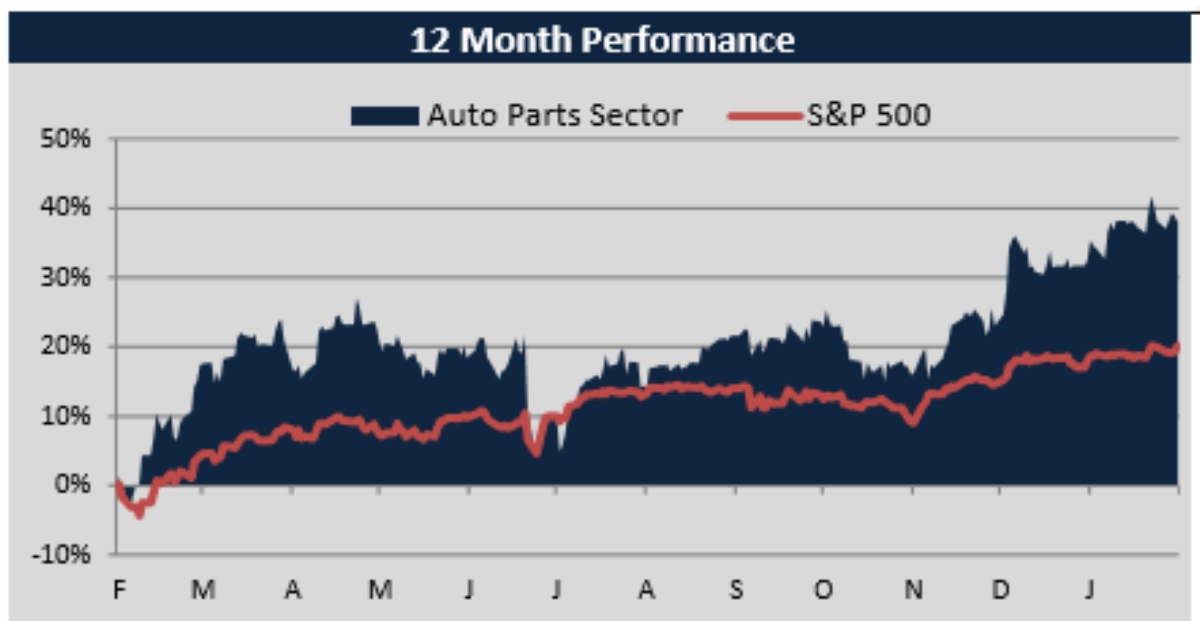
**Chapter 5** was structured for the conclusion and future research directions. It consist summary of research findings, recommendations, research limitations and future research directions.

## CHAPTER TWO - LITERATURE REVIEW

### 2.1 Overlook of the Automobile parts industry in the world

With the growing trends of the automobile industry in the globe, it is very much important to have proper design and operation of the spare parts management system as to cater for the increasing customer expectations. Thus, many researchers have been studied on the market weight position of the auto parts and equipment manufacturing companies by referring the industry statistics of different markets and demand drivers arise from the environmental dynamics. According to the comprehensive study carried out by Anand (2017); automobile spare parts industry is highly induced by the demand fluctuations of the automobile industry which is further illustrated based on the behavior of the US automobile market as follows.

Figure 02: 2016-2017 Industry behavior of the Automobile industry in United States



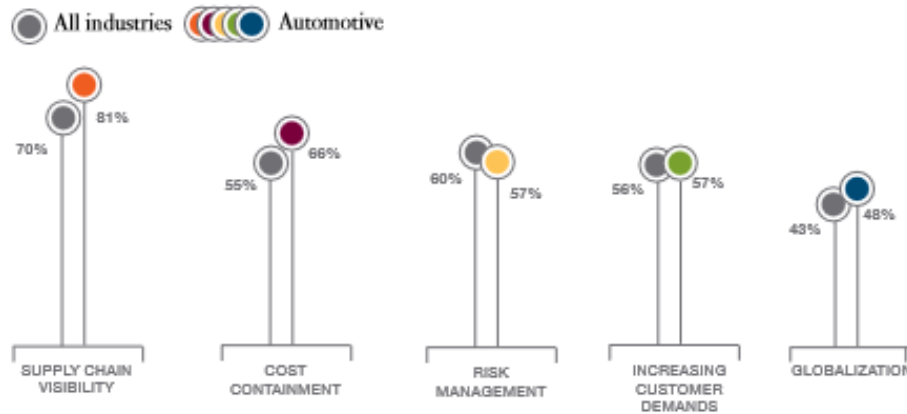
*Source: Factset (2017)*

According to the above; US automobile market has been recorded some ups and down mainly due to the unfavorable interest rates, political and economic risks of the country and NAFTA changes which highly impact over the performances of the spare parts manufacturing companies in the world. The report published by IBM corporation (2009); the possibility of establishing a smarter supply chain for the automobile companies has been properly analyzed with the industrial issues and following five



factors have been identified as the major challengers for the automotive supply chain which hinder the performance of its inventory control as well.

Figure 03: The top five challenges for the Automobile Supply chain



*Source: IBM Corporation (2009)*

As per above, supply chain visibility and cost containment are the major issues in automobile industry and they have proposed 03 concepts of instrumented, interconnected and intelligent which have to be embedded in a smarter supply chain which set off major issues in the automobile industry. Thus, with this positive outlook, it can be predicted that number of inventory controlling issues may also be reduced by smoothing its total in and outflows through smarter supply chains.

## 2.2 Inventory Management

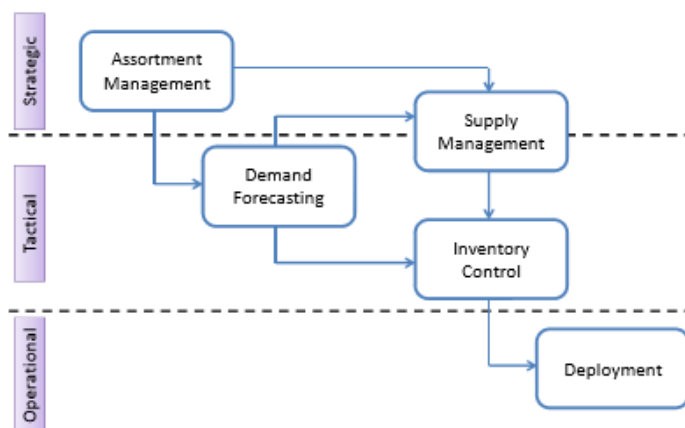
When referring the number of literatures available on “Inventory Management Concept”; many researchers have been discussed on the issues which are involved in inventory controlling and stores of the companies. Ravichandran (2014); has been carried out an extensive study on the inventory management of the leading automobile industry with special reference to the inventory management of Ashok Leyland Ltd. It included the complete study to conduct Ratio Analysis, ABC and VED Analysis for inventory.

Furthermore, the research deals about the entire activities of purchase and stores department to suggest the suitable technique to the company to have improved control over the inventory. It was found that in the firm’s master data was not maintained properly on SAP which was the major reason behind the unmatched sets of parts and

excess buying of materials. Also it was found that due to this the production process was affected in the company. It was suggested that the management of the plant should incorporate Total Quality Management, particularly in all departments of production to ensure better sales and reduce the inventory of finished products. While ABC Analysis has shown that the management must have more control on C items than that on A & B items, because C class constitutes more of higher in numbers. This is done through maintaining low safety stock levels, continuous check on schedules & ordered frequently in inventories, in order to avoid over investment of working capital.

Most importantly, Geertjes (2014) has comprehensively studied on the automated spare parts planning systems and newly proposed a framework for decision making of the management in inventory controlling which been derived from the study carried out by Driessen et al. (2013).

Figure 04: Decision making framework for inventory controlling of Automobile Spare parts



**Source: Adapted Framework of Driessen et al. (2013)**

Generally, supply lead times and demand forecasts serve as input data for inventory control. As per above, Strategic, Tactical and Operational decisions have to be made on different time periods such as on a strategic level, decisions are regularly taken less frequently, decisions on a tactical level are made more frequently and in operational decisions are made frequently. Based on that, it is recommended that major concepts of inventory replenishment such as Rounded quantities, Low and High unit value, High variability of demand, Low frequency of demand, Long lead time, , Maximum order quantities and so on can be effectively addressed by the high management involvement in inventory controlling of automobile industry.

Ueda (1984) explained some of the application systems, mainly the production control systems in the assembly plant, and the background against which those systems were introduced. The article will hopefully facilitate understanding of the computer control systems themselves, as well as how we, the company adopted them. As an example of how the computer is used in the Japanese automobile industry. The Introduction gives a profile of Nissan, followed by a brief explanation for the economics and history that caused the rapid pace of computerization in Japan. A general outline of the systems and their use at an assembly plant is described. Process control and some future prospects in this field are also discussed.

Bacchetti & Saccani (2011) investigated the gap between research and practice in spare parts management, with specific reference to durable goods addressed to private or professional customers. The paper provides a critical literature review of theoretical contributions about spare parts classification and demand forecasting for stock control. The discussion of ten case studies, then, allows analyzing the reasons for this gap, by addressing the limitations of models developed in literature, the role of contextual factors and the maturity in companies' spare parts management practices. Four main directions for research are proposed in order to bridge the gap, namely to develop integrated approaches to spare parts management to define contingency-based managerial guidelines, to favor the knowledge accumulation process in companies, and to supplement theoretical models with practical relevance.

### **2.2.1 Maintenance cost & effective planning of inventory**

Gua (2014) ; has highlighted the maintenance cost and effective planning of inventory in Airline industry. In airline industries, the aircraft maintenance cost takes up about 13% of the total operating cost. It can be reduced by a good planning. Spare parts inventories exist to serve the maintenance planning. Compared with commonly used reorder point system (ROP) and forecasting methods which only consider historical data, this paper presents two non-linear programming models which predict impending demands based on installed parts failure distribution. The optimal order time and order quantity can be found by minimizing total cost. The first basic mathematical model assumes shortage period starts from mean time to failure (MTTF). An iteration method and GAMS are used to solve this model. The second improved mathematical model

takes into account accurate shortage time. Due to its complexity, only GAMS is applied in solution methodology

Ekstrand (2012) has been summarized number of parameters affecting to the effective controlling of the inventory. At manufacturing companies the inventory is a buffer to handle demand fluctuation, high component variety, low forecast precision and other uncertainties. At the same time the inventory generates tied-up capital, which is an incentive to strive towards a lower inventory. Within the organization the trade-offs must be balanced in order to find a compromise between cost drivers and efficient solutions. The approach used to identify what parameters affecting this balance, was a case study conducted at Volvo Cars. Through empirical and literature studies a framework for expected inventory behavior and parameter categorization was developed. The parameters were categorized under suitable business units within the framework. Besides the parameters the strategic effects of the production and inventory strategies are also discussed since these decisions strongly affect how the inventory behaves. From a management perspective the responsibilities must be clearly defined for each part of the inventory, i.e. safety stock, cycle stock and in-transit material to handle the inventory efficiently. The idea behind this is to create a holistic view to minimize sub-optimization. From the complexity at the case company concerning the inventory management, challenging improvement areas was identified. These were connected to the theoretical framework and general conclusions were drawn. Concrete recommendations to improve the present situation for the case company are also presented in the report. The primary outcome from the thesis is suggestions for standardized working methods concerning the inventory management. In a long-term perspective a uniform safety stock calculation, categorization of the components and adequate KPIs should be used.

Saranga (2015) has carried out a research using a sample data of 58 firms consisting of automakers and auto component suppliers across a 14-year period, as to study the factors contributing to efficient inventory management in the Indian automotive Industry. He use fixed effects regression models to document trends in inventory holdings over time and how this varies across inventory types and across tiers in the supply chain. Results show that inventory holdings have declined differentially across tiers and across different types of inventories. They found tier-1 suppliers reduced all

components of their inventories with the help of TQM and lean efforts. This study is relative to my research.

Hellingrath et al, (2015) has carried out a study on an effective and efficient maintenance for achieving competitive advantage in today's more and more complex manufacturing systems. Breakdowns and system failures caused by insufficient maintenance can have huge effects and economic impact. Therefore, it is necessary to accurately and precisely forecast maintenance needs in advance in order to avoid unforeseen system failures by ensuring the availability of spare parts and maintenance personnel at the required location and time while operating at reasonable costs. This paper presents a solution that aims at improving the effectiveness and efficiency of managing spare parts supply chains (SPSC) for complex manufacturing systems. It is grounded on the idea of integrating information being provided by Intelligent Maintenance Systems (IMS) into improved forecasting, planning and coordination methods as well as processes in the SPSC. The various components of the solution as well as their interactions are explained.

Regoa et al, (2011), generally highlighted, spare parts inventory are needed for maintenance and repair of final products, vehicles, industrial machines and equipment, frequently requiring high investments and significantly affecting customer satisfaction. Inventory management is complex due to the large number of different items and low demands. This article presents a literature review on single location spare parts inventory control, embracing both demand forecasting techniques and inventory control decisions on the different life cycle stages. Overall, the literature review identified the following research opportunities on inventory management: criteria to decide to stock or not an item, how much to order in the first and the last batch, demand forecasting and inventory control models integration and case studies on real applications.

### **2.2.2 Spare-part logistics and operations planning**

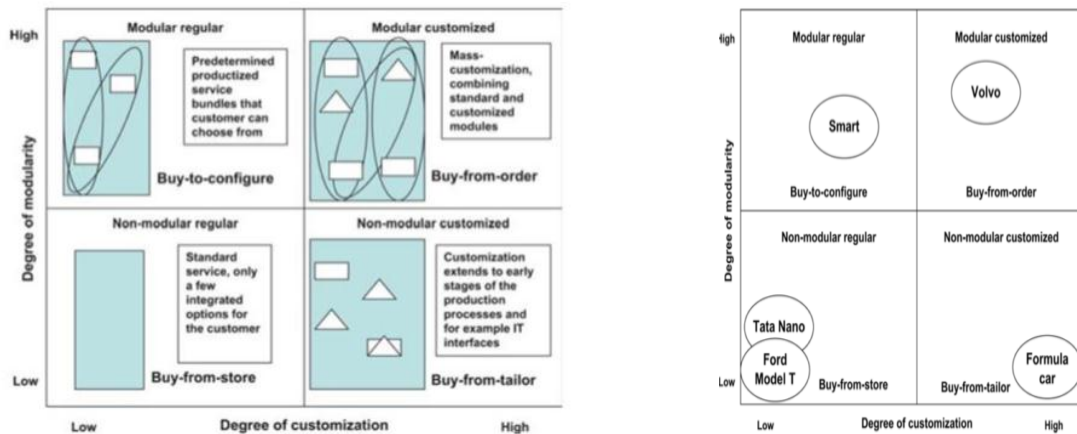
As per Ukenwe et al. (2012); spare parts company faces three major demands mainly from; transport company, maintenance section as well as thirdly from the external customers who wish to use for their personal use. Thus, spare parts planning and logistical controlling have been identified as one of the top urgent and top priority task of the company which has to be properly controlled within the limited time frame when the demand arise from the above stated scenarios.

With the unpredictable changes exist in the automobile industry; it has been explored by many researches that spare parts logistics and an operation planning is very much critical for an effective controlling of the inventories at the companies. According to the Zanjani (2014), there are several problem of coordinating spare-part logistics and operations planning for third- party maintenance providers. Due to the multi-indenture structure of the equipment, different types of components might randomly fail to perform at different points of time. The spare part logistics literature has been focused on spare part inventory management in an in-house maintenance context. In this article, a mathematical programming model is first developed to formulate the problem in the context of a third-party maintenance provider who is faced with strict due dates for the delivery of repaired equipment. The model seeks the optimal number of maintenance jobs that can be completed to deliver at each period, as well as the order quantity of spare parts so as to minimize the procurement, inventory, and equipment late delivery costs, while taking into account the spare part supply lead-time. Next, we model the spare part demand uncertainty as a non-stationary stochastic process in each period in the planning horizon. The deterministic model is then reformulated as a multi-stage stochastic program with recourse. We also discuss the complexity of the stochastic model and propose a preprocessing approach to reduce its size for large instances. Numerical results demonstrate how the proposed model links the spare part logistics and equipment delivery decisions under spare part demand uncertainty.

### ***Combining modularity and customization in service offerings***

Ruha (2012) has been explored the following framework based on the study of Bask et al. (2011); and according to that; four categories of “non-modular regular”, “modular regular”, “modular customized” and “non-modular customized are highly influence over the delivery time of a product or service. When referring the automobile industry, when a vehicle is more customized; it takes time to deliver to the customers in which the inventory controlling of the automobile spare parts also have to be adjusted with these two parameters.

Figure 05: Framework of customized in service offerings

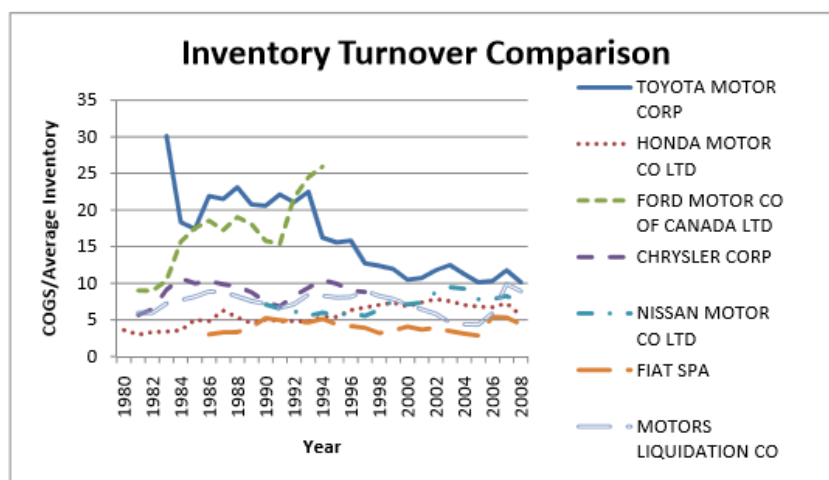


Source: (Bask et al. 2011)

### 2.2.3 Minimization of the total supply chain cost

Inventory cost has been identified as one of the main cost component in any supply chain as it determine the firm performance in terms of the profitability as well. Thus, proper inventory controlling will be the main concern of the shareholders, investors, business owners as large costs can be hidden in inventories which reduce profit share in to the greatest extend. As per with that; Gorkan (2010) has been analyses the trends in inventory management of automobile manufacturing companies and revealed that firms that have lean inventories in the automotive manufacturing industry can be better positioned to with stand the withstand economic pressures than non-lean firms and it has been illustrates as follows.

Figure 06: Inventory Turnover comparison for large automotive manufacturing firms.



Source: Gorkan (2010)

As per Barnabas (2015) research; it has determined the optimal allocation of spares for replacement of defective parts on-board of a usage. The minimization of the total supply chain cost can only be achieved when optimization of the base stock level is carried out at each member of the supply chain. A serious issue in the implementation of the same is that the excess stock level and shortage level is not static for every period. This has been achieved by using some forecasting and optimization techniques. Optimal inventory control is one of the significant tasks in supply chain management. The optimal inventory control methodologies intend to reduce the supply chain cost by controlling the inventory in an effective manner, such that, the supply chain members will not be affected by surplus as well as shortage of inventory. They focus specifically on determining the most probable excess stock level and shortage level required for inventory optimization in the supply chain so that the total supply chain cost is minimized. Therefore the overall aim of this article is to find out the healthy stock level by means of that safety stock is maintained throughout the service period.

#### **2.2.4 Spare parts ordering & planning process**

Panagiotidou (2013) has studied on the joint maintenance and spare parts ordering problem for more than one identical operating items. The operating items may suffer two types of silent failures: a minor failure, which results in item malfunctioning, and a major failure, which renders the item completely out-of-function. Inspections are periodically held to detect any failures and the inspected items are preventively maintained, repaired or replaced according to their condition. Two ordering policies are investigated to supply the necessary spare parts: a periodic review and a continuous review policy. The expected total maintenance and inventory cost per time unit is derived and the proposed models are optimized for real case data. In addition, the sensitivity of the proposed models is studied through numerical examples and the effect of some key problem characteristics on the optimal decisions is discussed.

The research carried out by the Regattieria (2005) deals with effective forecasting methods for typically lumpy demand for aircraft spare parts, and analyzes the behavior of forecasting techniques when dealing with lumpy demand. Twenty forecasting techniques are considered and tested and historical data from Alitalia are used to analyze and compare their performance. The results demonstrate that item lumpiness is the dominant parameter and show that demand forecasting for lumpy items is a



complex problem; results from previous studies are not very accurate. The best approaches are found to be weighted moving averages, the Croston method, and exponentially weighted moving average models.

The paper article of Bacchetti (2010) has discussed on hierarchical multi-criteria spare parts classification method for inventory management purposes and tested through an intensive case study in an Italian household appliances manufacturing company. In particular, the classification scheme under concern is built on the basis of several key dimensions in an almost hierarchical fashion, resulting in 12 different classes of spare parts, for which varying forecasting and inventory methods are proposed and tested. The results of our simulation study demonstrate the reduction of the total logistics costs by about 20% whilst the service target level is achieved for each of the classes. Even more importantly, the proposed approach is simple and straightforward enough to be understood by company managers, thus increasing the probability of its adoption (in the same or similar form) in other real world settings.

Wanga et al, (2011) has mentioned that demand for spare parts is typically intermittent and forecasting the relevant requirements constitutes a very challenging exercise. Why is the demand for spare parts intermittent and how can we use models developed in maintenance research to forecast such demand? They attempt to answer these questions; they present a novel idea to forecast demand that relies upon the very sources of the demand generation process and they compare it with a well-known time-series method. They conclude that maintenance driven models are associated with a better performance under certain conditions. Also outline an inter-disciplinary agenda for further research in this area.

Kocaga (2004) has studied the spare parts service system of a major semiconductor equipment manufacturer facing two kinds of orders of different criticality. The more critical down orders need to be supplied immediately, whereas the less critical maintenance orders allow a given demand lead time to be fulfilled. For this system, they propose a policy that rations the maintenance orders. Under a one-for-one replenishment policy with backordering and for Poisson demand arrivals for both classes, they first derive expressions for the service levels of both classes and then conduct a computational study to illustrate superior system performance compared to a system without rationing. Also conduct a case study with 64 representative parts and

show that significant savings are possible through incorporation of demand lead times and rationing.

Li and Kuo (2008) have developed an enhanced fuzzy neural network (EFNN) based decision support system for managing automobile spares inventory in a central warehouse. In this system, the EFNN is utilized for forecasting the demand for spare parts. However, without considering relevant domain knowledge, traditional neural networks are found to be suffered from the problem of low accuracy of forecasting unseen examples. Therefore, in his EFNN, the following improvement is made: First, it assigns connection weights based on the fuzzy analytic hierarchy process (AHP) method without painstakingly turning them. Second, by generating and refining activation functions according to genetic algorithm, EFNN can provide comprehensive and accurate activation functions and fit a wider range of nonlinear models. Last, but not least, an adaptive input variable is introduced to decrease the impact of the bullwhip effect on the forecasting accuracy. The proposed system is evaluated with the real word data and experimental results indicate that our EFNN outperforms other five models in fill rate and stock cost measures.

### **2.2.5 Relationship between inventory management and uncertain demand for other industry**

Uncertainty of the demand is becoming a major cause for issues in inventory controlling of many business setups where the Gu et al. (2015) has been analyzed on the spare parts inventory controlling of aircraft and suggested that manufacturer's manual and maintenance activities are the key drivers for demand prediction.

Research paper which has been carried out by Nemtajela & Mbohwa (2017); it has addressed the relationship between inventory management and uncertain demand for other industry. It also assesses the effects of uncertain demand on inventory management in the fast moving consumer goods (FMCG). Inventory management should be given attention it deserves in order for the business to stay competitive, flexible for the demand and at low cost. Inventories are difficult to manage and control, and inventory managers find it challenging to know when to order and how much to order. The research was descriptive in nature and was conducted through the use of quantitative research methods. A survey questionnaire was used to collect primary data from five FMCG organization's in the manufacturing industry around Johannesburg.

According to the findings, significant relationship between inventory management and uncertain demand exists. The findings imply that poor inventory management will result in demands not being satisfied, organizations' will either have too much or too little on hand, and this will result to the organizations' failure.

### **2.3 Chapter Summery**

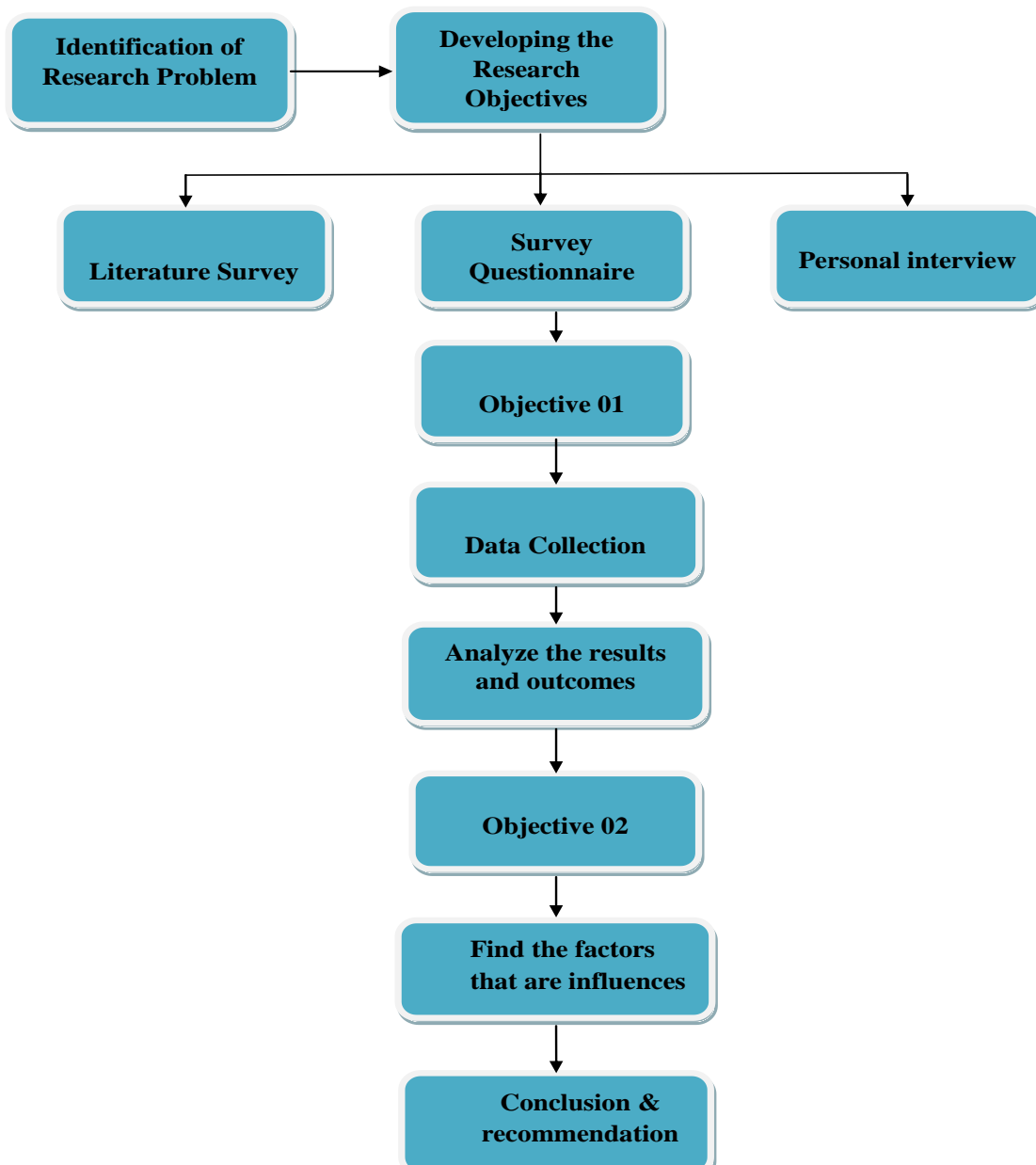
According to the literature review, it is clear that the topic has been attractive and requirement for a proper analysis of the Sri Lankan market. Therefore it is important to do a proper research on find the factors which are influencing inventory risk perception of automobile spare parts providers in Sri Lanka.

## CHAPTER THREE - RESEARCH METHODOLOGY

### 3.1 Research Framework

This chapter basically explains about the methodological approach used in the research which is implemented throughout the research. The methodology was developed based on studying of related literature surveys, and also information gathered through questionnaires and personal interview. Methodology was developed with the intention of achieving two objectives which were mentioned in Chapter 1.

Figure 07: Research Framework



After finalizing the research question, its objectives were identified. In order to minimize the non-responsive errors, it is decided to send the mail that included online questionnaire to all most all the companies within the population. To facilitate the research, literature survey, structured mail questionnaire surveys and personal interviews were conducted as main data gathering tools.

Questionnaire survey was conducted to identify prominent criteria in order to identify Factors influencing inventory risk and to calculate criteria. By using SPSS statistical tool and data were analyzed.

### **3.2 Research Design**

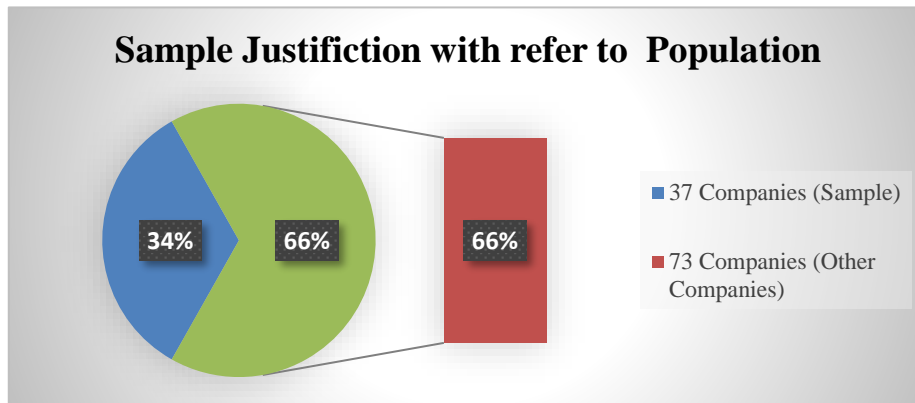
Research design may reflect the entire research process, from conceptualizing a problem to the literature review, research questions, methods, and conclusions, whereas in another study, research design refers only to the methodology of a study (e.g., data collection and analysis). This research is basically focused on inventory risk for automobile industry, Sri Lanka. It was designed in such a way where at the end of the analysis, all the mentioned objectives are achieved. In order to address research problem, research objectives were developed according to the research problem statement. Research design concerns make sure that the questionnaire design addresses the needs of the research.

### **3.3 Sample of the Survey- Justification**

As expressed by Saunders, et al. (2009), sampling is done due to several reasons and they are; when it is not possible to survey the entire population, when the budget and time of the research is limited the capacity of surveying the entire population and when the research required to be provided quick results.

Considering the fact, the sample of the study mainly comprised with 37 most resilient automobile spare parts companies who have stratified selected inside Colombo and Gampaha Districts. In order to rationalize and justify the sample, the sample has been selected by covering up of all demographic factors of population in which organization scale, no of employment and company ownership are justified with the population parameters.

Figure 08: Sample Size of the Survey



With reference to the most accepted online search drive for automotive spare parts provider in Sri Lanka; Lanka Auto parts: has explored that there are about 3000-4000 sellers are spread across Sri Lanka ranging from large to small scales in dealing automobile spare parts and accessories. But, when assessing the true capacity of the each spare parts providers; it is explored that there are less than 500 spare parts providers are competitive enough to stand with their own business ( directly engage in the international SC) without relying on the local dealer channels. By considering this, it has been selected only 37 automobile parts providers out of the 110 of the most complete companies in Colombo and Gampaha District which indemnified more than 30% from the total population.

### 3.4 Preliminary study

Since the study aims at exploring the most prominent decision criteria's when deciding the inventory level of the Automobile industry, it has been decided to carry out the preliminary study as an overlook for the study. As per with that, unstructured discussions (friendly discussions) were arranged with 15 managerial level employees who work across the supply chain of automobile industry in Sri Lanka as to inquire on the major issues which takes place messes in the inventory controlling of Automobile industry. During these discussions it was explored that issues in inventory controlling processes, unpredictable demand in the industry (stock variations), lack of supportive services in supply chain linkages, logistical issue and so on are the main reasons for creating issues in the inventory controlling of the Automobile industry. Furthermore, since automobile industry is highly rely on the international supply chain from its

manufacturing until receiving the parts to Sri Lanka through international transport network ( sea/ air); inventory controlling issues are highly rely on these aspects too.

### 3.5 Data collection

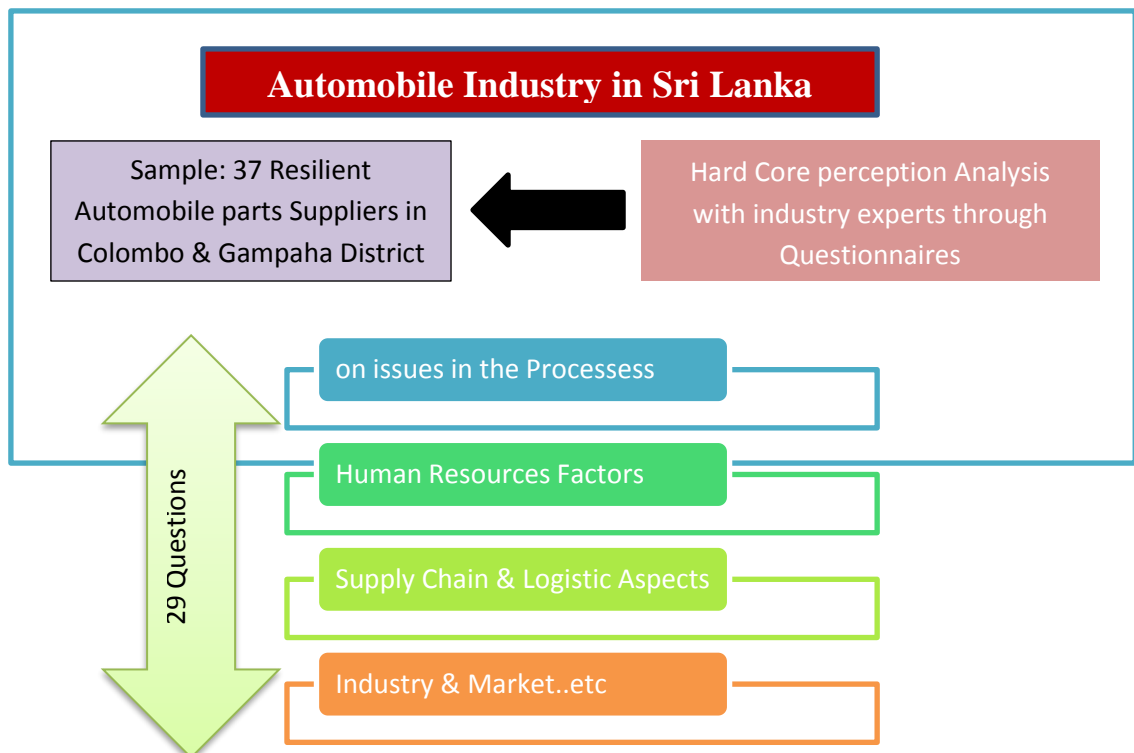
In the study, it has been identified that number of data collection approaches would need to be used in order to provide comprehensive understanding of the factors affecting to the inventory risk perception of automobile spare parts in Sri Lanka. Thus, following methods have been basically used in the study as to get the true perception of the industry professionals with regards to the issues related to the inventory controlling of the automobile spare parts dealers in Sri Lanka.

### 3.6 Collection of Primary data

#### 3.6.1 Questionnaires

According to Burns (2000) “a well-planned and carefully constructed questionnaire will increase the response rate and will also greatly facilitate the summarization and analysis of the collected data” Thus, the Questionnaire for the survey has prepared by using the information collected from the literature survey, and appropriately adapt to address the factors influencing the inventory controlling of the Automobile industry in Sri Lanka mainly based on the following framework which gives a greater insight to the research.

Figure 09: Questionnaire Framework



### **3.6.2 Questionnaire Framework**

As per with above, primary data is gathered through publication of structured self-administered questionnaire with industry experts which have highly developed by addressing the key aspects of the inventory controlling of the Automobile parts in Sri Lanka .It is been contained with 29 questions and Purposive sampling method is used to select the required fraction from the population. The questionnaire only takes less than 10 minutes to complete which still it provided a comprehensive overlook to identify the issues in the industry.

### **3.7 The Interviews**

Since the study requires to assess the true risk perception of the inventory controlling of the automobile spare part providers; the interviews also carried out with automobile spare parts provider's network with parallel to the questionnaire feedback. Furthermore, several interviews were arranged with the company professionals including managers, executives as well as the key frontline hands-on operational staff in spare part companies in order to get an overall picture of the inventory controlling issues which make uniqueness to the organization.

These interviews were generated an additional data and also opinions from all parties regarding the inherent issues to the company process, people, industry and product as well.

### **3.8 Collection of Secondary Data**

Secondary data is the data that have been already collected for some other purpose and can be used in analyzing which comprise with raw data or published data (Saunders, et al., 2009). To gain a general understanding prior to the research and also about the general practices and trends of the inventory controlling in automobile industry in the globe, secondary data was collected.

Accordingly, secondary data collected from appropriate reports, websites and internet articles with the view to find out the main drivers for arising the inventory controlling issues in the automobile industry in Sri Lanka.



### 3.9 Data Analysis and Consolidation

Based on these primary and secondary data collected in the study, all the information has been analyzed in line with the objectives of the study. Thus, both qualitative as well as quantitative analysis have been carried out in the study to derive the factors which mainly influence over the issues of the inventory controlling in automobile industry in Sri Lanka and for the proposing the recommendations to improve its risk perception of inventory controlling which will be benefiting number of automobile spare parts providing organizations in Sri Lanka.

#### 3.9.1 Qualitative Analysis

Questionnaires were provided with the solid information to identify the main issues and current practices associated with the inventory controlling of Automobile spare parts providing companies in Sri Lanka. So prioritization method like percentage graphs and table, have been used in the study in order to clearly understanding on the inventory controlling process, HR practices, Supply chain and logistics integration and so on which gives a clear indication on to identify the severity of main issues involve in the inventory controlling of the Automobile spare parts providers in Sri Lanka.

#### 3.9.2 Quantitative Analysis

Furthermore; the study is addressing on identifying the main drives for the inventory controlling issues in Automobile spare parts providers in Sri Lanka Thus, the quantitative data has used to get attitudinal rating based on the level of significance for each of the key issues identified for the inventory controlling in the questionnaires.

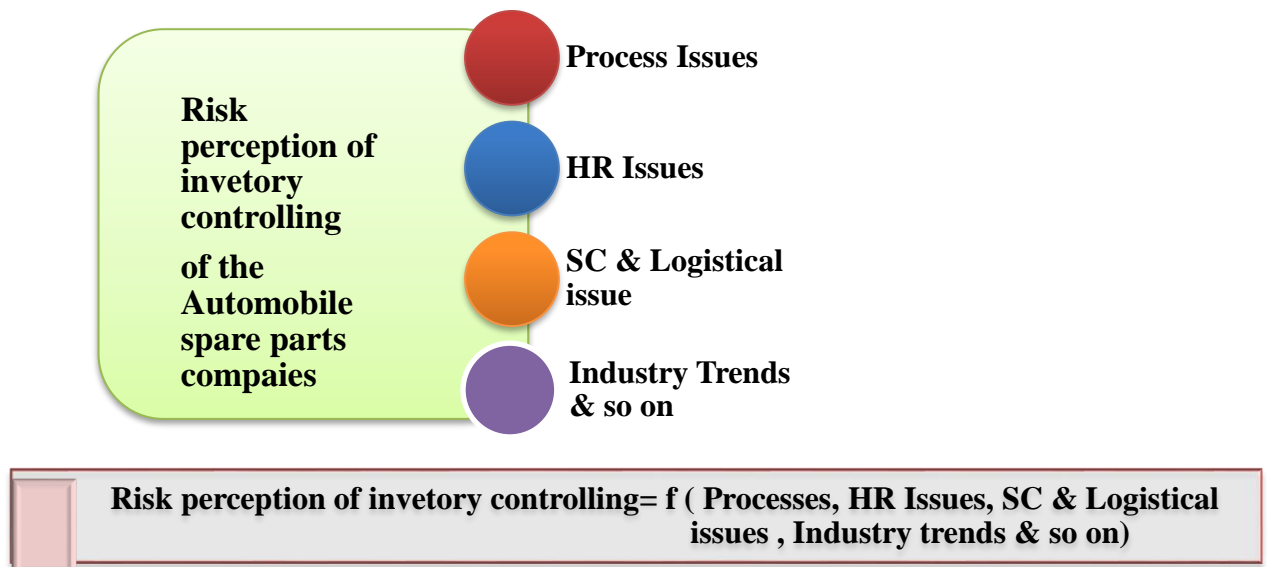
Table 04: Likert Scale

Scale	Weight age
Strongly Agree	5
Agree	4
Neither agree nor Disagree	3
Disagree	2
Strongly Disagree	1

As based on the above ratings; it has been given a qualitative measurement for the results which have derived from the Questionnaire and explored the severity of the current issues exist in the inventory controlling of the Automobile spare parts providers in Sri Lanka.

Furthermore, identified each and individual problems relates to the inventory controlling have been categorized against common factors to propose a general methodology for minimizing the risk of inventory controlling of automobile spare parts. In order to calculate the joint impact of the common variables to the depended variable of risk perception of inventory controlling of the automobile spare parts; Data analysis has been done by using SPSS and tested for categorization of the variables.

Figure 10: Framework for Quantitative Analysis



### 3.9.3 KMO and Bartlett's Test

This is a value extracted which can define the sampling adequacy for each variable in the model and for the complete model. KMO Coefficient is generally varies in between 0 and 1 and interpreting the statistics as follows.

1.  $0.8 \leq \text{KMO value} < 1$  - Sampling is adequate
2.  $0.6 < \text{KMO value}$  - Sampling is moderately adequate
3. KMO value close to 0 - Widespread correlations

This has been employed as the major tool in interpreting data gathered to determine the adequacy of the sample in the study which gives the validity of the research.

## CHAPTER FOUR: DATA ANALYSIS & FINDINGS

As per the research references; it has revealed that the management and controlling of the automobile inventory constitutes a complex matter as it influenced by several critical factors which are mainly associated with the unpredictability of the environment in automobile spare parts industry. Since, forecasting demand appears as an essential element for the study; collected data from the 37 companies have given the high priority in the study to achieve the defined objectives of the study. Thus; based on the interpreted data which are gathered from the questionnaire; different analysis have undertaken to examine the main issues associated with the inventory controlling of the automobile spare parts industry in Sri Lanka. And also; comments made during qualitative interviews have been used where relevant to aid interpretation and to provide confirmation.

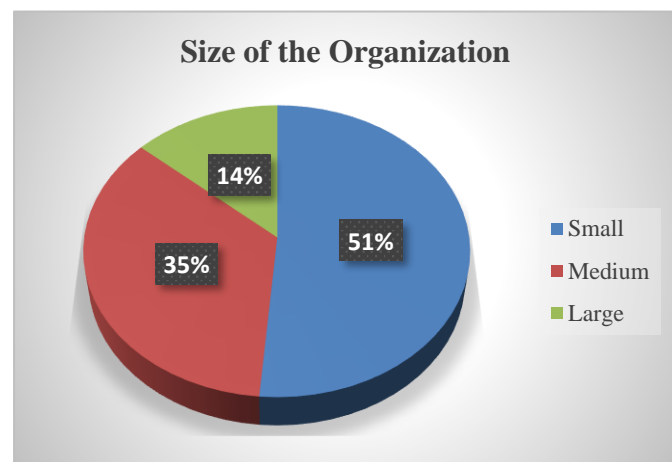
### 4.1 Questionnaire Analysis

#### 4.1.1 Sample Justification

When selecting the sample for the study; only 37 automobile spare parts providers have been selected who are mainly engaged in the inventory controlling of automobile spare parts companies in Colombo and Gampaha districts. Thus, in order to justify the sample from the total population; number of factors of the sample have been considered with population parameters as those factors are justified the sample to the population as follows.

Figure 11: Analysis of the Size of Organizations in the Sample

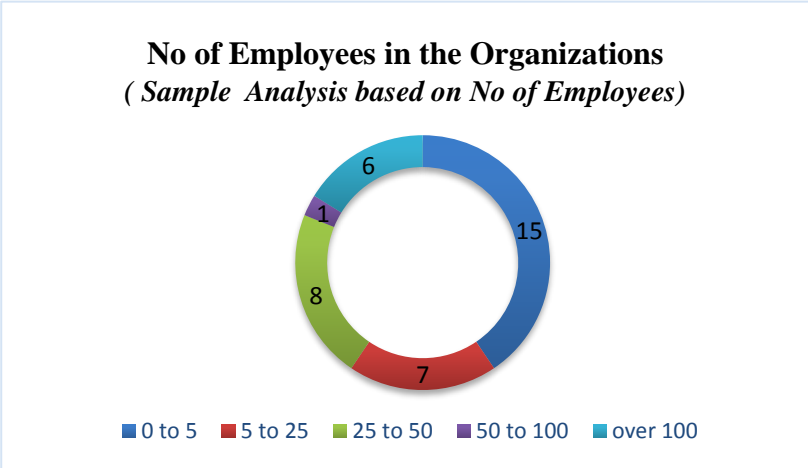
Variable	Frequency	Percentage
Small Scale	19	51%
Medium Scale	13	35%
Large Scale	5	14%



The above table indicates that majority ( 51%) of the organizations who included in the sample was small scale companies while 35% and 14% were the medium and large scale companies respectively. However the industry analysis prove that since sample included all scale business enterprises such as small scale, medium scale and large scale; the results analyzed from the sample can be directly applied to the population results.

Figure 12: Analysis of the No of Employees of the Organizations in the sample

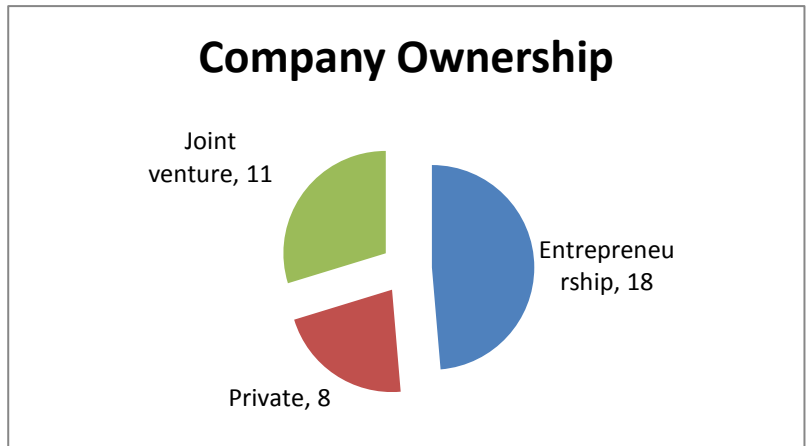
No of Employees	No of Organization
0 to 5	15
5 to 25	7
25 to 50	8
50 to 100	1
over 100	6
	<b>37</b>



When considering the no of employees in the organizations of the sample; majority was comprised with less than 05 no of employees (small scale companies) and same percentage of medium scale companies included 5-50 no of employees. Furthermore, the least majority was found for large scale companies with more than 50 no of employees. Thus, it proved that data gathered from the sample can be applied for all scale business enterprises in the population who engage in providing the spare parts of automobile industry in Sri Lanka.

Figure 13: Analysis of the Company Ownership of the Organizations in the sample

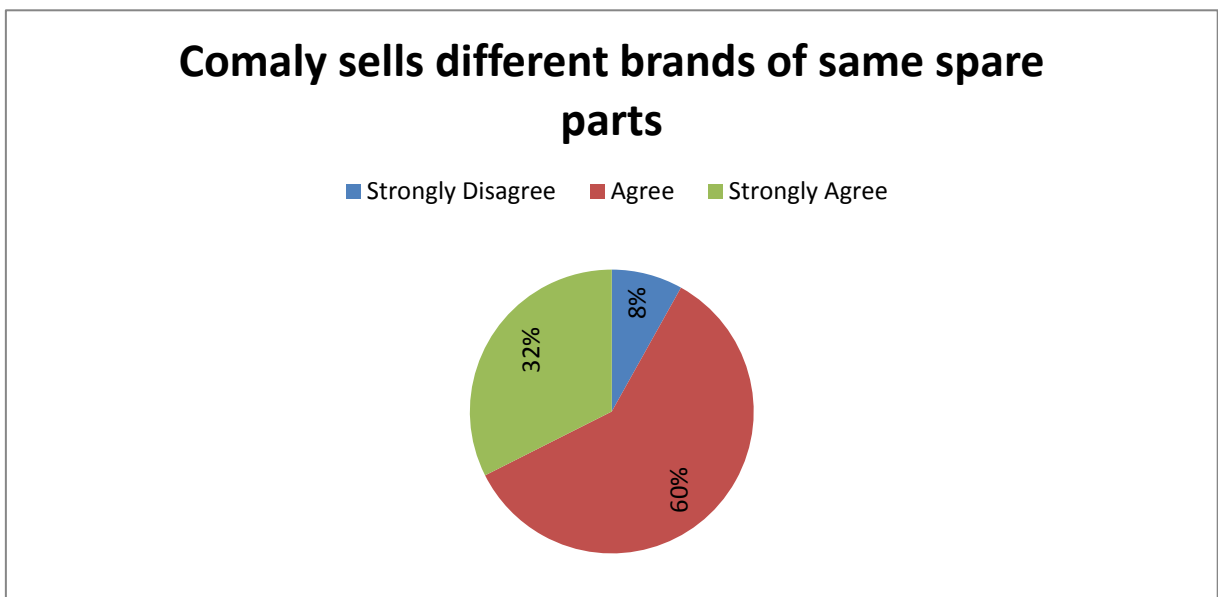
Company Ownership	No of companies
Entrepreneurship	18
Private	8
Joint venture	11
	37



The above table classified the responded companies based on their ownership. The majority of the companies fall under entrepreneurship which gives clear indication of having high degree of control over the spare parts inventories of their companies. And around 30% of the companies works as joint ventures as to gain the high market share with the most competitive and recognized suppliers in the globe. Thus, since the data sample comprised with the companies covering all types of business ownership models; the sample results can be generalized for the population.

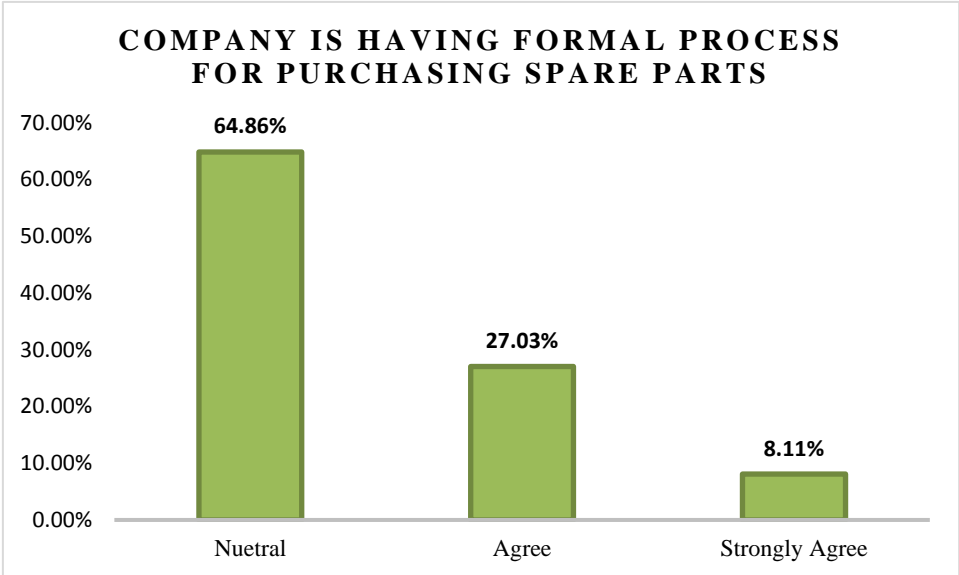
#### 4.1 Results Interpretation of the Questionnaire

Figure 14: My Company sells different kind of brands of the same spare parts. (Question 04)



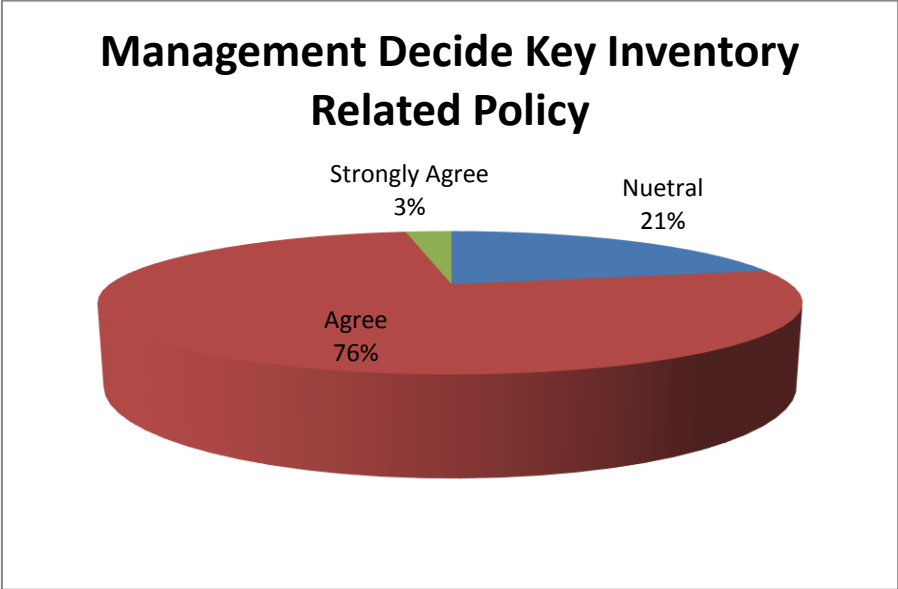
With the collected data of the research; it has been explored that majority of the companies sell different brands of the same spare parts which reduce the risk of not having proper inventories of all the brands of same product as the customer can go for substitution.

Figure 15: My Company has a formal process for purchasing spare parts (Question 05)



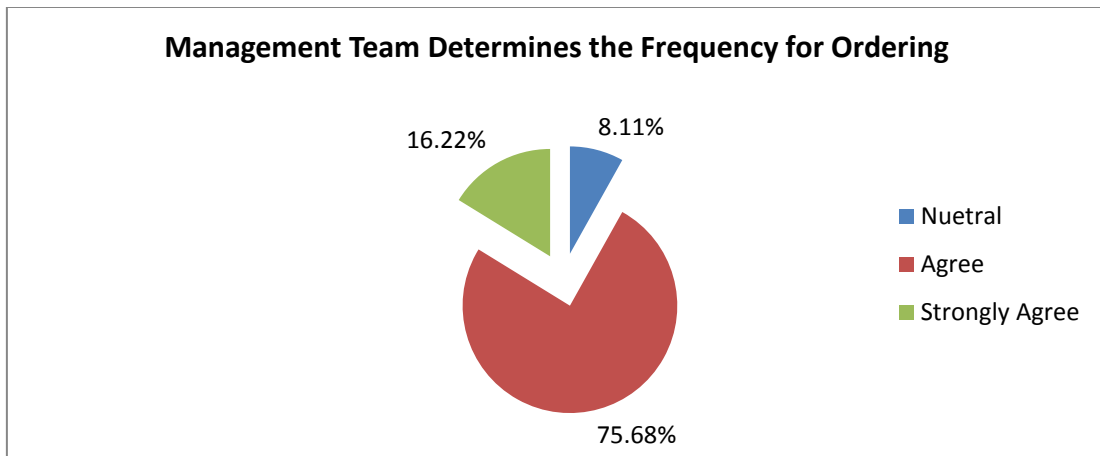
As per the above questionnaire details; it showed that more than 65% of the companies were neutral in the decision of having a formal process for purchasing spare parts from local and global markets which seems to be major cause for a rising inventories issues in Sri Lankan companies. According to the former transport minister (2014); Sri Lanka is manufacturing tyres, batteries, upholsteries and some rubber components for the auto industry in a small scale but the country has the ability and skills to produce various vehicle spare parts. As per with that, majority of the automobile spare parts providers have to be relied mainly on the international market to get the other automobile parts in which formal process has to be exercised to get the right inventory at right time in right quantity without making any unnecessary backlogs. Thus, above results revealed that failure of establishing a formal process for purchasing spare parts is one of the main issue in inventory controlling of automobile spare parts companies in Sri Lanka.

Figure 16: In my company, management team decides the key inventory-related policy such as striking the right balance between customer service and cost-effective product inventory levels. (Question 06)



Generally most of the global competitive automobile spare parts providers like Toyota; has put inventory controlling in to the first place in their operating strategy which the management greatly involving in inventory policy development by adequately managing movement and storage of the inventory. When this comes to Sri Lankan automobile spare parts companies; majority of the companies (more than 75%) have been accepted that management has to be created the inventory related policy which help to minimize performance disruption, promote efficiency, and reduce carrying cost of the spare parts inventories in to the greatest extend.

Figure 17: In my company, management team determines the frequency for ordering spare parts. (Question 07)



With regards to the responses received on the Question 07: it showed that more than 90% of the companies from the sample have been accepted that management team decide the frequency for ordering the spare parts for the company. Rigo and Mesquita (2011) have been explored on the most effective spare parts inventory controlling methods and stated that the criteria to decide to stock or not an item, how much to order and its frequency and so on always have to be accompanied with the management decision as spare parts managers always operate in a predictive or reactive position. Thus, above result indicates that, there is a high degree of management involvement in deciding the frequency of ordering of automobile spare parts in Sri Lanka, which reduce risk perception of inventory controlling in to some extent.

Figure 18: My Company appoints a separate employee to manage inventory and inventory surplus. (Question 08)

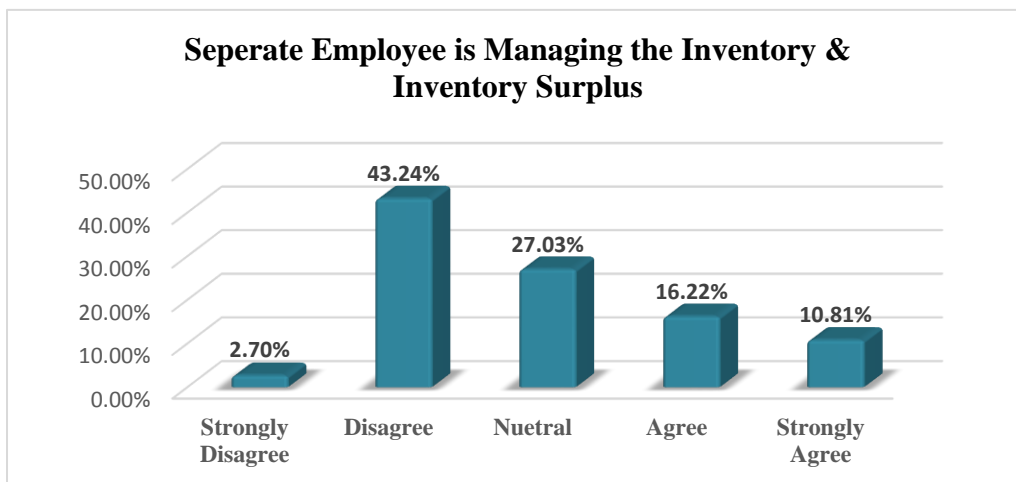
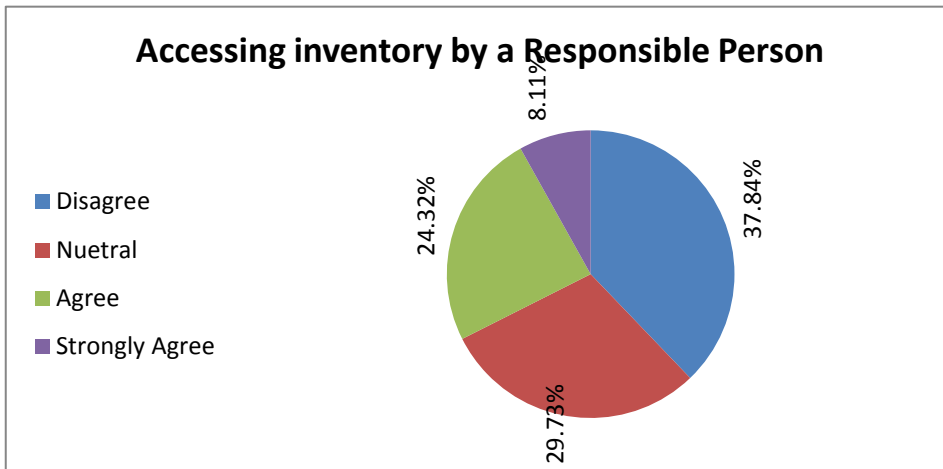


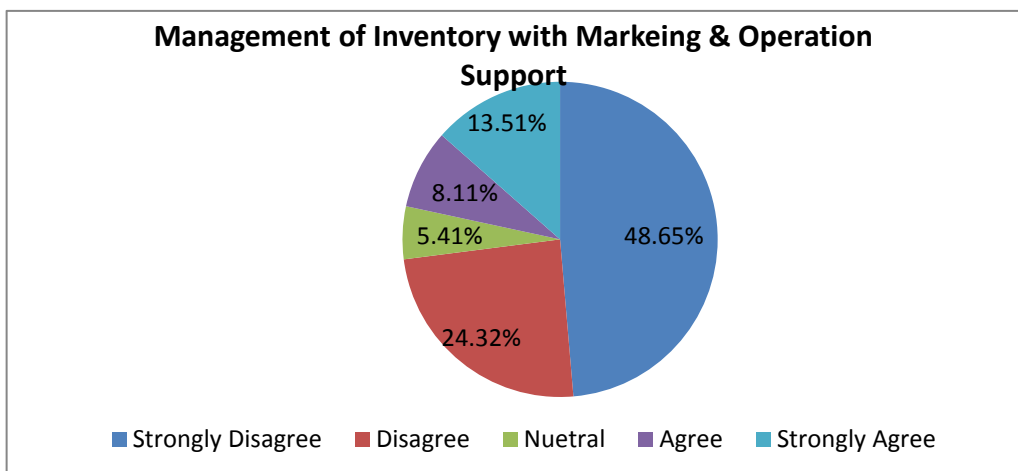


Figure 19: My Company has appointed a responsible person for accessing inventory, and who looks up inventory (Question 09)



When referring the nature of the automobile spare parts inventories; in fact it is unrealistic to stock large quantities of various parts. Since “critical auto parts” prioritize the inventory; recognition and controlling of those inventories required a separate employee to look after these multidimensional aspects of inventories as to ensure the risk of having inventory shortages and surpluses. Even it revealed as an essential for having a separate employee for managing inventory and its surplus; above results ( Questions 08 & 09) showed that around 30% of the respondents are practicing this while other are not. Thus, this would leads to have several issues in controlling of automobile spare parts inventories in Sri Lanka.

Figure 20: My Company gets support from the marketing & operational team for managing inventory (Question 10)



According to the IBM reports (2011); Inventory controlling of the Automobile spare parts industry is found very complex due to the sophisticated demand variations, variable cost structure and the integration failure with global and local suppliers. Thus, demand predictions and markets analysis of the marketing team always has to be coordinated and forwarded to the operation team as to ensure the right mix of vehicles and products on the roads at last. But, in Sri Lankan case, most of the companies in the sample are not agreeing on that which generate severe inventory issues in Sri Lanka automobile spare parts industry by creating severe variations in demand and supply of automobile spare parts.

Figure 21: My Company uses an effective method to calculate the stock level (Question 11)

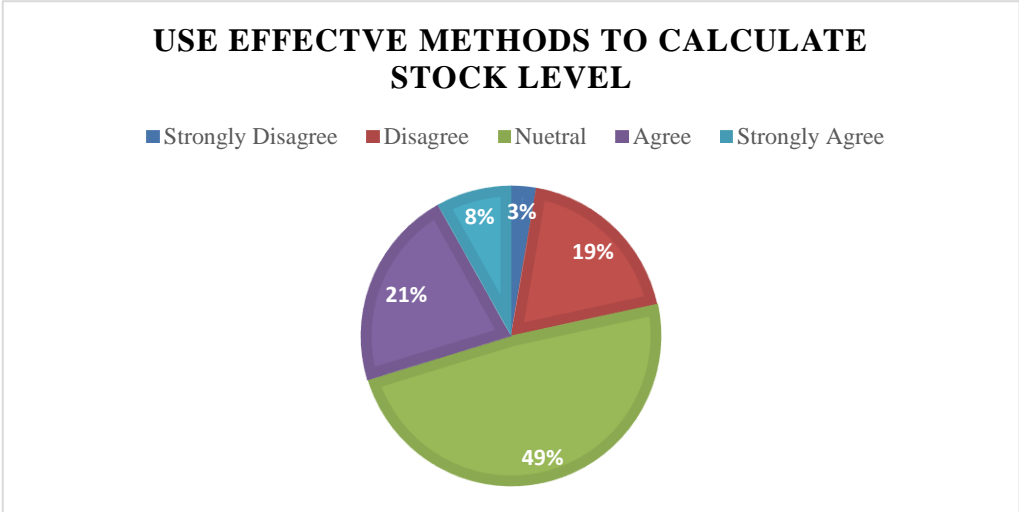


Figure 22: My company frequently carry out inventory counts (Question 12)

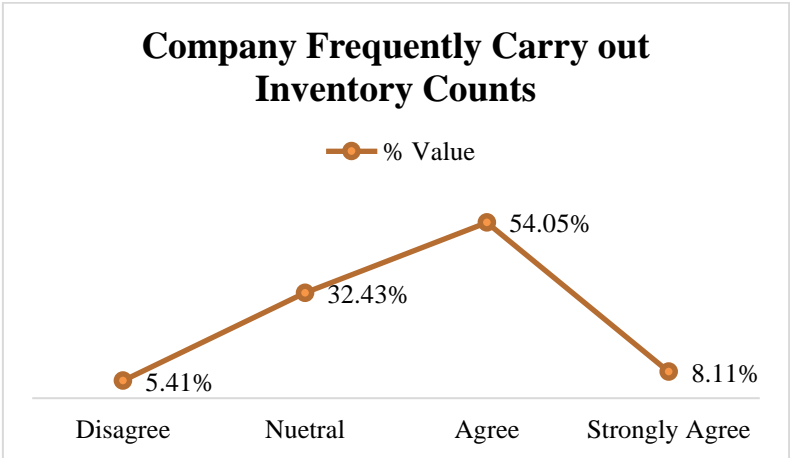
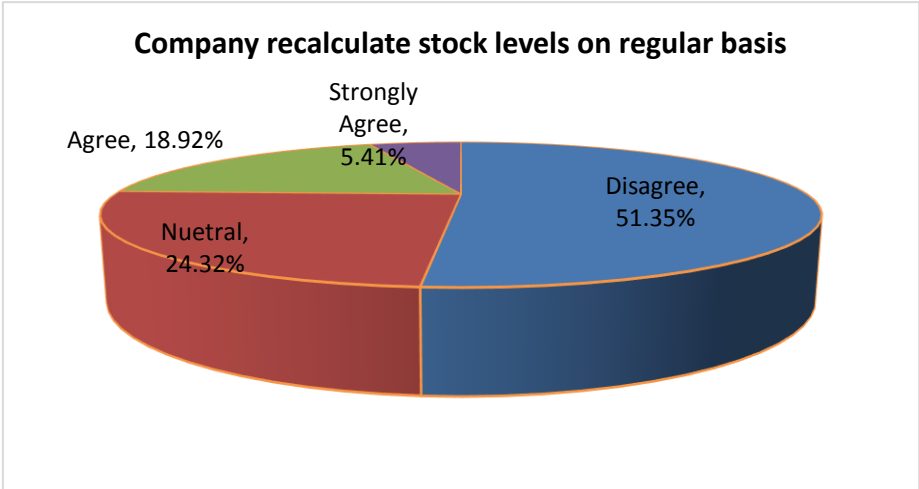


Figure 23: *My Company recalculates stock levels on a regular basis to ensure they are up to date.* (Question 13)



When referring the results achieved in Question 11; it revealed that most of the automobile spare parts providers are not following any effective method to calculate their stock levels which leads to have low service level and high inventories at unnecessary high cost. Rego and Mesquita (2011) have been introduced classical inventory models for stock count in which continuous review and periodic review proposed for high demand items and base stock for low demand spare parts.

Even though Question 12 results interpreted that majority of the respondents (around 60%) were agreed on carrying out inventory count at their companies, since they are not following any structured method (as per Q 11 results); they may struggle to manage their spare parts inventories sufficiently due to complexity of the outdated inventories. Furthermore, since Sri Lankan spare parts automobile providers are rarely carrying out inventory re-counting on their companies ( as Question 13 results); it also has be re-aligned with an acceptable inventory stock count method as to manage the inventory effectively.

Figure 24: My company records and counts for fast moving brands of spare parts. (Question 14)

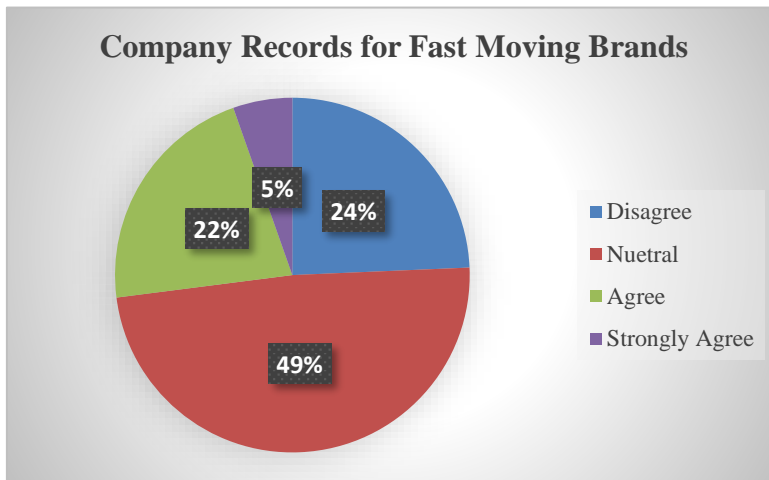
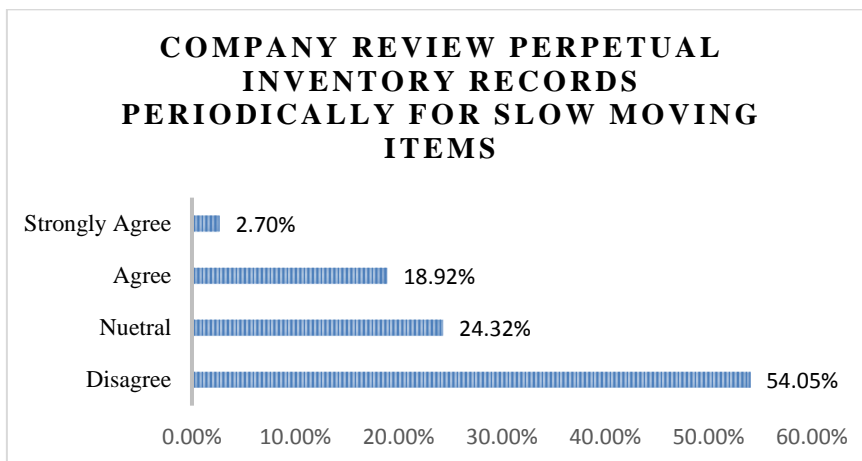


Figure 25: The Company review perpetual inventory records periodically for slow-moving items. (Question 15)



According to the results derived from question No.14 and 15; it shows that around 75% of the companies' do not review or keep any record over the fast moving / slow moving spare parts items which showcase major drives for arising inventory related issues in Automobile spare parts companies in Sri Lanka. Because, Sigma Thermal (2017) is proposed that items which are labeled as critical to the operational or critical to the specific machine function have to be given one designation over other. Therefore, keeping the records over "fast Moving and Slow moving items" may retain the company on correct track in keeping inventory at the right level without making unnecessary inventory carrying cost at large.

Figure 26: My Company's optimal order level frequency is calculated on a regular basis as part of a continuous improvement process. (Question 16)

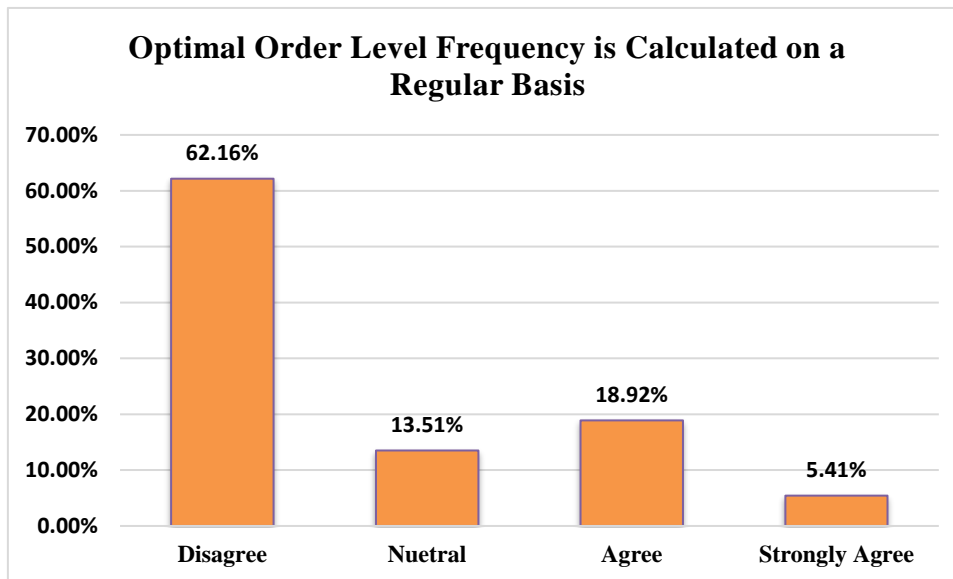
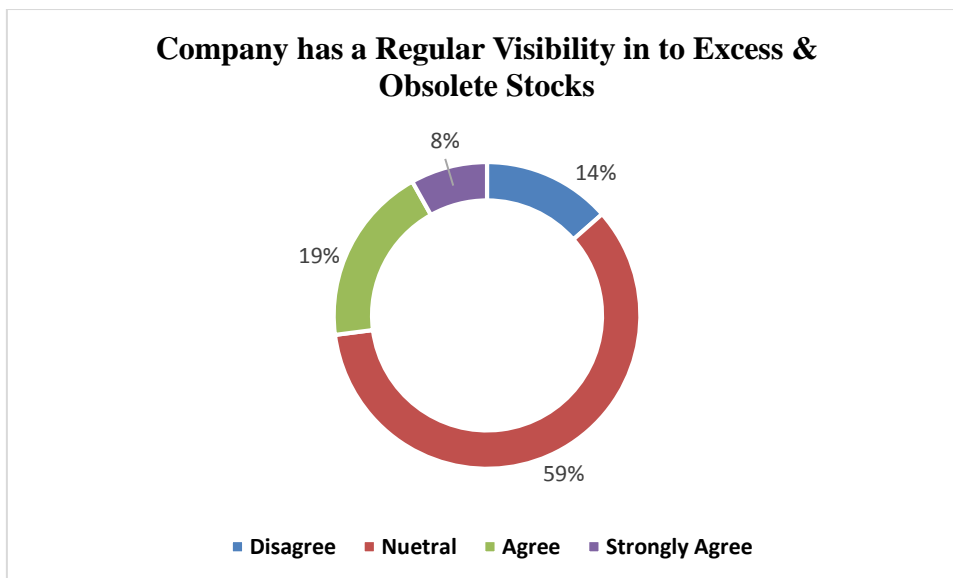


Figure 27: My Company has a regular visibility into excess and obsolete stocks (Question 17)



Even though the inventory management team of the company has to be worked on the proactive (in most of the time) and reactive (in a crisis) nature based on inventory controlling situations; above question 16 and 17 results prove that Sri Lanka automobile partners are not working on that ground. Because, as per the sample results, majority of the companies (more than 75%) not calculate optimum order level frequency as the part of the continuous improvement process. And also, majority does not have regular visibility for obsolete and excess stocks. As several online literature

revealed; having thorough understanding of spare parts lead times and regular visibility on stock count are very much important for building a successful stock program where the company can present himself as a viable substitute during a crisis also.

Figure 28: *The Company performs analysis on inventory balances between periods* (Question 18)

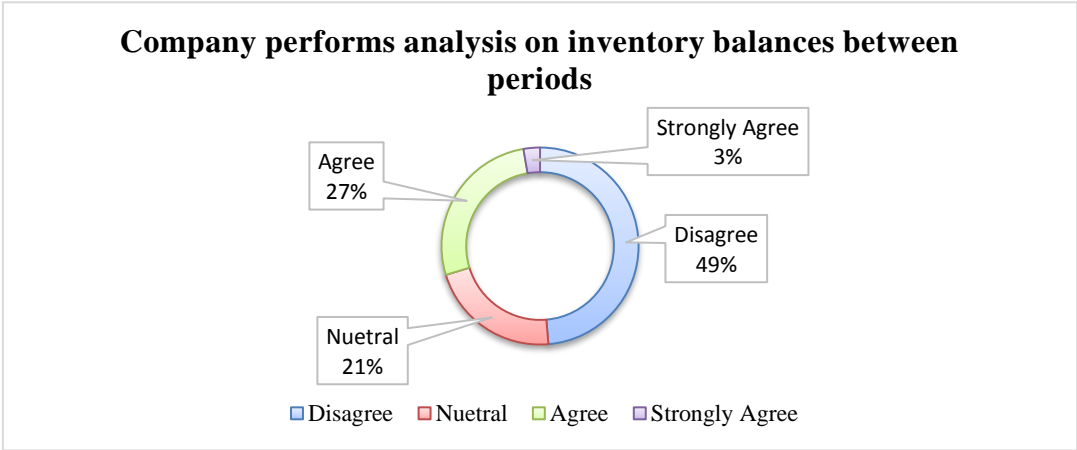
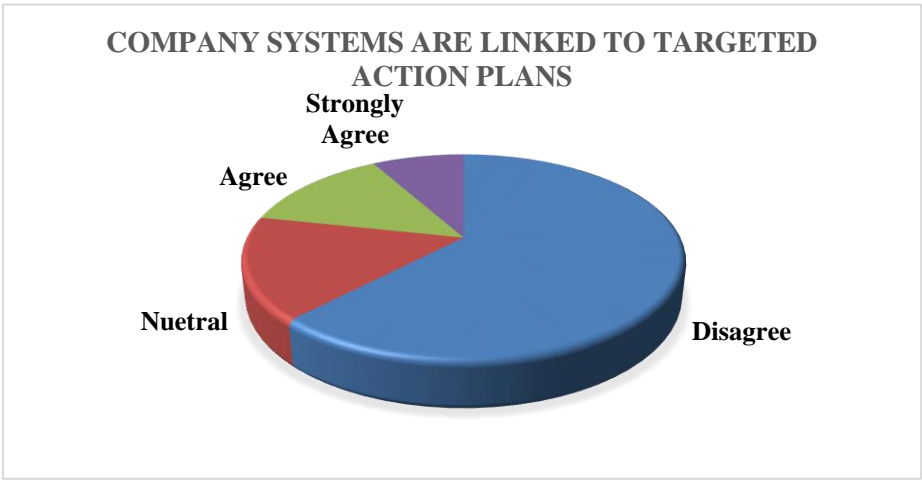


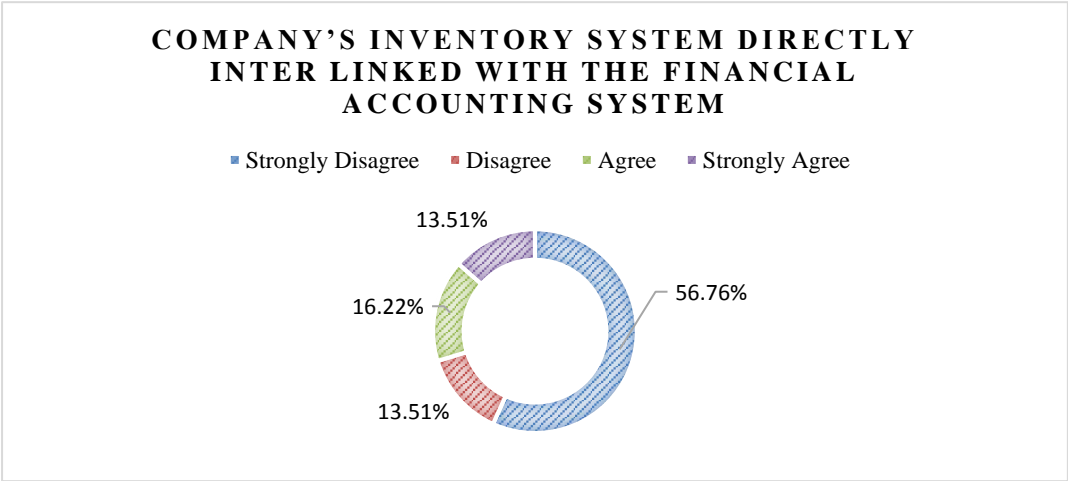
Figure 29: *My Company systems are linked to targeted action plans to sell off or reduce the inventory.* (Question 19)



As per the Gorkan (2010) comprehensive study on “tracking trends in Inventory management in the Automobile Industry”; it has revealed that thorough examination and review over the inventory level of its business cycle is very much required for an effective inventory controlling of the automobile spare parts providing companies. Furthermore, it leads to have a proper inventory valuation over the period and it can set for the proper provisioning of the inventories through the action plan of the companies. But, results of the question no 18 and 19 have revealed that majority of the companies

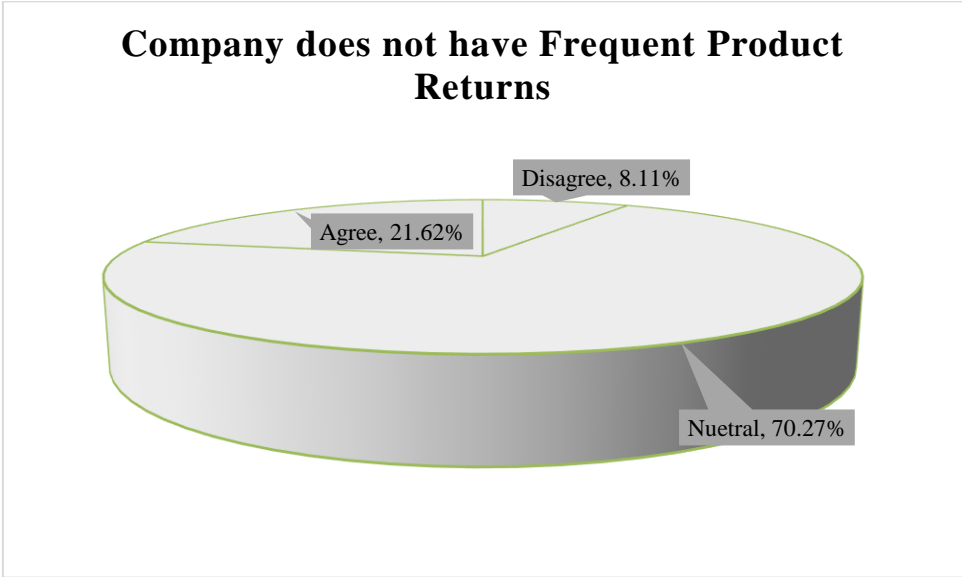
(more than 70%) are not performing analysis on inventory balances between period and the company systems are not linked to the targeted action plans to sell off or reduce the inventory. Thus, blind provisioning of inventories over years may leads to have unnecessary inventory back logs and shortages and it will badly impact over the financial performance of the company.

Figure 30: *My Company's inventory system directly inter linked with the financial accounting system.* (Question 20)



The accountant will have a role to play by keeping a proper record of the total inventory value and by monitoring the inventory movement in terms of financial figures. When the movement is low and when the model is getting old, discounts can be offered and try to liquidate the inventory to reduce of risk of having obsolete spares in the stock. But when this comes to Sri Lankan situation; around 70% of the companies' inventory systems are not directly linked with the financial accounting system which find difficult to assess the financial position of the company in short, medium and long run as well.

Figure 31: My Company does not have frequent product returns (Question 21)



The most accepted inventory controlling method XYZ analysis classified the inventory items in to high, medium and low volume classes and high, medium and low cost classes. As per with that the companies can establish the maximum level of stock and its reorder point based on the product type without facing for a stock out situation. Gorkan (2010); stated that since capital intensive nature of the automobile spare parts industry; rapid changes in preferences and modification result in obsolete inventory which does not make frequent product returns for the company. As per with the above results ; more than 80% of the companies in Sri Lanka does not have frequent product returns which make issues in purchasing the inventories on real time basis due to improper cash flow within the company.



Figure 32: My Company does not have frequent discrepancies between amount received and amount ordered (Question 22)

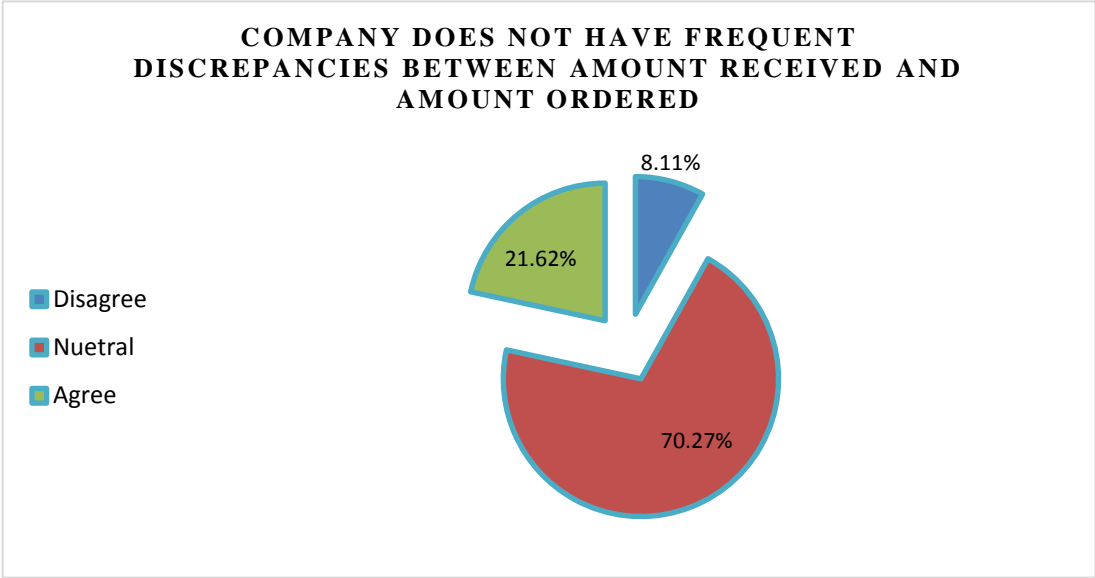
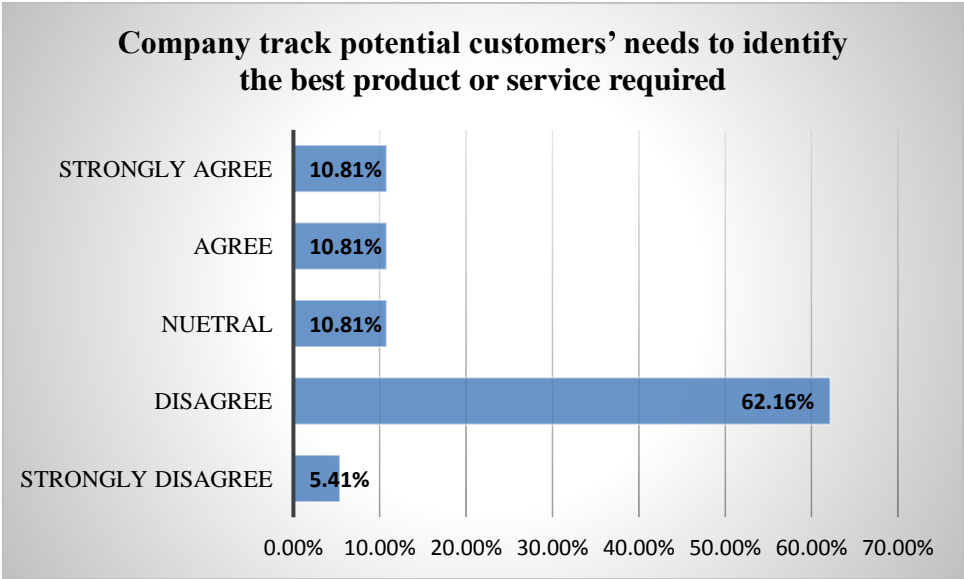


Figure 33: My Company track potential customers' needs to identify the best product or service required (Question 23)

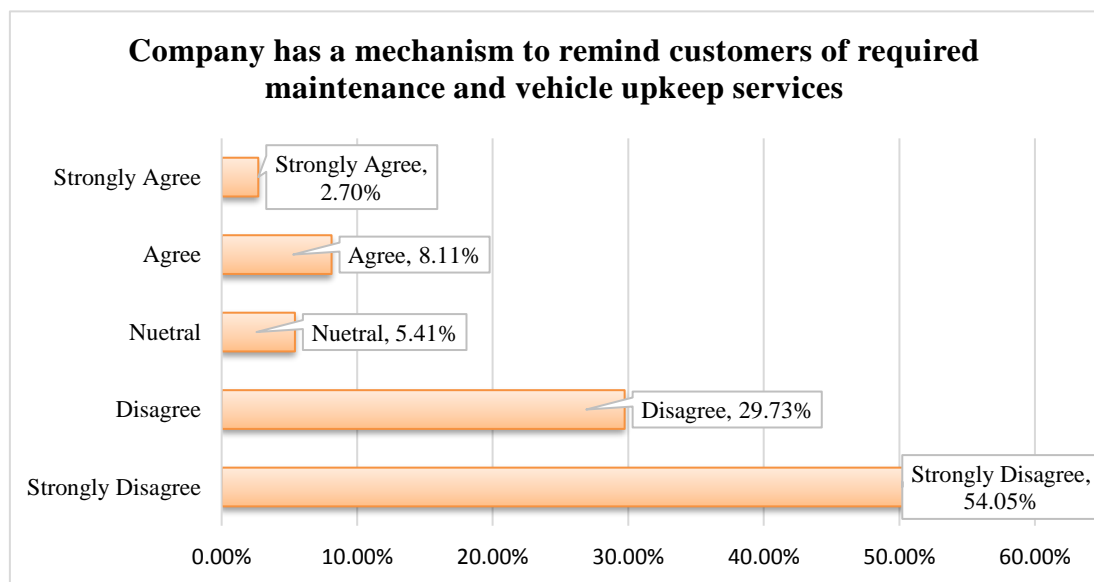


As in any other industry; customer is treated to be king of the business which everyone is trying to provide cost effective and excellent service and spare parts availability experience to their end customers. According to that around 20% of the companies does not have discrepancies between amounts received and amount ordered which can settle off the customer requirement as they have expected. But around 70% of the

respondents were in neutral in responding to the question no 23 which is not a good sign for having effective inventory controlling of spare parts companies in Sri Lanka.

But when this comes to question No. 24: around 70% of the companies do not track the customer's need to identify the best product or service required. Thus, customization is strongly absent in the automobile spare parts companies in Sri Lanka which the customers have to be satisfied with the generalized spare parts which may not be satisfied them to the fullest.

Figure 34: My Company has a mechanism to remind customers of required maintenance and vehicle upkeep services (Question 24)



Juha (2012) has been developed a car maintenance service concept for business customers which mainly derived based on the service attributes of the spare parts. Thus, when any customer is purchased any particular spare part; its maintenance and vehicle keep up service have to be properly communicated to the customers through a well-accepted mechanism. When this comes to Sri Lanka; other than the most recognized TOYOTA Company; many other medium and small scale enterprises are failed to keep a good repo with customers by providing exceeding customer requirement such as updating on service and maintenance records of the spare parts. As a result; many companies found difficult to retain their customer data base with them over the year's which badly impact over the business performances as well.

Figure 35: My company’s internal control is adequate for the inventory system overall (Question 25)

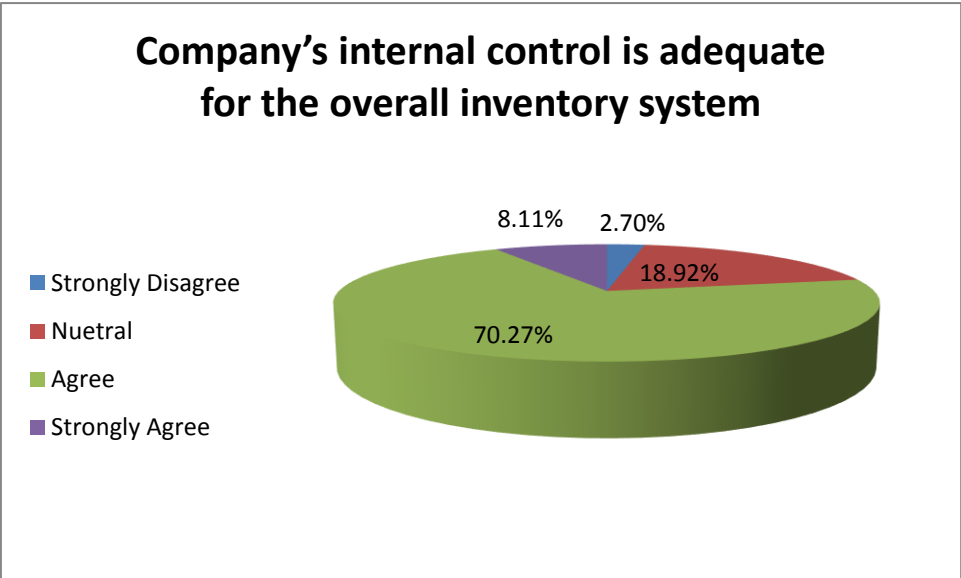
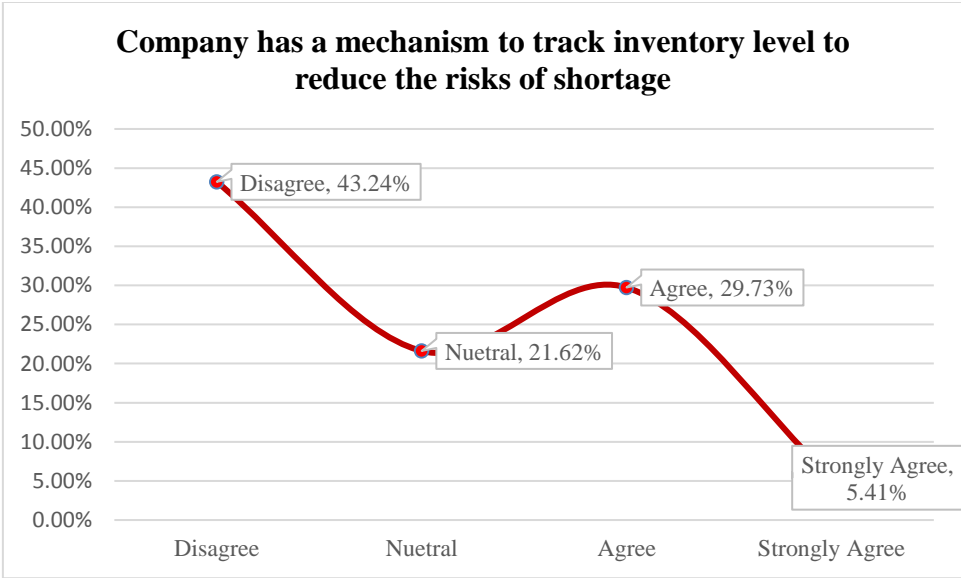


Figure 36: My Company has a mechanism to track inventory level to reduce the risks of shortage (Question 26)



As per the results of question No.25; more than 78% of the companies believed that their internal control is adequate for internal inventory controlling of the company which still be a questionable when refereeing the issues in the industry. As per Rego and Mequita (2011); spare part industry is pretty much complex due to 03 main reasons such as customer have rising expectation on quality, some parts have high and intermittent demand and products and life cycles are increasingly complex which essentially demand for having proper internal controlling of the company over their inventories.

Furthermore as per the results of Question No. 26; majority has been accepted that they do not equipped with proper mechanism for track inventory level as to reduce the risk of shortage. Since the forecast accuracy is quite complex as spare parts importing from international markets given lack of true demand visibility over the supply chain and its logistic network; there should be a correct mechanism for the companies to track their inventory levels to get the right quantity at right time without letting for shortages or surpluses.

Figure 37: My Company evaluates the fluctuation in the automobile market (Question 27)

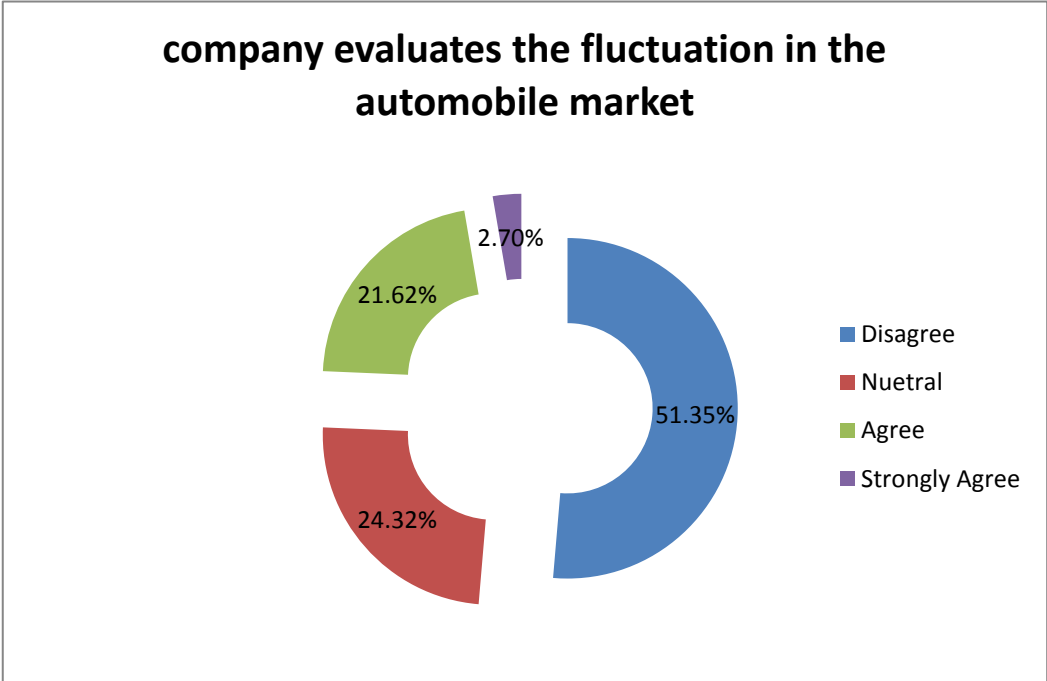


Figure 38: My Company keeps track of recurrent parts malfunctions (Question 28)

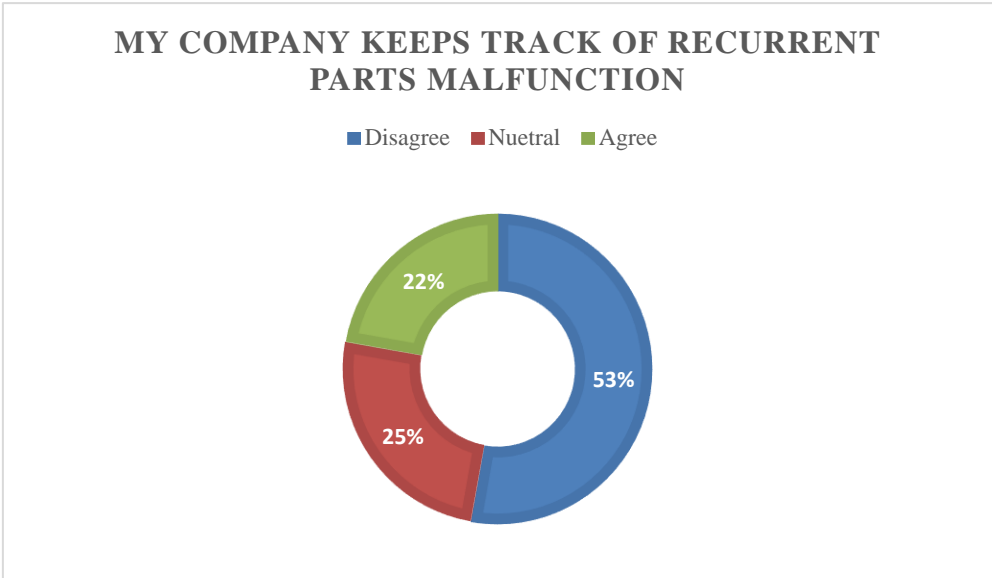
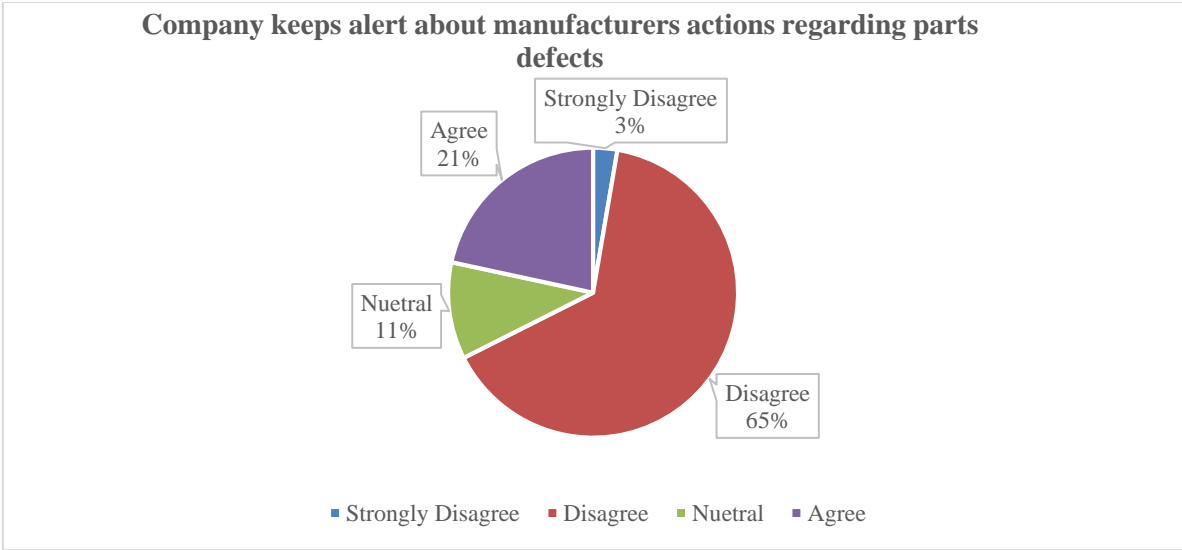


Figure 39: My Company keeps alert about manufacturers actions regarding parts defects. (Question 29)



Since automobile spare part industry is highly volatile in nature; environment analysis has to be carried out by each single company as to get aware of the industry fluctuations in the local and global markets. But, as per the results in question 27, around 75% of the companies do not analyze the industry fluctuations in Sri Lanka which they have to face no of risks in managing the inventories at the unexpected situations. As per Gorkan (2010); fluctuations of the inventory levels of Automobile spare parts companies are derived by the PESTEL factors where the companies have to be keep close attention on these factors to make adjustment to their inventory levels. Also, question no 28 revels that majority of the companies in Sri Lanka do not keep

track of recurrent parts malfunctions which is a major drawback of the companies as they fail to have high quality inventories.

Finally when concerning the global automobile spare parts industry; first mover advantage found to be a major advantage for getting edge over the competitors. But only; 25% of the companies keep alerts on the manufacturer's actions where they can order the highest quality spare parts by satisfying the customer with high satisfaction level.

So likewise; results obtained from all 29 questions were provided greater insight to identifying the major driver for raising the automobile spare parts inventory issues in Sri Lanka which will be further classified in to 06 main factors as follows.

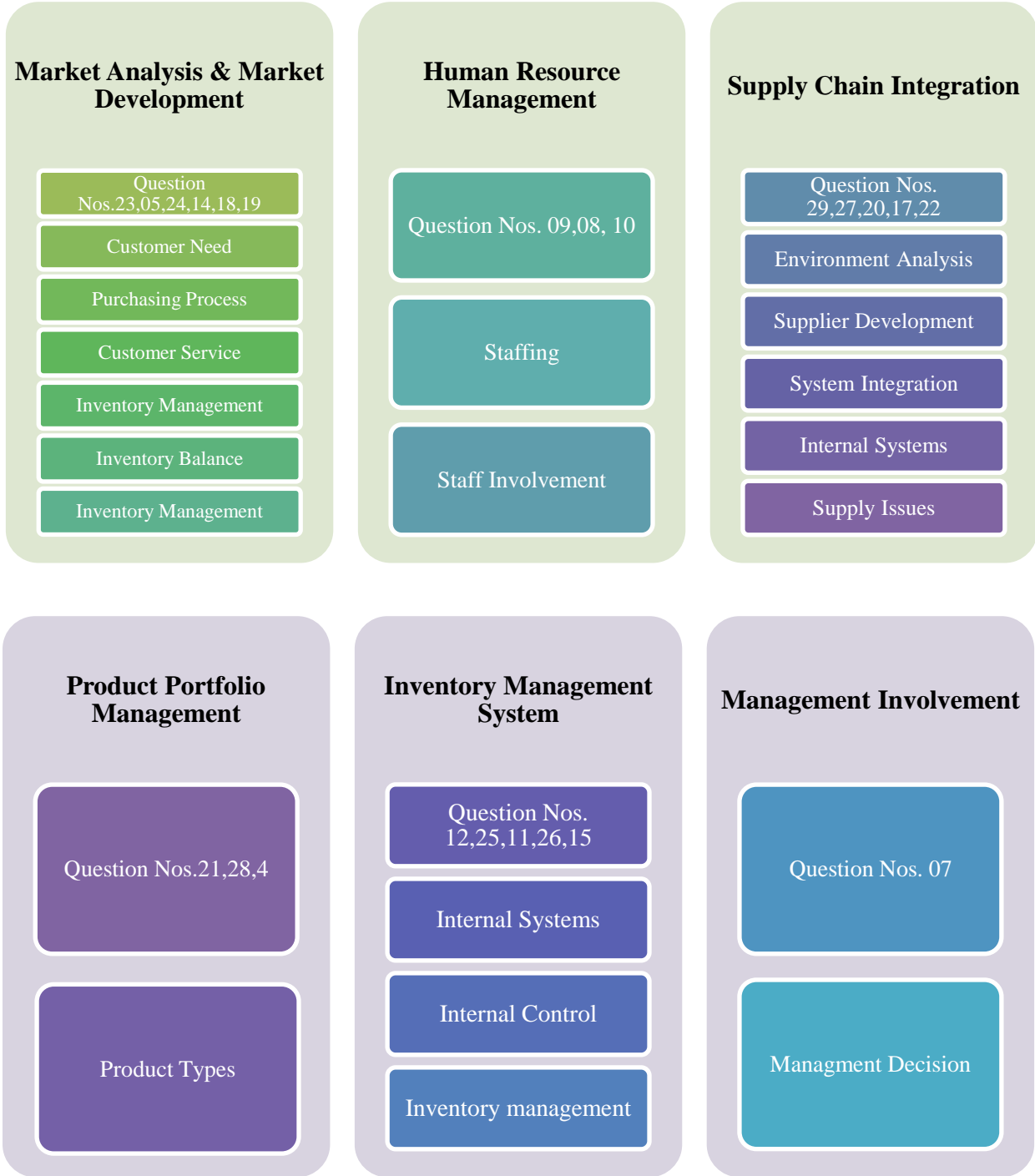
### **Automobile Spare parts Factor Categorization based on SPSS software**

Table 05: Rotated Components Matrix

	Questions	1	2	3	4	5	6
1	potential_customers_needs_to_identify_the_best_product	0.820					
2	formal_process	0.772					
3	mechanism_to_remind_customers_of_required_parts	0.710					
4	records_and_counts_for_fast_moving	0.629					
5	analysis_on_inventory_balances_between_periods	0.617					
6	systems_are_linked_to_targeted_action	0.601					
7	appointed_responsible_person		0.772				
8	appoints_a_separate_employee		0.769				
9	support_from_marketing_operation		0.566				
10	evaluates_the_fluctuation_in_market			0.884			
11	keeps_alert_about_manufacturers_actions			0.710			
12	inventory_directly_linked_accounts			0.696			
13	regular_visibility_into_excess			0.515			
14	frequent_discrepancies_between_received_ordered			0.543			
15	does_not_have_frequent_product_returns				0.808		
16	company_keeps_track_of_recurrent				0.719		
17	sells_different_brands				0.596		
18	company_frequently_carryout_inventory_counts					0.876	
19	internal_control					0.814	
20	uses_an_effective_method					0.734	
21	mechanism_to_track_inventory_leve					0.564	
22	review_perpetual_inventory					0.555	
23	company_management_team_determine						0.672

With the above results; it has been classified the main divers for creating inventory issue in Sri Lanka under following 06 factors which further illustrates by the rest of the chapter.

Figure 40:



## **CHAPTER 5: DISCUSSION AND CONCLUSION**

### **5.1 Introduction**

In this chapter, the results of the quantitative have been discussed. The discussion and conclusion linked to research objective of this study which is to find out the main drivers for automobile spare parts inventory issues in Sri Lanka. With these research findings, it provides valuable insights in relating to the risk perception of controlling inventories of automobile spare parts companies in Sri Lanka and further recommends what are the suggestions for improving the effective controlling of inventories in the Sri Lankan context.

### **5.2 Summary of the Study**

The main objectives of the study are to examine the factors that influence the risk perception of inventory controlling in automobile spare parts companies in Sri Lanka with special reference to the Colombo and Gampaha District companies. The study, focuses on factors such as market development, supply chain integration, Human Resource Management , management involvement and so on which found to be the major causes for raising inventory issues in companies in the Sri Lanka Context. In order to achieve above stated objectives, random sample has been selected for the study with 37 companies who are spread over the Colombo and Gampaha Districts and initially their demographic factors of organization size, no of employment and ownership have been analyzed as to justify the sample with the population parameters.

### **5.3 Achievement of the Objectives of the Research**

The objectives of the study is to evaluate the factors that influence the inventory issues in automobile spare parts companies in Sri Lanka and provide recommendations to mitigate such issues which arise in the future . Accordingly, qualitative & quantitative analyses have been used in exploring the outcome of the study.



### **5.3.1 Market Analysis and market development**

Many researchers have been defined that spare parts automobile industry is a volatile business industry which highly induced by the environmental changes exist in the local and global automobile industry. As a result, for any company that involves in automobile spare part industry needs to be vigilant with the market trends and should be very much aware of the existing vehicles on the road. Further to that these businesses should be very keen with the future direction of the automobile brands and about their future plans regarding the manufacturing of current models. Furthermore, the number of vehicles in the road in the country will be a main factor to decide on the potential sales of the spare parts and they should be aware of the figures of specific brands and models as well as the compatibility of the spare parts will vary from model to model.

Sri Lanka being a country which imports lot of used vehicles under registered category will need to be aware of the year of manufacturing as the auto manufacturers will discontinue the spare part manufacturing after some years and the spare part sellers should plan about the alternative methods of sourcing compatible parts to serve their customer base. This will be a very lucrative segment as the customer wouldn't mind to pay a premium for these parts as there will be very limited supply for these spares after around 10 years of manufacturing.

But the data indicates in the study explored that that most of the companies does not focus on the market trends or about the fluctuation of the automobile market and it is the perception and the practice across the industry. This can lead to a situation of accumulating non sellable or nonmoving spares and also to come across situations where the companies do not have spares which customers are looking for and losing potential sales. By keeping nonmoving spares will waste the company money as interest costs for the money they have invested and finally if a situation arises where you have to dispose a fraction of the inventory as obsolete parts, it will be very damaging situation to the financial health of the company.

Therefore it is being suggested that following factors which comes under Market Analysis and Market development should be main concerns of the automobile spare part companies in Sri Lanka when controlling their inventories.

- Customer Need
- Purchasing Process
- Customer Service
- Inventory Management
- Inventory Balance

### **5.3.2 Human Resource Management**

One of the major mistakes companies do in handling spare parts is that they do not give a focus and priority to this sector and are reluctant to invest on human capital. It is always important to have one or few members who are specialized in identifying and sorting the spares as it is not practical to purely depend on the systems as there could be wrong entries, system errors or part mismatches etc. which need involvement of humans.

Further, there should be a separate executive to monitor the inventory movement and someone who is responsible to report the monthly input and output of the inventory as a total and as a break up of different models and brands to identify slow moving and fast moving SKUs. This staff member should be given the responsibility to conduct periodical clearance sale lists based on the movement and to get the necessary higher approvals for the discount levels.

Marketing and sales teams of the companies do take the decisions on what brand to import in which quantities. Because of this there should be a close interaction between the spare part division and the marketing and sales teams who order the vehicles and decide on the quantities that are ordered. Further, the marketing divisions get more reliable and updated information from the principals on the termination of brands and models as well as of the decisions taken by the manufacturers to discontinue some models. If the spare part orders are placed without knowing these information, there could be situations where some spare parts are stagnated due to the orders placed more than of the real requirement.

There are ways to get the support from the marketing teams to move the stagnated spare parts by getting the customer information who are using vehicles of the existing brands and models. Based on these information, the inventory team can communicate to the customers and inform them about promotional discounts and about possible disposals of the spares. There could be some customers who will want those parts within few months and if an attractive discount is offered, they will purchase the parts.

It is recommended that following factors which comes under Human Resource Management should be primely considered by the companies as to have an effective inventory controlling at their companies.

- Staffing
- Staff Involvement

### **5.3.3 Supply Chain Integration**

#### ***Supplier Development***

For a specific brand or a model, there could be many suppliers. There could be suppliers with different tiers of quality standards because they may be supplying spares for different parts of the world with various quality controls. Because of this, the spare part sellers must be very alert of the parts they get through their suppliers and should get the feedbacks from the customers about the performance over the spares supplied to them.

Modern vehicle service industry is growing at a rapid rate where branded companies start marketing their services and customers too prefer getting their services, expecting a more professional service while getting a more quality service. When the customers are paying a higher prices for a better service, they cannot compromise on the quality of the spares they use to service or repair the vehicles. Because of this, there can be corporate level customers for these spare part sellers and ensuring the quality of the spares will be essential as losing the key accounts will be very damaging in terms of the business. Because of this, the sellers should always interact with the part suppliers and give them necessary feedback on the quality and always try to improve the quality and necessary data and details about reported part defects should be communicated to the suppliers to ensure they correct such defects in future and to get one to one claims for such spares and to pass that benefit to the final customer.

#### ***System Integration***

As a company it's very important to link the inventory system to the financial accounting system as it indicates the movement and remaining level of inventory in terms of rupees and cents. Stagnated inventory of a SKU indicates the wrong decision made at the time of placing the order and the value of the initial order, the current balance and the valuation, value of the movement, the Gross profit ratio of the sold parts, the minimum price to keep

a specific GP ratio etc can be traced from the system when it's linked to the financial accounting system.

### ***Internal System/ Supply Issues***

Companies should have robust processes and procedures to monitor the excess and obsolete stock levels by having frequent inventory counts in place. According to the latest accounting standards, conducting a full inventory count is compulsory once in a financial year and in between there should be cycle counts and random counts of the highest valued spare parts.

### **5.3.4 Product portfolio Management**

Product portfolio management is one of the vital aspects of inventory management as it will directly affect the valuation of the inventory as well as of its movement. When the company is selling different brands of the same spare part, there will be price differences of the parts based on the brand as there are premium brands as well as some other brands serving to the medium and low value segments. It's important to know the percentages of the different brands as the company should know the movements of each brand to place the next orders accurately. Based on the inventory balance of each brand, the company can take decisions on offering discounts or to get disposal decisions.

Further, the company should be aware of the nature and quantities of product returns as it can be damaging in terms of customer perception and necessary actions should be taken to claim from the principals and to educate them on the required improvements to do to eliminate those in future. Same manner, there should be records of the recurrent part malfunctions and those too should be timely informed to the principals for necessary improvements.

As per the study findings; following factor which comes under Product portfolio Management have to greatly concern when controlling the inventory at the companies.

- Product Types & its Characteristics

### **5.3.5 Inventory management System**

Further, when the vehicles are old and when the new supply of those models are reducing or when it is discontinued, the usual behavior of the spare part sellers would be to reduce the order quantity or to stop ordering these parts. But, even though it might be pointed out as working against the general acceptance of the industry, keeping some spares ordered for such kind of old models as well keeping a close eye on the market will be very profitable income if you properly communicate the availability and pricing to the customers.

There's a contrasting strategy for the above discussed logic. Most of the spare part sellers concentrate on ordering spares for the widely available brands and models to ensure they get adequate sales for their parts and to ensure they don't accumulate nonmoving spares in their inventories. But some sellers practice a focus strategy and give their attention on the premium vehicle segment as well as everyone doesn't involve in that segment. This too will be a very profitable area to touch as it'll be a niche segment. As a seller you should be aware of the latest models and about the high end vehicles to s keep an acceptable level of spares in their inventories to cater to the customers who comes searching for high end vehicle spares.

Thus, following sub aspects which comes under inventory management has be closely concerned by the automobile spare parts companies for an effective inventory controlling of the company.

It is always important to have proper internal systems and controls to ensure the initial ordering and reordering of the spare parts is happening properly. It is advisable to go through the pending part records of the system and identify the SKUs that are moving slowly and these lessons can be recorded and used when the next orders are placed.

- **Internal Systems**

It is highly recommended to have internal systems in place to ensure the processes are smoothly operated and to ensure the deviations are minimized during transactions. It's economical in the long run to have systems in place as the staff will know what to do when in which way. All the methodologies will be documented and will be transparent to everyone. Basically the inventory, Finance and Operations will be interlinked through an ERP system to synchronize the transactions and this will let the operation run with minimal disputes.

- Internal Control

Implementing the internal controls is the responsibility of the Finance and the Internal Audit division. The primary responsibility to draw the internal controls is with the Accountant / Finance manager of the company. Internal Audit division which reports to the chairman of the company are responsible to conduct periodical counts, compliance audits and to ensure the processes and procedures are properly in place. The findings are reported to the chairman and the director board and the responsible operational / financial management is accountable to come up with the answers to the reports. These compliance audits will ensure the process is aligned properly and the inventory differences will be minimized at the annual audits. Having proper internal controls is essential to face the quarries raised by the external auditors as they will highlight the major findings to the shareholders and public when the company is public quoted.

### **5.3.5 Management Involvement**

As a company, the operational and financial management should get involved in the ordering process of the stocks. There can be a process to follow the when ordering spares and there can be some guidelines to prepare the order quantities based on the movement over the last 3, 6 months and based on the existing part quantity. Further, the number of actively used vehicles on the road can be always a major indicator when deciding this number.

After the reorder list is prepared, there can be limitations with the approval levels based on the value of the order. If the value exceeds a pre agreed amount, it can be approved from the next layer of authority.

For the initial order placing, the technical team should get involved and they should give their feedback on the part list that needs to be ordered based on their past experience with the failures they have come across. Same manner, they can get the consultation of the principals about their recommended part lists that needs to be ordered initially. As there are no records of the movement of these, it's very high risk to place the initial orders without any technical expert's consultation.

As per with the above discussed facts; it is recommended that following aspect which comes under Management involvement have to be closely addressed when managing the inventories.

- Management initiation and their decision

Finally it can be stated that; with new technological advancements recorded in the globe; automobile industry to be increased its foothold and grow in terms of profitability. Thus, when the companies are fine tune with the above findings of the study; a healthy growth in the personal consumption of auto parts will be created no of opportunities which has to be tapped by the companies, resulting in a boost in demand for auto parts in Sri Lanka and finally in the globe.

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## ANNEXTURES

### Questionnaire

*The Following questionnaire is a part of the academic requirement Master of Business Administration in Supply Chain Management Which is conducted under the topic of Factors Influencing Inventory Risk Perception of Automobile Spare Parts Providers in Sri Lanka*

*Data collected will be utilized only for the research purpose and the confidentiality of the data will be maintained.*

***Please read the question and mark the relevant box indicated with a “X” mark by considering your purview on the above topic.***

<b>Gender:</b> Male	<input type="checkbox"/>	Female	<input type="checkbox"/>
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<b>Age:</b> below 30	<input type="checkbox"/>	30-35	<input type="checkbox"/>	35-40	<input type="checkbox"/>	41-45	<input type="checkbox"/>	46-50	<input type="checkbox"/>	50+	<input type="checkbox"/>
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<b>Income Level:</b> Below 40,000	<input type="checkbox"/>	40,000- 80,000	<input type="checkbox"/>	80,000-120,000	<input type="checkbox"/>	above 120,000	<input type="checkbox"/>
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01. Size of Organizations in the Sample

Small Scale	<input type="checkbox"/>
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Medium Scale	<input type="checkbox"/>
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Large Scale	<input type="checkbox"/>
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02. No of Employees of the Organizations

No of Employees	No of Organization
0 to 5	<input type="checkbox"/>
5 to 25	<input type="checkbox"/>
25 to 50	<input type="checkbox"/>
50 to 100	<input type="checkbox"/>
over 100	<input type="checkbox"/>
	<input type="checkbox"/>

### 03. Company Ownership of the Organizations

Company Ownership	No of companies
Entrepreneurship	
Private	
Joint venture	



	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Size (L.M.S)	0-5	5-10	5-25	25-50	50-100	over 100	Private	Entrepreneurship	Joint venture	
1) Size of the organization																
2) The number of employees																
3) Ownership.																
4) My company sells different kind of brands of the same spare parts.																
5) My company has a formal process for purchasing spare parts																
6) In my company, management team decides the key inventory-related policy such as striking the right balance between customer service and cost-effective product inventory levels.																
7) In my company, management team determines the frequency for ordering spare parts.																
8) My company appoints a separate employee to manage inventory and inventory surplus.																
9) My company has appointed a responsible person for accessing inventory, and who looks up inventory.																
10) My company gets support from the marketing & operational team for managing inventory.																
11) My company uses an effective method to calculate the stock level.																
12) My company frequently carryout inventory counts.																
13) My company recalculates stock levels on a regular basis to ensure they are up to date.																
14) My company records and counts for fast moving brands of spare parts.																
15) The company review perpetual inventory records periodically for slow-moving items.																
16) My company's optimal order level frequency is calculated on a regular basis as part of a continuous improvement process.																
17) My company has a regular visibility																

into excess and obsolete stocks.																			
18) The company performs analysis on inventory balances between periods.																			
19) My company systems are linked to targeted action plans to sell off or reduce the inventory.																			
20) My company's inventory system directly inter linked with the financial accounting system.																			
21) My company does not have frequent product returns.																			
22) My company does not have frequent discrepancies between amount received and amount ordered.																			
23) My company track potential customers' needs to identify the best product or service required.																			
24) My company has a mechanism to remind customers of required maintenance and vehicle upkeep services.																			
25) My company's internal control is adequate for the inventory system overall.																			
26) My company has a mechanism to track inventory level to reduce the risks of shortage																			
27) My company evaluates the fluctuation in the automobile market																			
28) My company keeps track of recurrent parts malfunction																			
29) My company keeps alert about manufacturers actions regarding parts defects																			

Thank you for your time contributed for this questionnaire.

If you have any clarification that you wish to discuss contact me via No:.....

## Results of the Factor Categorization based on SPSS software

23) My company track potential customers' needs to identify the best product or service required.	Customer Need
5) My company has a formal process for purchasing spare parts	Purchasing Process
24) My company has a mechanism to remind customers of required maintenance and vehicle upkeep services.	Customer Service
14) My company records and counts for fast moving brands of spare parts.	Inventory Management
18) The company performs analysis on inventory balances between periods.	Inventory Balance
19) My company systems are linked to targeted action plans to sell off or reduce the inventory.	Inventory Management
	<b>Market Analysis and Market Development</b>

9) My company has appointed a responsible person for accessing inventory, and who looks up inventory.	Staffing
8) My company appoints a separate employee to manage inventory and inventory surplus.	Staffing
10) My company gets support from the marketing & operational team for managing inventory.	Staff Involvement
	<b>Human Resource management</b>

27) My company evaluates the fluctuation in the automobile market	Environment Analysis
29) My company keeps alert about manufacturers actions regarding parts defects	Supplier Development
20) My company's inventory system directly inter linked with the financial accounting system.	System Integration
17) My company has a regular visibility into excess and obsolete stocks.	Internal Systems
22) My company does not have frequent discrepancies between amount received and amount ordered.	Supply Issues
	<b>Supply Chain Integration</b>
21) My company does not have frequent product returns.	Product Types
28) My company keeps track of recurrent parts malfunction	Product Types
4) My company sells different kind of brands of the same spare parts.	Product Types
	<b>Product portfolio Management</b>

12) My company frequently carryout inventory counts.	Internal Systems
25) My company's internal control is adequate for the inventory system overall.	Internal Control
11) My company uses an effective method to calculate the stock level.	Inventory management
26) My company has a mechanism to track inventory level to reduce the risks of shortage	Inventory management
15) The company review perpetual inventory records periodically for slow-moving items.	Inventory management
	<b>Inventory Management System</b>

7) In my company, management team determines the frequency for ordering spare parts.	<b>Management Involvement</b>

No	1) Size of the organization	2) The number of employees	3) Ownership.	4) My company sells different kind of brands of the same spare parts.	5) My company has a formal process for purchasing spare parts	6) In my company, management team decides the key inventory-related policy such as striking the	7) In my company, management team determines the frequency for ordering spare parts.	8) My company appoints a separate employee to manage inventory and inventory surplus	9) My company has appointed a responsible person for accessing inventory, and who looks up inventory	10) My company gets support from the marketing & operational team for managing inventory.	11) My company uses an effective method to calculate the stock level.	12) My company frequently carryout inventory counts.	13) My company recalculates stock levels on a regular basis to ensure they are up to date.	14) My company records and counts for fast moving brands of spare parts	15) The company review perpetual inventory records periodically for slow-moving items.	16) My company's optimal order level frequency is calculated on a regular basis as part of a continuous improvement process.	17) My company has a regular	18) The company performs analysis on inventory balances between periods.	19) My company systems are linked to targeted action plans to sell off or reduce the inventory	20) My company's inventory system directly inter linked with the financial accounting system.	21) My company does not have frequent product returns.	22) My company does not have frequent discrepancies between amount received and amount ordered.	
1	Medium	50 to 100	Entrepreneurship	Agree	Agree	Agree	Strongly agree	Disagree	Neutral	Agree	Agree	Disagree	Disagree	Agree	Disagree	Agree	Disagree	Agree	Agree	Disagree	Disagree	Neutral	
2	Large	Over 100	Private	Strongly disagree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree	Strongly agree	Agree	Agree	Agree	Agree	Agree
3	Small	0 to 5	Private	Agree	Agree	Agree	Strongly agree	Agree	Strongly agree	Agree	Agree	Agree	Agree	Strongly agree	Agree	Agree	Strongly agree	Agree	Strongly agree	Strongly agree	Agree	Agree	
4	Large	Over 100	Private	Strongly disagree	Strongly agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Agree	Neutral	Agree	Agree	Agree	Agree	Neutral	
5	Medium	25 to 50	Private	Agree	Strongly agree	Agree	Agree	Strongly agree	Agree	Strongly agree	Neutral	Strongly agree	Agree	Neutral	Strongly agree	Agree	Agree	Agree	Strongly agree	Strongly agree	Neutral	Agree	
6	Large	Over 100	Private	Agree	Agree	Neutral	Strongly agree	Agree	Agree	Strongly agree	Strongly agree	Strongly agree	Agree	Neutral	Agree	Strongly agree	Strongly agree	Agree	Neutral	Agree	Neutral	Agree	

7	Medium	Over 100	Private	Strongly agree	Agree	Agree	Agree	Agree	Agree	Strongly agree	Strongly agree	Neutral	Strongly agree	Agree	Agree	Agree	Agree	Agree	Strongly agree	Strongly agree	Disagree	Agree
8	Small	0 to 5	Entrepreneurship	Strongly agree	Neutral	Agree	Agree	Disagree	Disagree	Strongly disagree	Neutral	Agree	Neutral	Disagree	Disagree	Disagree	Neutral	Disagree	Neutral	Strongly disagree	Neutral	Neutral
9	Small	0 to 5	Entrepreneurship	Agree	Neutral	Neutral	Neutral	Disagree	Agree	Disagree	Agree	Agree	Disagree	Disagree	Disagree	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Neutral	Disagree
10	Small	5 to 10	Entrepreneurship	Strongly agree	Agree	Agree	Strongly agree	Neutral	Neutral	Neutral	Neutral	Agree	Agree	Neutral	Neutral	Neutral	Neutral	Agree	Disagree	Agree	Neutral	Neutral
11	Small	0 to 5	Entrepreneurship	Strongly agree	Neutral	Agree	Strongly agree	Disagree	Disagree	Disagree	Neutral	Neutral	Disagree	Neutral	Neutral	Neutral	Disagree	Disagree	Disagree	Disagree	Agree	Neutral
12	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Strongly disagree	Disagree	Strongly disagree	Neutral	Agree	Disagree	Neutral	Disagree	Disagree	Neutral	Disagree	Neutral	Strongly disagree	Neutral	Neutral
13	Small	0 to 5	Entrepreneurship	Agree	Neutral	Neutral	Agree	Neutral	Disagree	Disagree	Disagree	Neutral	Disagree	Neutral	Disagree	Disagree	Disagree	Disagree	Disagree	Disagree	Neutral	Neutral
14	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Disagree	Disagree	Strongly disagree	Neutral	Neutral	Disagree	Neutral	Disagree	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Agree	Disagree
15	Small	0 to 5	Entrepreneurship	Agree	Agree	Neutral	Neutral	Disagree	Disagree	Strongly disagree	Agree	Disagree	Disagree	Agree	Agree	Disagree	Agree	Agree	Disagree	Disagree	Neutral	Agree
16	Small	0 to 5	Entrepreneurship	Agree	Neutral	Neutral	Agree	Neutral	Neutral	Disagree	Neutral	Neutral	Disagree	Disagree	Neutral	Disagree	Neutral	Neutral	Disagree	Disagree	Neutral	Disagree
17	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Disagree	Disagree	Strongly disagree	Neutral	Agree	Disagree	Agree	Disagree	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Neutral	Disagree
18	Small	0 to 5	Entrepreneurship	Strongly agree	Neutral	Agree	Agree	Disagree	Disagree	Disagree	Disagree	Agree	Neutral	Neutral	Neutral	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Neutral	Disagree



19	Small	0 to 5	Entrepreneurship	Agree	Neutral	Neutral	Agree	Disagree	Disagree	Disagree	Disagree	Agree	Disagree	Neutral	Disagree	Disagree	Neutral	Neutral	Neutral	Agree	Agree	Agree
20	Small	0 to 5	Entrepreneurship	Strongly agree	Neutral	Agree	Agree	Neutral	Disagree	Strongly disagree	Disagree	Neutral	Disagree	Neutral	Disagree	Neutral	Neutral	Neutral	Disagree	Strongly disagree	Neutral	Disagree
21	Medium	5 to 10	Entrepreneurship	Strongly agree	Neutral	Neutral	Neutral	Neutral	Agree	Disagree	Agree	Neutral	Agree	Agree	Neutral	Neutral	Disagree	Disagree	Disagree	Agree	Neutral	Disagree
22	Small	0 to 5	Entrepreneurship	Strongly agree	Neutral	Agree	Agree	Disagree	Neutral	Disagree	Strongly disagree	Neutral	Neutral	Agree	Disagree	Neutral	Neutral	Neutral	Disagree	Strongly disagree	Agree	Neutral
23	Large	Over 100	Private	Strongly agree	Agree	Agree	Agree	Strongly agree	Strongly agree	Strongly agree	Agree	Agree	Neutral	Neutral	Neutral	Agree	Agree	Agree	Agree	Strongly agree	Disagree	Agree
24	Small	0 to 5	Entrepreneurship	Strongly agree	Neutral	Agree	Agree	Disagree	Disagree	Strongly disagree	Disagree	Neutral	Disagree	Neutral	Disagree	Disagree	Agree	Disagree	Disagree	Strongly disagree	Agree	Neutral
25	Large	Over 100	Private	Strongly disagree	Neutral	Agree	Agree	Strongly agree	Agree	Neutral	Agree	Neutral	Neutral	Neutral	Agree	Agree	Agree	Agree	Agree	Strongly agree	Neutral	Disagree
26	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Disagree	Disagree	Disagree	Disagree	Neutral	Disagree	Neutral	Disagree	Disagree	Agree	Neutral	Neutral	Strongly disagree	Neutral	Neutral
27	Small	0 to 5	Entrepreneurship	Strongly agree	Neutral	Agree	Agree	Disagree	Disagree	Strongly disagree	Neutral	Agree	Disagree	Neutral	Disagree	Disagree	Neutral	Disagree	Neutral	Strongly disagree	Neutral	Disagree
28	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Disagree	Neutral	Strongly disagree	Neutral	Agree	Neutral	Disagree	Disagree	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Neutral	Neutral
29	Small	0 to 5	Entrepreneurship	Strongly agree	Agree	Neutral	Agree	Disagree	Disagree	Strongly disagree	Disagree	Neutral	Disagree	Agree	Disagree	Disagree	Neutral	Neutral	Disagree	Strongly disagree	Neutral	Neutral
30	Small	0 to 5	Entrepreneurship	Agree	Agree	Agree	Agree	Agree	Agree	Strongly disagree	Neutral	Agree	Disagree	Neutral	Neutral	Disagree	Disagree	Disagree	Disagree	Strongly disagree	Neutral	Neutral

31	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Neutral	Neutral	Strongly disagree	Neutral	Agree	Disagree	Neutral	Neutral	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Neutral	Neutral
32	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Neutral	Neutral	Strongly disagree	Neutral	Agree	Disagree	Disagree	Disagree	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Neutral	Neutral
33	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Agree	Agree	Strongly disagree	Neutral	Agree	Disagree	Disagree	Disagree	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Neutral	Disagree
34	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Neutral	Neutral	Strongly disagree	Neutral	Agree	Neutral	Disagree	Neutral	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Neutral	Neutral
35	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Disagree	Neutral	Strongly disagree	Neutral	Agree	Agree	Neutral	Disagree	Disagree	Neutral	Disagree	Disagree	Strongly disagree	Neutral	Neutral
36	Small	0 to 5	Entrepreneurship	Agree	Neutral	Agree	Agree	Neutral	Neutral	Strongly disagree	Neutral	Agree	Neutral	Disagree	Disagree	Disagree	Neutral	Neutral	Disagree	Strongly disagree	Neutral	Neutral
37	Small	0 to 5	Entrepreneurship	Agree	Agree	Agree	Agree	Neutral	Neutral	Strongly disagree	Neutral	Agree	Neutral	Disagree	Disagree	Disagree	Neutral	Neutral	Disagree	Strongly disagree	Neutral	Neutral