TECHNOLOGY ENABLED REVERSE LOGISTICS AS A MEANS OF REDUCING LPG DISTRIBUTION COST: THE CASE OF A LPG SUPPLIER IN SRI LANKA

M. P. N. S. Pathirana

(179216E)

Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree
MBA in Supply Chain Management

Department of Transport and Logistics Management

University of Moratuwa
Sri Lanka

April 2019

Declaration page of the candidate & supervisor

Candidate declaration

"I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:

Supervisor/s declaration

The above candidate has carried out research for the Masters/ MPhil/ PhD thesis/ Dissertation under my supervision.

Name of the supervisor:

Signature of the supervisor: Date:

Abstract

In the context of business industry; globalisation, innovation of technology and severe competition have been playing pivotal roles in reshaping its theories and practice for the last few decades. Presently the competition is there among players who control effective and efficient supply chains even though big or small which is not totally depends on the size or establishment of the company as before. This is very important for any product supplier because some companies are focusing on its forward supply chain while several companies focus on both forward and reverse supply chains as its product characteristics.

This research primarily focuses on comparative study of a typical reverse logistics problem of refilling of LPG cylinders in Colombo areas based on the LPG distribution process of a leading LPG supplier (ABC Company). And secondly the study focuses on potential suggestions that could be useful to reduce the cost of cylinder distribution/ collection process in long term via implementing technology enabled cylinder distributional process. Accordingly, this research investigates most influential cost factors in cylinder distribution, its technology usage, potential technology features to be implemented and issues in current distribution system as well. Thus, a physical survey was conducted for a period of 15 days focusing on 30 employees covering 6 employees from each department in ABC Company to get primary data. Stratified sampling technique was used for data collection due to varieties among employee viewpoints in each department regarding cylinder distribution process.

Finally, possible cost reduction strategies via technological enhancements are proposed to manage cylinder distribution process. And its execution on cost minimisation, dependability and flexibility management has also discussed as well.

Key Words: Reverse Logistics, Distribution and Collection, Technological Enhancements, LPG

Acknowledgement

I would like to thank my research supervisor Mr. Nishal Samarasekera who guided me and directed me to make this research success. He always showed me the right way and give guide lines to achieve this target. His support and guidance led me to make this task a reality. I would like to thank Mr. Kumara (who works at ABC Company) for his guidance, patience, words of encouragement, invaluable guidance and suggestions through the entire process.

I would like to thank specially following individuals, who helped me, encouraged me and supported me to be successful in objectives of this research and also my friends and all the staff of University of Moratuwa. Then I would like to take this opportunity to thank University of Moratuwa and Faculty of Engineering to provide us better facilities and friendly educational background to make this task a success.

I should offer my gratitude all the respondents of the questionnaire survey of my research for answering the research questionnaire patiently during the data collection phase. Without their contribution, this research study would not have been a success.

Finally my special thanks go to my parents and company currently I'm working.

Table of contents

List of figures

List of tables

List of abbreviations

EDI – Electronic Data Interchange

ESM – Electronic Security Marker

KMO – Kaiser Meyer Olkin

LPG – Liquid Petroleum Gas

RFID – Radio Frequency Identification

RL – Reverse Logistics

ROI – Return On Investment

SCM – Supply Chain Management

1. INTRODUCTION

1.1 Background of the research

In the context of business industry; globalisations, innovation of technology and severe competition have been playing pivotal roles in reshaping its theories and practice for the last few decades. Presently the competition is there among players who control effective and efficient supply chains even though big or small which is not totally depends on the size or establishment of the company as before (Adipola, 2017). It is important not only forward flow but also reverse flow of logistics handling where it depends on the nature of product to be competitive in the market place due to its characteristics of one time use products or reused product nature. This is where the logistics flow comes in where forward flow is more important for one time products and reverse logistics flow is utmost important for reused products to grab the share of market by effective handling the supply chain because of better management of reverse logistics could increase the competitive advantage.

Here in this study, the paper presents a comparative study of a typical reverse logistics problem of refilling of LPG cylinders in Colombo areas based on ABC Company's LPG distribution process. ABC Company is a diversified business conglomerate in Sri Lanka which was established in 1995 and mainly operates in power and energy, retail, industrial, services as well as hospitality industry and is operating internationally as well and engages in lubricants, petroleum, real estate, leisure, rubber chemical and hotel businesses (Bloomberg, 2018). In this research, company's petroleum products were the consideration where main objective is to identify the technologies that can improve reverse logistics operations in LPG cylinder distribution process in order to improve visibility over the distribution network. Currently Sri Lanka has only fewer suppliers of LPG gases but is a need of most of the houses in Sri Lanka for food processing purposes where demand ranges from very smallest house to biggest organisations, hotels, institutes and etc. Hence demand is extremely bigger and out of stock situation must not be happened at all. As LPG cylinder is a reusing product, not only forward supply chain but also reverse collection flow also utmost important but in contrast, LPG reverse logistics process

must be further improved in the context of ABC company as said by (Udayangani, 2019).

1.2 Problem statement

This subjected research will find critical factors for making a successful RL strategic framework that will guide ABC Company operators for enhancing its customer satisfaction and increase visibility over distribution network. Initially a qualitative interview was conducted with logistics manager in LPG gas cylinder distribution section where he has noted the need of technology oriented reverse logistics management flow in order to control the distribution between company and LPG distributor (Udayangani, 2019). In 2017, selling and distribution costs amounting to LKR 1,092 million increased by 40% year on year basis with increasing marketing efforts especially in rural LPG markets focused on increasing awareness of LPG usage (AR, 2017). Further staff costs was increased by 52% during the year 2017 driven by growth in the number of employees and increased training projects in management of LPG distribution process (AR, 2017).

Indeed, large consumption of LPG cylinders for domestic purpose results more and more imports to Sri Lanka which is hugely affected with market price fluctuations of gas reserves that are present in Sri Lanka as well as future imports. But the product price could not increase for highest level as it is required by every home which already becomes almost a necessary product. In the context of distribution, cylinders are filled at a separate place and need to distribute to every household via set distributors but filled cylinder distribution and empty cylinder collection is not standardised due to dynamic characteristics of ordering environment. It is because, usage period of a cylinder cannot be defined where it depends on the number of members in home, season, degree of engage in cooking activities and etc (Udayangani, 2019). Thus amount of empty cylinders in hand of a defined distributor is always changing and it results frequency change of orders from the cylinder filling station. Further there is no visibility at all for ABC Company to monitor the demand variation and identify the areas of higher utilisation once the distributor left with filled cylinders from the filling station (Udayangani, 2019). In addition, sometimes

ABC Company delivers many filled Cylinders to some distributors even though they have no higher demand but due to size of order. As a result, company has to face for lower stocks to deliver at high demand places which are not healthy for the organisation. Nevertheless, demand has to be filled as far as cylinders in hand of distributor thus transportation cost will be higher in these kinds of situations (Udayangani, 2019). Hence, there is a need of optimising the transportation costs, cycle time, cost effective distribution model considering environmental concern, consumer satisfaction, lead time and increase distribution visibility as well.

Therefore, author focus on critically analyse reverse logistics network with reference to both rural and urban agencies, considering supply chain management drivers thus this phenomenon led researcher to study about this research topic.

1.3 Significance of the study

Basic outcome of this research is to analyse how cylinder capacity has been utilised to cater the demand, route has optimised to deliver smoothly, minimise cycle time to avoid time and cost attributes and to identify potential technologies to empower distribution model of LPG gas cylinders.

Hence, this study provided new insight on reverse logistics process in order to acknowledge with the technological solutions to increase management visibility over the process. For instance, competitive advantage and management cost effectiveness through implementing Radio Frequency Identification Device (RFID) will be discussed here in this research and propose a cost effective distribution model. The reverse logistics framework that is going to be developed in this research will be able to add value to supply chain and logistics processes in ABC Company as well. Additionally, subjected report would be serving as a useful source for entire LPG distributors in order to identity potential solutions to reduce their distributional costs as well as increase ABC Company's visibility over cylinder distribution process. However only few researches are there for identifying the technological ways of improving reverse logistics processes in LPG cylinder distribution.

1.4 Research objectives

Overall objective of this subjected research mainly categorised for 3 dimensions.

- To study current LPG cylinder distribution network and reverse logistics practices between LPG supplier and LPG cylinder distributors.
- To discover the technologies that could enhance reverse logistics functions in LPG cylinder distribution.
- To identify the effect of implementing technologies to improve the reverse logistics operations between LPG supplier and LPG cylinder distributors in both urban and rural areas.

1.5 Research questions

- What are the issues in current LPG cylinder distribution network and reverse logistics practices between LPG supplier and LPG cylinder distributors?
- What are the technologies that can improve reverse logistics operations in LPG cylinder distribution?
- How will be the impact of implementing technologies to improve the reverse logistics operations between LPG supplier and LPG cylinder distributors in both urban and rural areas?

2. LITERATURE REVIEW

2.1 Introduction

In this part, across the board writing identifying with the examination has being done seriously which incorporates past expert diaries, modifications, articles and books identified with innovation utilization in switch coordination procedure concentrating on LPG gas circulation industry.

Aside from the physical documental written works, look into incorporates the literary works gathered through industry experts in oil industry just as from research experts which is beneficial gaining from their encounters where it is significant in light of the fact that writings help to contend on same view point and here and there acknowledge similarities (Adipola, 2017). Or maybe it would encourage by some of basic components which ought to be controlled through organization itself. In addition, literature review consist of mainly two frameworks as theoretical framework as well as conceptual framework, nevertheless the theoretical framework consist of several sub chapters which initially evaluate about reverse logistics, technological usage in reverse logistics as well as future trends and practices all around the world through several sources with deep analysis regarding the way researchers agree upon and argue on the scenario (Adipola, 2017).

Further, here the researcher has embraced content investigation technique for writing audit which is an observational research strategy that is utilized to efficiently assess the representative substance of all types of recorded correspondence. As of late, an impressive number of contextual analyses have been accounted for which address backward network system plan in the item recuperation and remanufacturing setting. Thereby, in this literature review author will discuss the points of reverse logistics processes, barriers in LPG reverse logistics, general LPG distribution method, technology enabled reverse logistics processes, associated cost in LPG distribution, future technologies that can support reverse logistics as well as reverse logistics in LPG industry in Sri Lanka.

Finally the study is included about the relationship between technology oriented reverse logistics practices and LPG cylinder distribution methods to prove that the objective of this research is viable and workable to be implemented in the industry. Moreover the conceptual framework with regards to research scope also incorporated at the closing stages of the literature to evaluate how effective is that this study in petroleum industry to focus overall direction to another differentiated and economical end rather than uneconomical. Consequently subjected section can be looked as a thorough lead just as establishment to direct this observational research by exploring the business speculations and practices on research theme territory.

2.2 Reverse logistics industry

In 2000s, implication of RL was on rise where no time period can match hence more and more researches tend to emerged on this regards resulting enormous definitions for reverse logistics (RL) that covers different scopes and different focal points. According to Fuller et al (1996), topic of RL was been an interesting topic in business areas due to the higher consciousness of reusing the products rather than throw away as trash. Besides Sumali & Vilas (2014) has stated the area of reverse logistics has been explored many times by authors with the focus of varied interests rather than environmental concerns whereas lacking point is that most of them did not gave much attention on products that has characteristics of reusing as a part of supply chain and not as an option. In this context, LPG gas cylinder reuse for filling can be show as an instance. In this sense, Murphy & Poist (1989) were the initial authors who use reverse logistics term for products such as gas cylinders and thereafter many of other researchers started using it with various value additions.

According to Sumali & Vilas (2014), RL can be defined as *"a term that refers to the role of logistics in production returns, source reduction, recycling, materials substitution, reuse of materials, waste disposal, refurbishing, repair, and remanufacturing"*. Similarly, Rogers et al (1996) has stated that *"The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the*

point of consumption to the point of origin for the purpose of recapturing value or proper disposal".

However, De Brito & Dekker (2003) criticised existing description on RL which was provided by (Rogers, et al., 1996) and affixed as: *"We do not refer to 'point of consumption' (...) nor do the products need to be returned to their origin (...)" and demonstrating that RL coordination would exist regardless of whether material assets are sent in reverse, not from the purpose of utilization and to the point of root, however from any phase of the production network to some other stage in a similar chain".* According to this argument with these researchers it's cleared that reuse need will not always occurred at the end of a frontward logistics chain but can generate in any stage. However in the case of LPG cylinders, almost all refilling cycle start in the last part of onward SC cycle due to its characteristics of safer manufacturing which not let for damaging the product at in-between stages. Thereby De Brito & Dekker (2003) has renewed the definition by changing last part as *"....from the point of recovery need or point of proper disposal".*

2.2.1 Types of Reverse Logistics

De Brito & Dekker (2003) classified the categories of returned activities in reverse logistics process in much more detailed way as return to supplier, resell, salvage, refill, recycle, landfill, reuse, refurbish, remanufacturing and etc. Accordingly this categorisation was more detailed and exhaustive.

Table 2.1: Types of reverse logistics

Material	Reverse logistics activities
Product	Return to supplier Resell Sell via outlet Salvage Recondition Refurbish Remanufacture Reclaim materials Recycle Landfill
Packing	Reuse Refurbish Reclaim materials Recycle Salvage

Source: (De Brito & Dekker, 2003)

Fleischmann, et al (1997) has divided RL into 3 forms and those are bulks refilling, network refilling and remanufacturing networks according to its characteristics. LPG gas cylinder refilling is in the category of bulk refilling network where cylinders are collected by distributor and then cylinders are collectively sent for filling stations for start its selling chain cycle again.

Besides, in the current context more attention was not given to improve the process of reverse logistics as LPG market in Sri Lanka is an oligopoly market where only few players are there which has no huge competition over the processes effectiveness. However need is already arisen as current few competitors grab the market share due to product unavailability in market and inefficiencies in reverse logistics flow as mentioned by (Udayangani, 2019).

2.3 Barrier of reverse logistics activities

In the research of (Rogers, et al., 1996), it has scrutinised some petroleum company's operation from reverse logistics aspects and concluded that there are several barriers caused on reverse logistics process inefficiencies.

Table 2.2: Barriers of reverse logistics

Barriers	Percentage
Importance of RL relative to other issues	39.2%
Lack of technological systems	35.0%
Company policies	34.3%
Competitiveness issues	33.7%
Management inattention	26.8%
Financial resources	19.0%
Personnel resources	19.0%
Legal issues	14.1%

Source: (Rogers, et al., 1996)

In addition, Ravi & Shankar (2014) has concluded that company regulations, lack of technology, lack of proper process, financial issues and human culture are the most effective barriers in reverse logistics in LPG industry where it needs fundamental transform of peoples' state of mind and technological actions effective RL processes. Further, author describes technological factor as one most important factor which lead to good reverse logistics operation where it can be achieved by Radio Frequency

Identification Devices (RFID) and real-time visibility tools integrated with EDI. In this sense, allocating budgets on improving technological usage over the distribution network may not be a waste. Whatsoever, Ravi & Shankar (2014) has further described that higher visibility must be earned in distributing LPG cylinders in rural areas because there is no standard or assumable time period of cylinder usage due to rural people use other sources also for their domestic cooking activities. Thus distributor may not have an exact idea of how much cylinders will they collect for refilling from rural areas and LPG supplier may not know even the little information that distributor know. Thus technology enabled system is needed for increase the visibility over the process where it will help to better service between LPG supplier and distributor.

2.4 General LPG distribution methods

Useful LPG originally generates from dealing out fossil fuel & also stabilisation of natural crude oil in the Earth. Some sea view countries import refined as well as crude products for their domestic and industrial purposes while land lord countries mostly import refined products as well. They maintain large LPG storage facilities; typically in associate with import terminal stores where LPG has being supplying by big specially designed high risk ships. In many countries pipelines are used as main distributional method but here in Sri Lanka people do not need that much of pipeline distribution as land size in Sri Lanka is very less compared to other countries. Then LPG will be loaded to tankers for the purpose of delivering them to supplier storages. (Sriyogi, 2014). Thereafter, LPG local supplier distribute filled LPG cylinders to its distribution points island wide through prime movers and last mile delivery for customer is done by this distributors by using bicycles, three-wheelers and through small lorries. It's the end of forward logistics flow of LPG distribution where reverse flow starts when the customers returned empty cylinders back to its purchase places.
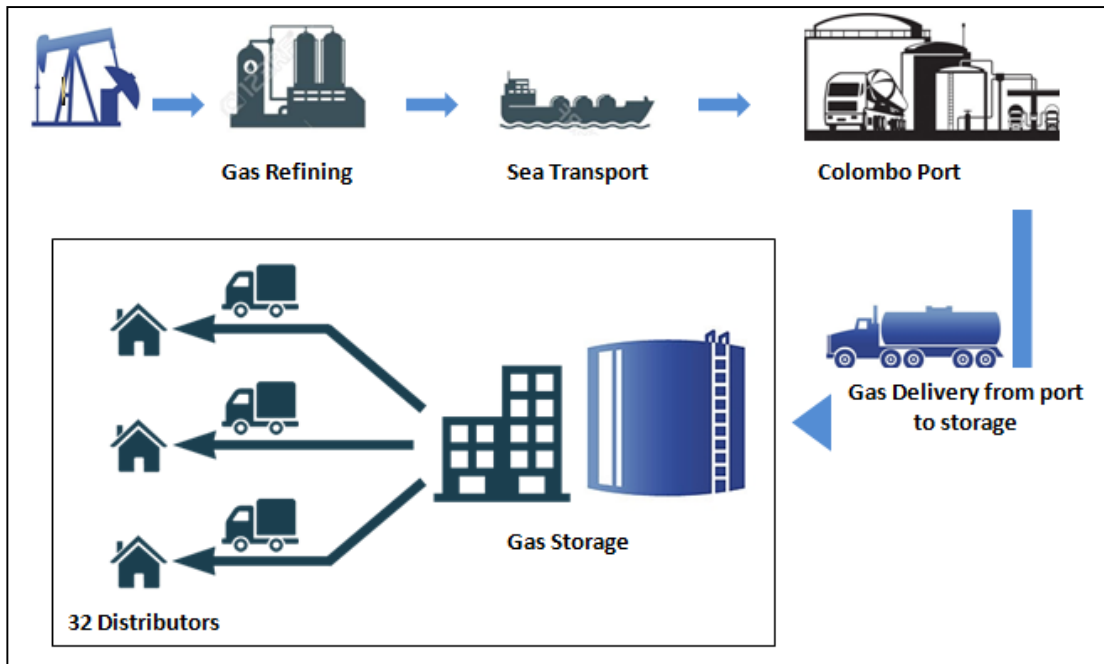
Figure 2.1: LPG Distribution Network
Source: Author (2019)

The particular distributor in that area need to collect all used cylinders from its retails customers while delivering the filled products to retail customers. Once considerable amount of empty cylinders were gathered to distributor point, then distributor will inform about the cylinders to supplier where supplier arrange the collection vehicle to distributor with filled stock in vehicle itself (Sriyogi, 2014).
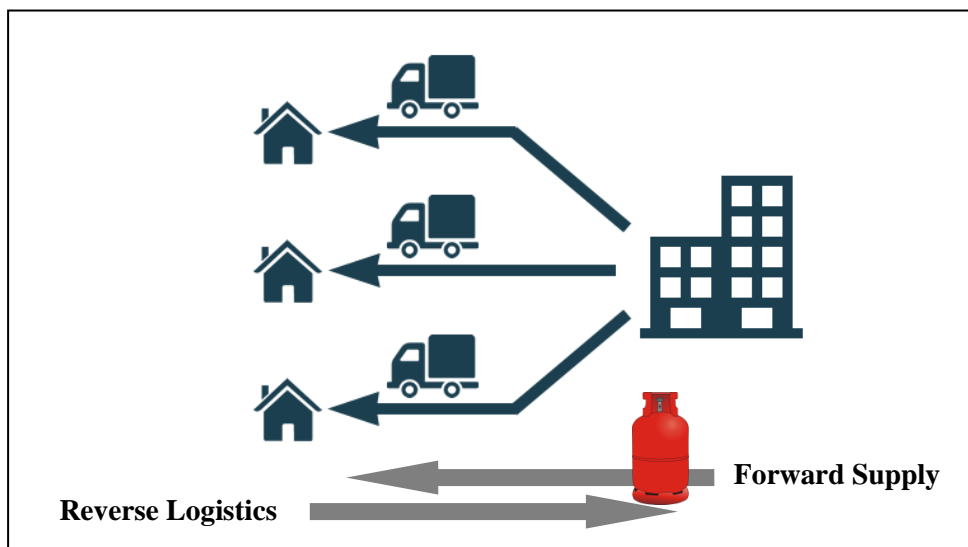
Figure 2.2: LPG Cylinder Forward and Reverse Logistics Flow
Source: Author (2019)

RFID along with other technologies will track inventory with lot of accuracy in real time leading to reduced interval and labor. There are several potential applications for manage the inventories in motion where entire visibility can be managed since supplier manufacturing place up to customer's place and till empty cylinder returns back for refilling.

2.5 Technology enabled reverse logistics processes

Significance of using IT in turn around coordination is many. At the operational measurement, it decreases costs and bungles through overhauled perceive-ability, improved coordination, and data driven component (Hakan & Bulent, 2016). The diminishing in lead time and cost changes over into cost hold and various characteristics in regards to progressively conspicuous capability and better responsiveness. At a key dimension, innovation permits continuous information sharing among gatherings take part backward coordination to soak with data in regards to stocks, developments and refilling (Tae, 2016). This develops affiliations and extends forcefulness of the whole creation and dispersion arrange as time goes on.

From 2002 to 2009, Langley et al (2009) has referenced that there was an extensive normal hole between expected IT exhibitions in conveyance part of organizations and genuine workableness. Be that as it may, undoubtedly, organization needs to comprehend why such a hole exists and how it very well may be limited over the long hauling.

In the context of LPG industry, rising operational complexities can be seen due to its reuse of product nature where focus is double for the management regarding selling the product and bringing back the used product for production again. Thus technology usage in the process at least for one direction specially the reverse logistics part will reduce the work load and increase the process visibility. According to the US study led by Langley et al (2009), innovation utilization in four locales to be specific North America, Latin America, Asia-Pacific, and Europe, run from 47% to 66% in 2009 and are anticipated to increment to 54% to 74% by 2014. In US, yet

additionally in different nations, oil players are looking for coordinated coordination administrations with innovation empowered instruments to cause a decent relationship so as to streamline the general administration administrations (Lau & Ma, 2008). Along these lines for offer efficient and snappy reaction to the merchants, LPG providers are putting resources into IT to upgrade correspondence, improve perceivability and coordinate with wholesalers data where supplier have low information.

Vidgen, et al (2004) has expressed that innovations that can be utilized in these procedures are RFID following, scanner tag perusing, EDI and so forth where these advances decrease the mistake, outlines non-moving, moderate moving and improve the whole overseeing procedure effectiveness. RFID will be sketched out as partner programmed distinguishing proof innovation made out of: labels fused into or associated with any sensibly object (items, apparatuses, creatures, products, soul, and so on.). A particular RFID reader that peruses the learning keeps those inside the labels and exchanges them to a procedure gadget (a workstation for example). There are many key varieties between RFID where fundamental parts are reader (likewise alluded to as investigative specialist) and a tag (or transponder), that might be a microchip associated with partner reception apparatus. When a label goes through the circle lined by a reader, the information keep inside the tag is transmitted to the reader (Asghar & Ganesh, 2008). Therefore with regards to LPG chamber circulation; these labels will be an extensive assistance to distinguish the piece of the overall industry, requesting territories just as area through its development signals. Bit of leeway of uninvolved labels is the size that is a littler sum than the size of a dime that makes them clear to incorporate or connect to things. These gifts, low esteem and decreased size, happen to the detriment of output fluctuate. The output differ of a tag relies upon each the capacity of the reader and furthermore the recurrence need to convey. As referenced before by Asghar and Ganesh (2008), presenting RFID in an exceedingly give chain isn't exclusively a specialized downside. The RFID innovation has a few qualities which will oblige the corporate to redesign and potentially plan its dispersion and warehousing frameworks.

For describe the process of RFID setting on LPG cylinders, let's assume tags have been placed with prime movers, distributor place and in LPG cylinders. Accordingly each single unit can be tracked within the provided signal scope and integrated computer system can monitor the cylinder movement either filled or empty since the cylinder dispatched from its suppliers place until it receives at the refilling place (Abdelkhak, et al., 2012). Thus it will track movements, consuming time, storage time and places, lead times, distance from supplier to consumer and many more details. In addition, below are several other advantages too that can be received through RFID systems.

- Reducing body blunders, due to the computerization of data exchange.
- Simplifying generation the board, as a result of the adaptability to follow work-in-advance continuously.
- Reducing procedure stress, as a result of early information associated potential creation issues.
- Being prepared to start business relations with real customers who need RFID use from their providers.
- Controlling the standard of things after they precede onward the arrangement chain. RFID innovation allows the social occasion, progressively, of information that impacts quality. For instance, labels will screen temperature, bacterium thickness, level of mugginess, and so on. In fact, dynamic or semi-dynamic labels are expected to perform recognition.
- Managing yards, distribution centers and processing plants. For instance, labels are additionally needed to direct trucks to the preeminent efficient drop-off areas.
- Robustness of labels is another vital aspect of RFID innovation. RFID will include messy, wet, sleek, warmth or cruel setting. Additionally, inactive labels will keep going for escalated sum, making the innovation safe. (Abdelkhak, et al., 2012).

Inventory network Management (SCM) is partner way to deal with arrange materials and information streams between business substances in satisfying client's interest.

The SCM situation is concentrating on parcel of commonly useful procedure for each partner while SC individuals endeavor to keep their monetary opportunity and basic leadership self-sufficiency. The coordination challenge lies in associating the appropriate a piece of colleagues' information frameworks worried in an exceedingly SC. An overall issue in SCM is then to create information trade components to adjust the destinations of clients and innovative abilities. These specialized constraints for RFID reception should be expelled by building up a dispersed reenactment stage to help the arranging and check of decisions Support Systems (DSS) committed to improve RFID-based providing frameworks (Raghav, et al., 2013). The stage arranged amid this paper is a great deal of included by the administration of a vehicles armada of providing administration providers to exhibit the benefits of RFID in sorting out transport activities; it gives a legit on account of perform tests and approval of the most thoughts that might be authorized inside the improvement of equipment and information framework required for genuine technique execution of item conveyance.

The current miss between the ideal vision of RFID execution, delineation its structure possibilities, and its genuine utilization as far as forming its additional in item streams the board has prompted the rise of logical works (Gregory, et al., 2011) and (Alexandre & Jean, 2016) whereas technological problems with RFID readying are mentioned for small-scale systems as well.

The applications abuse RFID, connected to the circle of transport the executives, center a great deal of on the discernibility and assets follow-up than on the idea of wise item. The greater part of them is included with the improvement of the vehicle exercises bolstered by the localisation of any reusable instrumentality or transport mean in order to diminish their costs. (Cheung et al., 2008) consider the conviction that GPS (Global Positioning System)/GIS (Geographic information System) and RFID will be coupled to portray the vehicle situation progressively (vehicles localisation, enhancement of information on the exceptional dispersion of courses and places to go to, recognizable proof of the steering setting) and supply a hypothetical response to determine a DVRP (Dynamic Vehicles Routing Problem)

devoted to an armada of transport vehicles (Raghav, et al., 2013). Wen (2010) recommended that partner canny traffic the board proficient framework including an inactive tag, a RFID reader, a private PC, a join of infrared sensors, and a lot of fast servers with a data framework. The elements of the framework typify the discernibility of suspicious autos included by petty criminal offenses or lawful offense, the giving of reasonable traffic information supportive to educate blockages or to figure the briefest way between 2 positions in an exceedingly street traffic arrange. Abdelkhak, Zitouni, and Bouksour (2012) have directed the work of RFID in switch providing to check precisely the amounts of gathered things in variety focuses. Information is then treated to plan vehicles that exchange things and to help the areas of arrangement indicates so as amplify the inclusion of customers.

The PRODIGE venture is conceived on the lack of specialized answers for help agreeable providing abuse RFID; it means to support the presentation of the conveyance chain by misuse constant information on 'savvy' item and street live setting. The paper has given one among the essential task stages, comprising inside the style of a circulated stage for recreation of cutting edge providing frameworks, in order to approve hypothetical standards, valuable and specialized needs before usage in sensible things. The providing information streams model arranged amid this paper is speaking to relate RFID based generally framework supporting a regular correspondence between reasonable items and furthermore the information frameworks utilized by the partners for recognition the item transportation (Asghar & Ganesh, 2008). The activity between G-DEVS formalism and HLA disseminated recreation standard has spanned holes from unmistakable occasion displaying to the significant framework usage by proposing a gathering of interconnected models progressively comparative by genuine components while not interfering with the HLA based for the most part information stream (Abdelkhak, et al., 2012).

The particular occasion reproduction ends are by and by used to check the blend of physical components went up against to reenactment parts. The occasion of PRODIGE stage for dispersed providing accomplices is promising identifying with

first blended reconciliations of recreation and execution components each upheld the "item determined" rising build. These works are imagined to be turned around to urban quality issues that face comparable issues.

2.6 Associated pros and cons in technology oriented LPG distribution

- Labor Reduction
- Enhanced Visibility
- Asset chase and revertible things
- Item Level chase
- Traceable Warranties and merchandise recollects
- Reliability
- Quality Control and Regulation
- Yard, Warehouse & plant Management
- Improved Inventory Management
- Security
- Ability to face up to Harsh Environments
- Cost Savings

In interaction with LPG distribution firms, management expressed massive considerations in addressing cylinders management and operations. The reprocess of cylinders in LPG production network has been all the time a center business disciplinary and wasn't associated with the latest contemplations of natural and property plug because of the high worth of cylinders contrasted with the product itself. The cylinders securing uses have persistently been contemplated by a few LPG appropriation organisation as capital consumptions rather than partner operational ones (Michael, 2010). Notwithstanding, this record can essentially target cylinders since it higher fits the realized global hazard profile for LPG for example 80-90% chamber park is outside any immediate administration by LPG circulation firms about zero for tanks (Michael, 2010).

One definition that hopes to clarify cylinders the board is: cylinders the board might be an exhaustive administration method that spotlights on what makes LPG particular inside the give chain the board and extremely remarkable ordinarily in business - the bundling is reused. Cylinders the executives grasps every one of the elements of an organization, for example advertising; deals; security; specialized; activities; coordination; lawful; monetary; monetary and money related. The cash and issues of security issues are commonly the most drivers of genuine cylinders the executive's arrangement and drive every single elective issue. Be that as it may, elective issues like selling will for the most part assume a significant job in cylinders the executives too (Michael, 2010).

Cylinders management is critical to LPG business because of the actualities that:

- Cylinder populaces are commonly greater, and speak to a noteworthy extent of benefits.
- Cylinders are on the far side firms' administration for a considerable lot of the time; anyway still these organizations are responsible for chamber upkeep and wellbeing.
- Cylinder the board needs an extravagant, recurrent, strategic framework.
- A mammoth of piece of the calculated cycle is worked by outsider firms (merchants, retailers). Cylinders the board is at the center of partner LPG business because of as route as Cylinders the board.

Organizations aren't ordinarily positive cylinders return. Cylinders are versatile resources that lose organization's immediate administration for a large number of their time frame. Cylinders at the filling plant, on trucks, at merchants and retailers type the corporate working supply of cylinders and may speak to a noteworthy extent of the chamber pool. Firms should fathom the gas deals capability of its cylinders: they should limit mind that not exclusively cylinders are utilized as a working stock, anyway moreover a few cylinders direction by clients aren't "dynamic". Clients normally utilize a second cylinder as an extra save in order to abstain from coming up short on gas. Hence it's very risky to believe entirely on gas margins to recover cylinder capital.

2.7 Future technologies that can support reverse logistics

The utilization of RFID ranges from making and movement of physical item like vehicles and its varied parts to printing ensured receipts, conveying and port undertakings and pharmaceutical pack shapes, among others. RFID may be a sort of modified distinctive evidence and learning get (AIDC) advancement that usages electrical or alluring fields at radio frequencies for unmistakable verification, affirmation, region, or customized data verifying and transmit, and reinforce a better than average move of employments—everything from notwithstanding the administrators and seek after to get to the officials and customized portion. RFID systems have the bowed of sharing data across over structure limits, as give chain applications. Reno GmbH, one among Europe's greatest shoe firms, employable in excess of 700 stores in fifteen countries, plans to install remote RFID contributes shoes oversubscribed at stores over the landmass. City has been misuse RFID advancement to pursue thing shipments from its mechanical offices to its stores for quite a while at any rate has for no situation used the development to pursue solitary thing inside each store. These thin RFID chips are arranged particularly for shoes from its Asian creation workplaces. By having the RFID names consolidated into its shoes, city hopes to check wrongdoing for boxed thing, those on show, and besides the shoes customers wear inside the stores.

The RL providing item review and happen to imperfect item - is normal in production network activities. RFID innovation, through its reasonable Electronic Security Marker (ESM) can even encourage come the board by serving to retailers comprehend on the off chance that they oversubscribed the thing being came. Partner ESM ties the association of a chose item to a given deal then to the come. Creators may pick up favorable position from the disposal of offensive item being come to retailers by embeddings thing level RFID labels on their high completion item and components. Customer returns can expand the stock heap as restriction exhausting it. These profits will be seen as RFID giving downstream deceivability of negative requests.

3. RESEARCH METHODOLOGY

3.1 Defining research methodology

Research is an examination to acquire particular and gain confirmations so as to look at the circumstance and suggest arrangements (Johnson, 1994). Research procedure is the method for finding an answer for the examination issue by a logical and deliberate way. So also Creswell (2008) has referenced that, analysts used to assemble and inspect the information of a topic which includes three stages in the process which are making sense of an issue, accumulate information lastly present an answer for the issue.

Along these lines, the target of this part was to give all angles, for example, how to confirm the issue, look into methodologies and strategies, test and populace plans, poll structures, information gathering procedures, moral contemplations just as expository devices which requires to display an answer for set topic.

3.2 Research approaches

As mentioned by Creswell (2008), there are main three research approaches namely inductive, deductive and abductive. Deductive approach is worried on testing a hypothesis while inductive approach is foreseen with making another idea from the information while abductive research then again, begins with amazing certainties or confuses and the examination procedure is dedicated their clarification.

In this subjected research, author mainly targeted on inductive path as it tries to develop a mechanism to improve the reverse logistics of LPG cylinder operation, develop a cost effective distribution model along with the introduced reverse logistics process. Thus it will finally illustrate a comparison between after implementation of new process and current process as well as how the company could overcome the distribution and reverse logistics challenges. Indeed, an inductive approach was the best suitable approach for this research.

3.3 Research methods

Research Methods can be mainly recognized as subjective, quantitative or blended research (Rhodes, 2018). Quantitative research is worried about the information which can be dissected as far as numerical information. Also, quantitative research applies measurable techniques and surveys an enormous number of members to distinguish in general examples in identified with the procedures (Rhodes, 2018). Subjective information is tied in with understanding the human conduct from source's point of view.

In this subjected research, researcher will use quantitative data in order to make solutions as obtaining qualitative data from an office premise was not easy.

3.4 Research strategy

According to Saunders, Lewis, and Thornbill (2000), there are a few kinds of examines systems where creators can choose the best procedure dependent on the direction of the researcher.

In this manner, in this examination, it was a questionnaire which was completing by the researcher as this exploration endeavors to gather the information, break down and speak to the arrangements as needs be for the set topic.

3.5 Conceptual framework

According to the objectives referenced above, underneath applied system has been delivered using the likenesses and logical inconsistencies that have been condensed in Chapter 2. Figure 3.1 represents the conceptual framework which makes the base for the examination by holding the relationship, the ideas and the exploration setting utilized in the investigation.
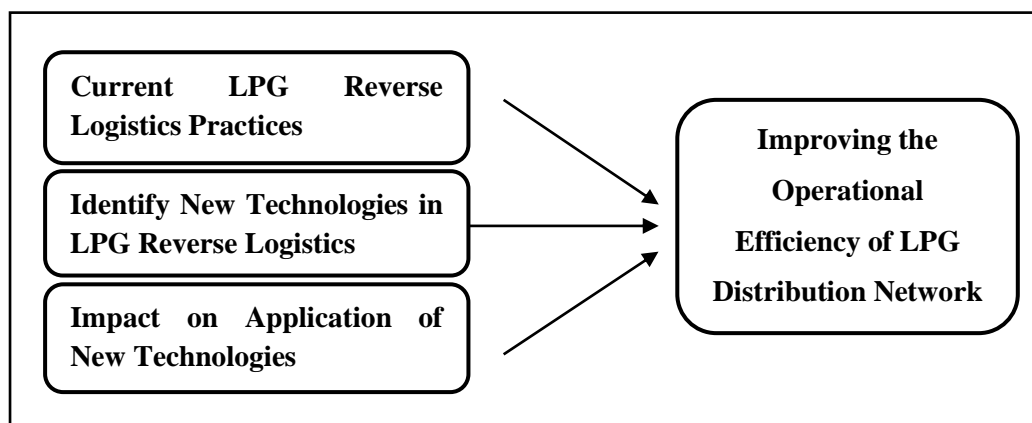

Figure 3.1: Conceptual Framework
Source: Literature Supported

3.6 Sample design

3.6.1 Target population

In a better research of how can technologies improve the reverse logistics operations between LPG supplier and LPG cylinder distributors, engagement of everyone in the organisation and engagement of affecting stakeholders are worthwhile for getting a better response. Author has mainly targeted on substantial number of employees covering of five subject matter affecting departments of ABC Company. Mainly 5 departments are on the population focus which are operational, logistics, finance, security and warehousing departments which consist of 120 employees. In addition, author will focus on getting responses from ABC Company's perspective thus distributor's viewpoints may not be considered.

3.6.2 Sample

There are main two types of probability methods namely probability and non-probability techniques. Probability inspecting is the place every member of the gathering has a perceived chance of adding to the examination where in non-probability testing just certain people of populace can add to the investigation (Wilson, 2018).

As the survey can be filled by any representative in chose branches of ABC Company as taken in the population, it was disseminated among each chosen departmental workers without thinking about religion or culture or some other socio economics. Subsequently test will be chosen as 30 representatives covering 6 workers from every office along these lines physical polls will be conveyed for them.

For the purpose of sampling decision, stratified sampling method was used as well.

3.7 Data collection

3.7.1 Data collection techniques

Data collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated

research questions, test hypotheses, and evaluate outcomes (Wiki, 2018). In this research, author has utilized a few information accumulation strategies, for example, interview and survey both techniques.

Interview is the verbal discussion procedure between at least two individuals with the goal of gathering applicable data with the end goal of research (Vinay, 2014).

A survey is an exploration instrument comprising of a progression of inquiries to accumulate data from respondents (Wiki, 2018).

3.7.2 Primary data set

Subjected research was mainly based on a physical questionnaire where author will distribute survey to selected sample under defined sample technique to collect the necessary data for research analysis.

3.7.2.1 Questionnaire design

Questionnaire is added as an attachment in the end of research paper.

It will consist with two main parts namely section A and section B where 'section A' focus on descriptive information, LPG industry environment as well as distribution network related questions. 'Section B' will focus on operational performances after implementing new technologies in the process. As per the different scopes of different research questions, all the questions were based on interval, nominal, ordinal and four or five-point likert scale.

3.7.2.2 Questionnaire measurements

Interval, nominal, ordinal and likert scales were used by following respective research questions as summarised in table 3.1.

Table 3.1: Measurement Types of Questions

Focus area	Measurement Type	Question No
Demographics of respondents	Interval/ Nominal/ Ordinal	1, 2, 3
LPG industry behavior	Short answers/ Nominal	6, 7, 11
Distribution network related	Nominal/ Ordinal/ Likert	4, 5, 9, 10
Technology related	Nominal/ Likert	8, 12, 13, 14, 15

3.7.3 Secondary data

Secondary data implies second-hand information which was already collected and recorded by any person other than the user for a purpose, not directly relating to the current research problem (Surbhi, 2018). These secondary data were cost efficient and reduces time in data collection.

In this study, secondary data was not given a priority whereas required secondary data was obtained through internal sources such as internal ABC Company documents under the approval of relevant person. Further several data was obtained from scholarly articles, journal articles, books, websites and reports based on technology enabled reverse logistics means that have been written by related authors in Sri Lanka as well as in international regime. Those ideas were critically analysed in literature review section as well.

3.7.4 Justification of the sampling approach

Here the research only focused on working employees in ABC Company for the purpose of getting their viewpoints regarding issues in LPG reverse distribution network and ways of improving the process. When distributing the questionnaire, it was mainly focused on reducing LPG distribution cost and then rests of questions

were based on that foundation. And in the context of data collection, response ratio was 100% where it was a justifiable rate as every employee in selected sample tried to response for the survey and it was within the standard sampling size as well. Thus sample can be justified as it covers the ideas of all employees in different departments in ABC Company regarding the research topic area.

3.8 Ethical consideration

At first an online informed consent for research members and company informed consent structure will be given to ABC Company in regards to the date gathering and use of the gathered information. Furthermore, it was informed that taking part in an exploration study was totally deliberate and they can pull back from the examination whenever or decide not to take an interest. In any kind of report which will make openly accessible, author will exclude any data that will make it conceivable to distinguish the information gave. All polls will be put away on an individual devices and will use for information investigation. Nobody was approved to access as it was a author own device which is mean to use for research reason. When the exploration was finished the polls will be erased alongside the information too.

3.9 Limitations

Due to high scope of the population, author has taken only a sample which consists of one third among population. Sometimes, there are contradictions between responses as different employees have varied view points on LPG distribution networks as well as technological supports on the process. All the data will be collected through office hours when employees are in work thus exact information could not be received as employees are engaged their own office works.

3.10 Statistical methods of data analysis

There are main two parts in data analysis chapter which are descriptive analysis and factor analysis. In initial section, it has analysed demographics, company environment and reverse logistics industry behavior focusing on LPG distribution.

However, factor analysis section focuses on possible effect on LPG distribution process by introducing technology oriented reverse logistics flow.

3.10.1 Validity, reliability and factor analysis

SPSS 16.0 (a statistical programming instrument) was utilized to investigate the gathered information of the study and following measurable information examination techniques were utilized in breaking down the informational index obtained.

To start the factor investigation, Cronbach's Alpha will be estimated as it use to quantify inside consistency/unwavering quality which is most routinely used to approve the dependability of a different Likert-Scale survey. Higher statistics than 0.7 is required for Cronbach's alpha coefficient to have solid informational index. Further, Kaiser-Meyer-Olkin (KMO) test will be done to test the adequacy of the informational index for continue with a factor investigation where it needs test esteem higher than 0.7 to be acknowledged. Nonetheless, higher KMO qualities are better since it speaks to higher relationships between's sets of factors. KMO esteem will be estimated alongside Bartlett's test where it checks whether there is an applicable repetition among factors to abridge for modest number of factors by distinguishing the likenesses and contrasts of the underlying factors.

3.10.2 Chi-square test of independence

Chi-square test is completed with the focus of deciding whether there is a considerable connection between two straight out factors in the informational collection. Accordingly, null and alternative hypothesis will be developed for every investigation and test will be done with 95% certainty level. In this manner, huge test esteem lesser then 0.5 will prompt reject null hypothesis and acknowledge the other which will prove that there is a critical connection between chosen factors.

4. RESEARCH ANALYSIS

4.0 Introduction

Chapter 4 depicts the outcomes of the data analysis. It mainly consists with descriptive statistics and inferential statistics where factor analysis, average scale analysis have been completed through inferential statistics whilst descriptive analysis used to represent evaluated data in a momentous way. Collected data was fed into SPSS 16.0 in order to get inferential data for conclusion.

4.1 Descriptive Analysis

Here the analysis part will be included illustrations and tabular for ease of understanding the context of responses received by 30 employees.

Table 4.1: Demographics of Respondents

#		Working Experience in the Company			
		Less than 1 year	1-3 years	3-5 years	Above 5 years
Gender	Male	4	7	7	1
	Female	3	4	2	2

Table 4.1 depicts the demographic of respondents where most of them are male (19) and rest are female (11). In cross analysis, 2/3 of employees have 1 to 5 years of experience where employees likely to have higher no of working years in the company which concludes that their total HR procedures, salaries and incentives are favorable to the employees. Moreover these employees further will have better knowledge on how the processes are going on within the company due to higher years of working experiences.

Figure 4.1: No of Respondents

Figure 4.1 illustrates the engagement of respondents. Initially author has focused on main 5 departments which had direct impact from cylinder distribution operation and six employees were focused from each department for data collection. Thus in this analysis stage, all of those 30 employees responses are summarised which will lead to better conclusion.
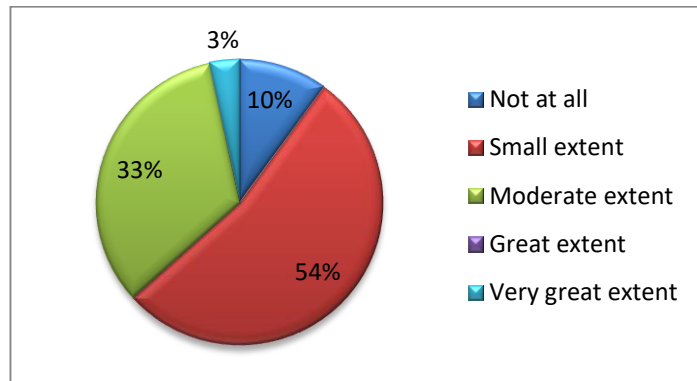
Figure 4.2: Degree of RL Practices Usage

Figure 4.2 illustrates the degree of reverse logistics (RL) practices usage in the company. As per the responses views, 54% of them denoted that usage of better RL practices is in small extend and 33% of them have mentioned that usage is moderate that is altogether 87% of low using perceptions. As LPG cylinder is almost a necessary product in any house in Sri Lanka nowadays, its forward distribution and reverse logistics collection and as well as refilling is utmost important to fulfill the continuous demand. However as per the responses, current RL innovative practices

usage is very low which is a must to be upgraded either with technological or process optimisation.
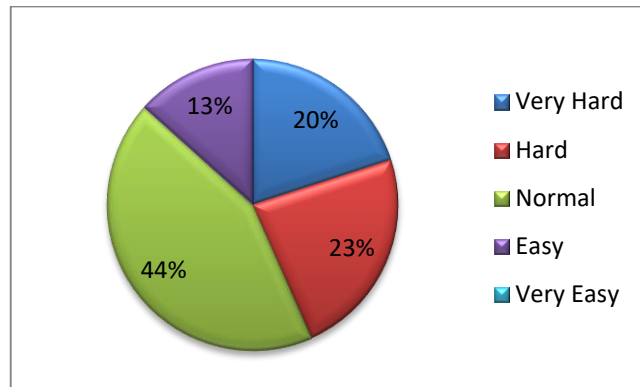
Figure 4.3: Easiness of Cylinder Distribution Process

Figure 4.3 illustrates the current process easiness in cylinder distribution in subjected company. 20% of respondents said that process management is very hard, 23% said hard. And 44% said it is a normal procedure and only 13% of respondents said that it is easy. This concludes that cylinder distribution process is not easy that may be due to several process issues in managing.
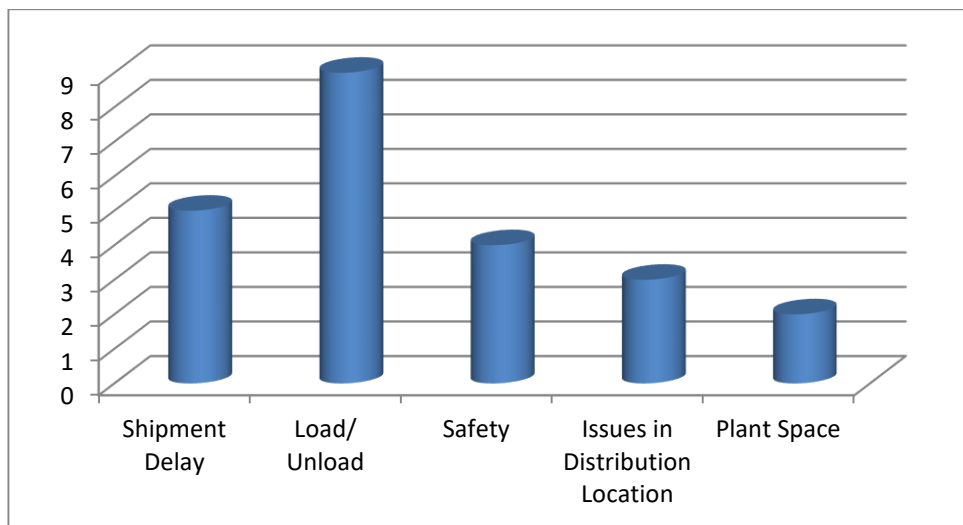
Figure 4.4: Mostly Issues Rising Areas

Above figure summarises the main issues that are arising in cylinder distribution context. Most concerning issue is the loading and unloading function in distribution where the driver's supporter has to load and unload all the cylinders in the delivery vehicle solely. It is not efficient but a labor oriented operation which has to be done.

Second most important issue is the shipment delays which may occur due to logistical issues load/ unload issues, process visibility issues or sometimes mismanagement as well. Third, fourth and fifth issues are respectively safety issues, issues in distributor location and supply plant space issues. Safety issue is always there with cylinder operation thus proper actions are already taken with safety control equipments in each and every delivery vehicle. However, the issues in distributor location cannot manage by the supplier but can be mitigate through proper visibility management application. This can be done by technological solution through detecting the cylinder locations such as most turnover location identification, most demand identification, highest cylinder stuck locations identification and etc. Technologies such as RFID can be used in here for tracking all the movements in order to get an idea on how and when the cylinders are moving and its visibilities can be maintained through this as well.

Currently all the delivery and collections were outsourced and done by prime movers. Thus if technologies such as RFID is going to be implemented, tags will be attached to each and every cylinder but will not be tracking the vehicle as it is outsourced. Moreover, memorandum of understanding between both supplier and distributor will help to track the vehicle with the cylinder movements also in real-time.

	Milk Run Distribution	Separate Delivery Trips
■ Series 1	11%	19%
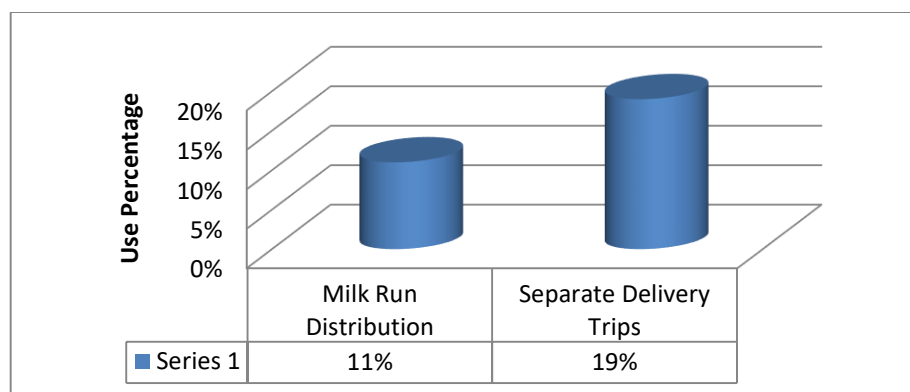
Figure 4.5: Cylinder Distribution Methods

Figure 4.5 denotes that current cylinder distribution methods and most used method is separate deliveries for each distributor locations. This will depend based on the size of the distributor where single full delivery has to be made if the distributor is a major or due to its demand. If the demand is low in several particular distributors, milk run distribution can be done in these places. In explaining, milk run distribution is about having a full lot in the start of delivery and delivers to each and every location that need its products and come back to same origin place by collecting empty cylinders at the same time. Obviously initial method is cost saturated and milk run is cost effective in these cylinder operations.
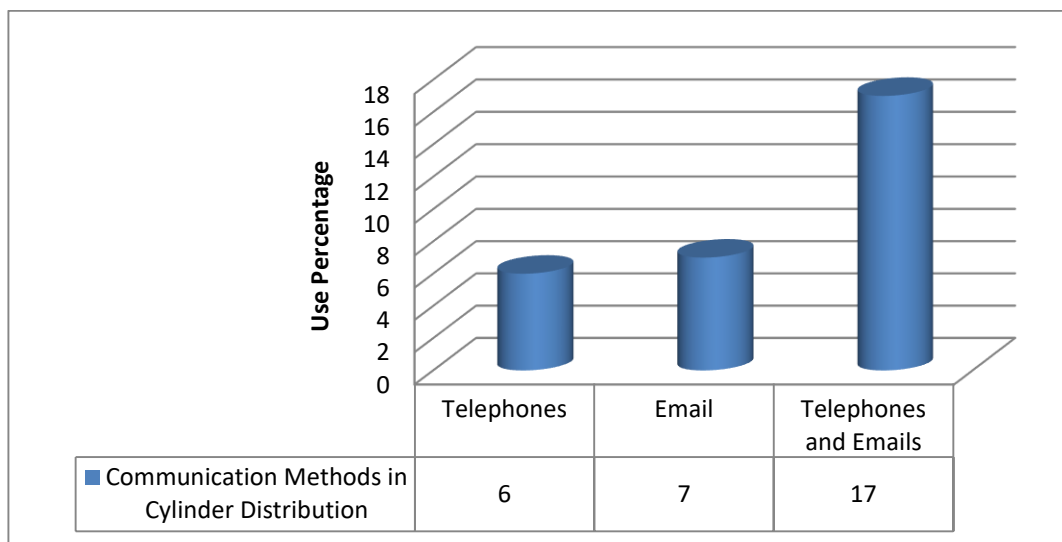
Figure 4.6: Communication Methods Use

Figure 4.6 shows the communication method in cylinder operation and it denotes that communication methods are traditional and should be innovated the process with technological integrations. Currently most used methods are telephone communications as well as emails in managing entire distribution network thus there is opportunity to implement Delivery Management System (DMS) which helps both supplier and distributors to reach information in real-time without anyone's interactions.
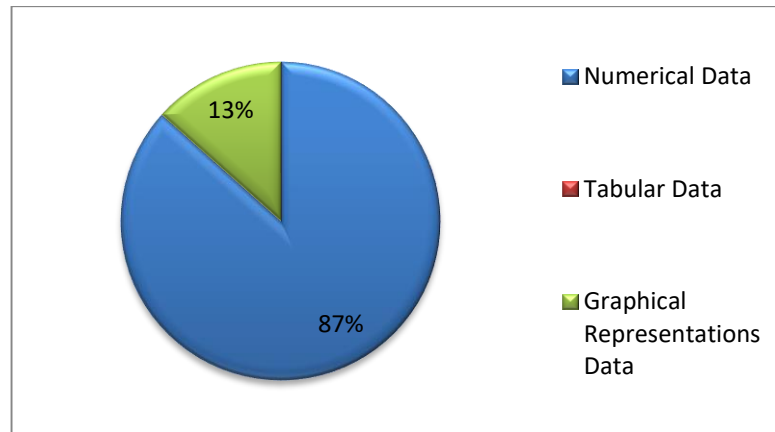
Figure 4.7: Data Format in Analysis

Figure 3.7 is about the data management ways in LPG distributor points where highest usage is numerical while only 13% is graphical. Thus current data management is very hard and takes time to give a useful output in the decision making process.

It further affirms that 51% of respondents have noted as supply area information examination is extremely hard because of increasingly crude information which need numerous filtrations and procedure to get a helpful result which expends time. What's more, 43% have said that an ever increasing number of spreadsheets likewise make the examination time taken. It affirms that having graphical outline of provider area information will facilitate the examination which does not take numerous procedures to change over into a valuable result. Be that as it may, effectiveness of provider exhibitions examination basically rely upon how quick the information and data are accepting for investigation purposes. Thus technological usage is needed in here as well in order to improve the process efficiencies.
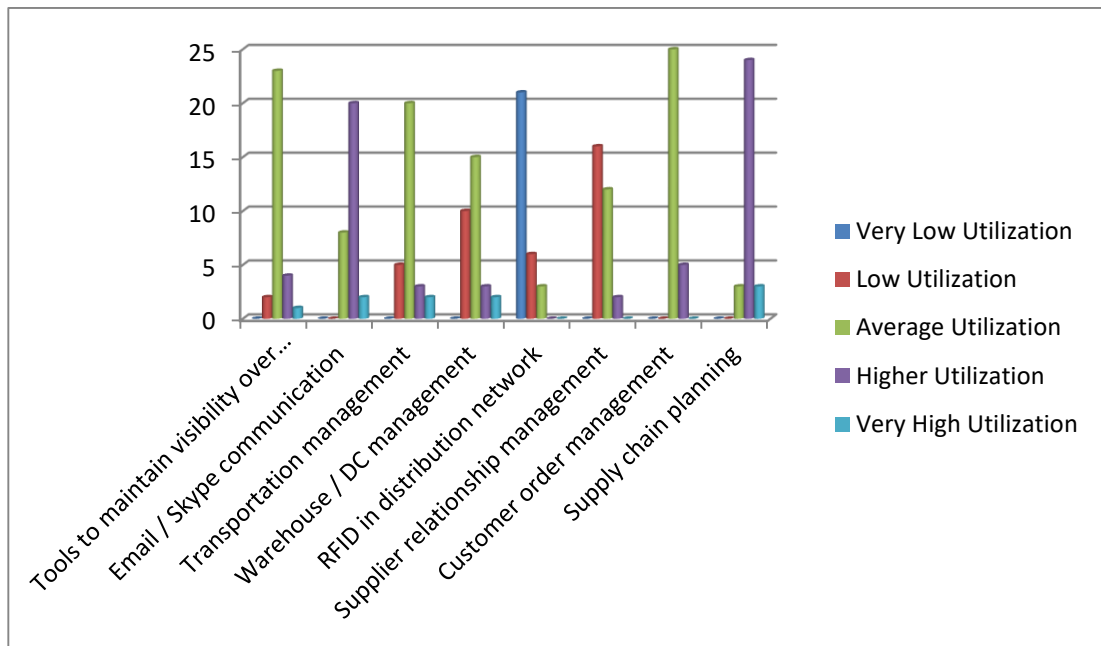
Figure 4.8: Degree of IT Tools Utilisation in Cylinder RL Management

Figure 4.8 illustrates the current IT tools utilisation in the RL process. Most reverse logistics management process such as supplier management, RFID in distribution and warehouses management have very lower utilisation of IT tools over its process management. Tools on managing supply chain and communication management account for higher IT tools utilisation. And customer management as well as visibility management tools are also average utilisation.

Thus currently in cylinder operation, company is focus for satisfy supply chain planning and maintaining interactions only. This will help to establish new IT solution for smooth the process where current system wouldn't helps to make good overall visibility on the operational process. Eventually it will reduce the visibility gap. In addition, opportunity is pending in supplier management as currently there is lower utilisation of IT tools in supplier management. Thereby possible solutions have been included in survey by author to get an idea over the solution and to see the respondent's ideas as well
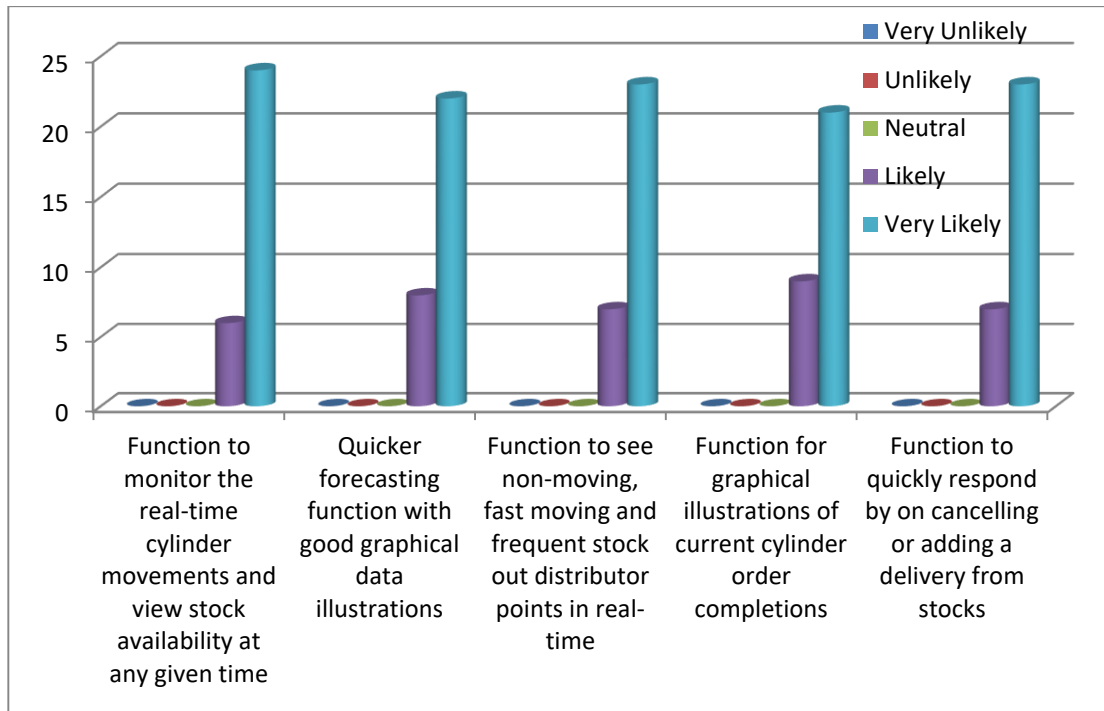
Figure 4.9: Likeliness of Additional Functions to be implemented in RL
Management Process

As summarised in figure 4.8, here the figure 4.9 shows the respondents view on
having new IT tools in improving RL process in cylinder distribution. All the
respondents have mentioned that they are very likely to have functions such as real-
time monitoring, quicker forecasting features, identification of slow moving and high
moving cylinder locations, graphical data analysis function and flexible order
management functions as well.
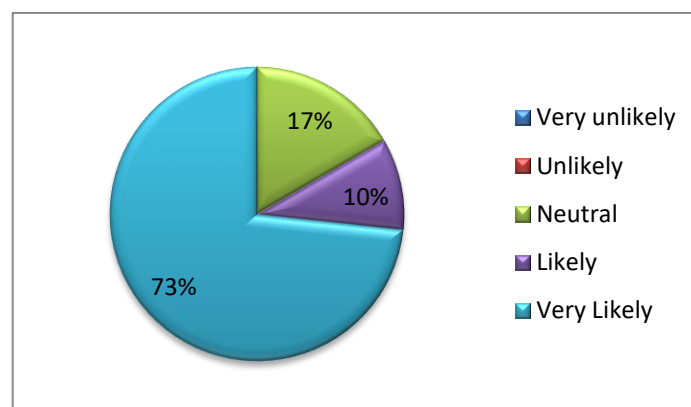
Figure 4.10: Overall Likeliness to Implement Sophisticated IT System for
real-time monitoring of cylinder stocks and its movements

Finally figure 4.10 illustrates overall likeliness to have technology oriented reverse logistics process in cylinder distribution and 83% of respondents noted likely to the concept.

4.2 Hypothesis Analysis

H_0a: The Order Fulfillment Lead Time (OFLT) will have no bond with no.of orders made by respective distributors.

H_1a: The Order Fulfillment Lead Time (OFLT) will have bond with no.of orders made by respective distributors.

H_0b: Stock of refilled cylinders has no considerable bond with finalysed orders amount in a given day.

H_1b: Stock of refilled cylinders has considerable bond with finalysed orders amount in a given day.

H_0c: Stock at hand vs. cost of maintaining finished inventories ratio has no significant relationship.

H_1c: Stock at hand vs. cost of maintaining finished inventories ratio has significant relationship.

Table 4.2: Hypothesis Test

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
23	The distribution of H1 is normal with mean 3.93 and standard deviation 0.691.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
24	The distribution of H2 is normal with mean 3.77 and standard deviation 0.774.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.
25	The distribution of H3 is normal with mean 3.73 and standard deviation 0.640.	One-Sample Kolmogorov-Smirnov Test	.000[1]	Reject the null hypothesis.

Above table 4.2 illustrates the hypothesis testing summary results. Accordingly, all the test information is below than recommended 0.05 values where it can prove

higher than 95% confidence. Thus test statistics lies on rejected region and therefore null hypothesis is rejected. Accordingly the entire alternative hypotheses are accepted.

Thus technological solution must be given to increase the order fulfillment rate to minimize the time of order finishing. In addition, amount of re-filled cylinders in hand defines the efficiency of the distributor in the same day operations. And finally demand and supply planning must be catered with technological solution in order to identify the demand pattern and stock re-filled cylinders in order to reduce the stocking cost of finish products.

Below table 4.3 shows the test results for hypothesis analysis between proposed technological functions to improve the cylinder distribution operations. Here also test statistic lies on rejected region which lead to reject null hypothesis and accept alternative relationships. Thus all the technological proposals are good and have significant relationship with cylinder distribution process improvements.

Table 4.3: One-Sample Test for Additional Technological Features for Cylinder Operations

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Function to monitor the real-time cylinder movements and view stock availability at any given time	64.622	29	.000	4.800	4.6481	4.9519
Quicker forecasting function with good graphical data illustrations	57.641	29	.000	4.7333	4.5654	4.9013
Function to see fast moving, non moving and frequent stock out distributor points in real-time	60.691	29	.000	4.7667	4.6060	4.9273
Function for graphical illustrations of current cylinder order completions	55.232	29	.000	4.7000	4.5260	4.8740

Function to quickly respond by on cancelling or adding a delivery from stocks	60.691	29	.000	4.7667	4.6060	4.9273

4.3 Factor Analysis

Below factor analysis is based on the operational performances as a result of adopting new technological reverse logistics practices to cylinder distribution/ collection process.

Table 4.4: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.793	.826	22

Cronbach's Alpha value of this research is 0.793 which is in better level where it can conclude that data set is acceptable for factor analysis. Its recommended vale lies on 0.7 where higher the test statistics value that that will better the data collected for analysis.

Table 4.5: Total Variance Explained Values

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
Cost	7.204	32.747	32.747	7.204	32.747	32.747
Quality	5.859	26.630	59.377	5.859	26.630	59.377
Speed	3.931	17.870	77.247	3.931	17.870	77.247
Flexibility	2.006	9.120	86.366	2.006	9.120	86.366
Dependability	1.139	5.179	91.545	1.139	5.179	91.545
Factor 6	.626	2.843	94.389			

The above table 4.5 depicts the summary of influence on selected components by enhancing the operational efficiency through technological solutions where main five factor categories are used in the analysis which is Cost, Quality, Speed, Flexibility and Dependability. Each and every percentage of variance explains the each factor

loading where highest numbered factor will have higher influence and get lower by other factors. SPSS exact all factors with eigenvalue greater than one because value over 1 has higher impact on the subject matter. According to the table 4.5, all eigenvalues are greater than 1 in selected five factor categories. The % of variance column numbers depicts how each factor has got influenced through technological innovations in the organisations. Thus all of these five factors are affecting with better results when technological innovation are implemented.

Factor 1 explains 1/3 of the total variance (32.747). Initial percentage of variance numbers accounts for higher number of variance where variance gets lower for rest of factors in ascending order. Factor 2, factor 3, factor 4 and Factor 5 explain 26.630%, 17.870% 9.120 and 5.179% of variance correspondingly. As a whole, initial 5 variables accounts for 91.545 % of total variance which is cover of almost all the possible advancements of the process. Thus advancement of technological features will increase speed, flexibility, quality and optimise dependability and cost of cylinder operations in the subjected company.

4.4 ROI Analysis on RFID Implementation

Here author will suggest using RFID tags and systems in supplier places, distributor places, vehicles and cylinders. However supplier must ask for distributors to upgrade their facilities to RFID tracking, and must ask vehicle providers to set GPS to prime movers. Accordingly they will have to adhere otherwise they will lose the business from ABC company. As the market giant, ABC Company has this bargaining power already. Rest of the process such as RFID tracking equipments in supplier places and RFID tag setting to cylinders should be bear by the ABC supplier.

No of Houses in Sri Lanka (CB,2017)	5.5 Million
Assume 30% is using ABC Company Gas Cylinders	
Accordingly there are 1.5 millions of cylinders around Sri Lanka	
Cheapest RFID cost average (RS)	70
Total RFID cost LKR	20,000,000
System implementation cost LKR	2,000,000
Total Cost in RFID implementation LKR	**22,000,000**

	2017	**2016**
Revenue	10,386,886,352	9,719,503,073
Cost of Sales	-9,244,995,763	-7,975,524,176
Cost has increased by 16'17		16%
Sales increased by 16'17		7%
Sales forecast for 19'20 financial year		11,670,705,505
Cost forecast for 19'20 financial year		(10,724,195,085)

Previous analysis statistics have shown that distributional cost optimisation will be 32% due to technology involvement. And distributional cost is accounted in ABC Company is 15%.

Thereby,

Distribution cost in 19'20 without tags	(1,608,629,263)
Distribution cost in 19'20 with RFID tags	(1,608,629,263)*68%
Total Cost in 19'20	10,209,433,721

ROI = (Net profit/ Total Outflow) * 100%

= {(11,670,705,505 - 10,209,433,721)/ (10,209,433,721 + 22,000,000)} * 100%

= **14.3%**

Positive ROI will confirm the positive results of the project that going to implement thus RFID implementation will give positive distributional results which reduces cost in operation.

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion and Recommendations

This is the most important chapter which summarised all conclusions of the research and potential recommendations to reduce the LPG distribution cost. RL is a main function in any production industry where FMCGs will have damage products collection flow while ABC Company has cylinder collection flow. Being stated that, this research has addressed the factors affecting the current cylinder distribution process as well as how to reduce cost in cylinder distribution/ collection process via technology enabled procedures. Based on data collected from the employees in subjected company, it is found that current logistical innovative practices usage in cylinder distribution are very low which is a must to be upgraded either with technological or process optimisation as well as respondents concludes cylinder distribution process is not easy that may be due to several process issues in managing.

Most concerning issue is the loading and unloading function in distribution where the driver's supporter has to load and unload all the cylinders in the delivery vehicle solely. It is not efficient but a labor oriented operation which has to be done. Second most important issue is the shipment delays which may occur due to logistical issues load/ unload issues, process visibility issues or sometimes mismanagement as well. Third, fourth and fifth issues are respectively safety issues, issues in distributor location and supply plant space issues. Safety issue is always there with cylinder operation thus proper actions are already taken with safety control equipments in each and every delivery vehicle. However, the issues in distributor location cannot manage by the supplier but can be mitigate through proper visibility management application. This can be done by technological solution through detecting the cylinder locations such as most turnover location identification, most demand identification, highest cylinder stuck locations identification and etc. Technologies such as RFID can be used in here for tracking all the movements in order to get an idea on how and when the cylinders are moving and its visibilities can be maintained through this as well. This process can be upgraded by attaching RFID tags to each

and every cylinder to monitor its movements and demands while memorandum of understanding can be signed with prime mover providers to track their vehicle also.

In the context of distribution and collection, cost can be minimised through milk run distribution method which is distributing empty cylinders and come to the same started place while collecting empty cylinders in the same route. Current direct distributions is high thus it should focus more on milk run distributions except for larger distributors who need huge stocks at once.

In the context of data analysis, graphical illustrations will be a good solution to get the conclusion quicker than analyzing just numbers and getting information by consuming time. However, data management process is not easy and all the data cannot be graphically illustrated but having graphical illustrations for most used information then it will be a good action to increase the efficiency of the process. Thus technological usage is needed in here as well in order to improve the process efficiencies which will save time and cost in long term. In addition to that, currently in cylinder operation, company is targeting on catering supply chain planning and maintaining better people interaction only. This won't make legitimate administration deceivability over stockroom which will have a chance to execute another IT arrangement in distribution center so as to defeat to deceivability gap. In addition, opportunity is pending in supplier management as currently there is lower utilisation of IT tools in supplier management. Hence author has proposed several functionalities to be implemented in the system which are real-time monitoring technologies, quicker movement identification procedures, quick responds to order changes and good graphical illustration in data analysis as well.

Hypothesis test concludes that technological solution must be given to reduce order fulfillment lead time while letting amount of re-filled cylinders in hand to define the efficiency of the distributor in the same day operations. And finally demand and supply planning must be catered with technological solution in order to identify the demand pattern and stock re-filled cylinders in order to reduce the stocking cost of finish products. In particular, it has been seen that the solid connection exists

between request satisfaction lead time and number of requests set by purchasers, orders have been satisfied inside one day, working stock proportion has solid connection with stock conveying cost, and chamber use markers help in dealing with the switch coordination resources and basic leadership organized devices in keeping up the ideal dimension of stocks.

Factor analysis has concluded that advancement of technological features will increase speed, flexibility, quality and optimise dependability and cost of cylinder operations in the subjected company. Finally 14% of positive ROI confirms the success of the technology implementation over the distributional process where eventually it will reduce the overall cost in ABC Company. Thus as per the objective of the research, technology enabled LPG cylinder distribution/ collection process will optimise the cost of logistical operations in long term.

5.2 Limitations of the Research

Here the researcher has thought only on working employee's perception in smaller scale thus there might be some concerns regarding the operational views in rural areas distribution procedures. And data was collected from small sample due to time limitation which will not cover the overall aspects as well. In addition, author has focused on reducing long term cost through introducing technologies which may increase initial cost thus short term cost structures will not be analysed.

5.3 Future Research Areas

In the context of future areas to extend the research arena, distributional channel management is a good opportunity to conduct a comprehensive research where it will eventually help to increase the management visibility as well to increase LPG distributor and supplier satisfaction. Further, there are more and more opportunities are there to a comprehensive research on locating pipeline gas distribution in Sri Lanka without harming to structural and social wellbeing as well.

REFERENCES

Abdelkhak, N., Zitouni, B. & Bouksour, O., 2012. RFID to enhance visibility in a Closed loop Supply chain: Case of Cylinders Management in a Moroccan LPG distribution chain. *Moroccan LPG distribution chain.*

Adipola, D., 2017. Factors affecting waste generation and ways of optimize in fast moving goods industry in Sri Lanka. *Cinec Journal.*

Alexandre, D. & Jean, M. P., 2016. RFID technology in supply chain management: state of the art and perspectives. *Science Direct,* pp. 4464-4475.

AR, 2017. *Annual report - ABC Company PLC,* Sri Lanka: ABC Company Finance Team.

Asghar, S. & Ganesh, V., 2008. Effectiveness and Efficiency of RFID technology in Supply Chain Management: Strategic values and Challenges. *Indiana University South Bend, School of Business and Economics.*

Bloomberg, 2018. *Industrial Conglomerates.* [Online] Available at: https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=105305855

Creswell, J. W., 2008. *Educational Research: Planning, conducting, and evaluating quantitative and qualitative research.* 3rd ed. Upper Saddle River: Pearson.

Creswell, J. W., 2008. *Educational Research: Planning, conducting, and evaluating quantitative and qualitative research: 3rd Edition.* s.l.:Upper Saddle River: Pearson.

De Brito, M. & Dekker, R., 2003. A Framework for Reverse Logistics, ERIM Report Series Research in Management. *Erasmus Research Institute of Management (ERIM).*

Fleischmann, M. et al., 1997. Quantitative models for reverse logistics. *A review, of European Journal of Operational Research,* p. 1–17.

Fuller, D., Allen, J. & Glaser, M., 1996. Materials recycling and reverse channel networks: The public policy challenge. *Journal of Macromarketing,* pp. 52-72.

Gregory, Z., Jean, C. D. & Julien, F., 2011. Distributed Simulation Platform to Design Advanced RFID based Freight Transportation Systems. *Elsevier,* pp. 597-612.

Hakan, G. & Bulent, C., 2016. Logistics outsourcing and 3pl selection: a case study in an automotive supply chain. *Faculty of Engineering and Natural Sciences, Sabanci University.*

Langley, J. et al., 2009. *Third-Party Logistics - Results and Findings of the 14th Annual Study.* [Online]

Available   at: http://www.3plstudy.com
[Accessed 16 November 2018].

Lau, K. & Ma, W. L., 2008. A supplementary framework for evaluation of integrated logistics. *International Journal of Information Systems and Supply Chain Management,* Volume 1, p. 49–69.

Michael, K., 2010. The pros and cons of RFID in supply chain management. *University of Wollongong.*

Murphy, P. & Poist, R., 1989. Management of logistical retromovements: anempirical analysis of literature suggestions. *Transportations research forum,* pp. 177-184.

Raghav, R. S. et al., 2013. RFID in Supply Chain Management of Gas Cylinders. *Sri Manakula Vinayagar Engineering College, Puducherry.*

Ravi, V. & Shankar, R., 2014. Analysis of interactions among the barriers of reverse logistics. *Technological Forecasting and Social Change Journal,* pp. 1011-29.

Rhodes,   J.,   2018.   *Chronicle   of   evidence   based   mentoring.*   [Online] Available   at: https://chronicle.umbmentoring.org/on-methods-whats-the-difference-between-qualitative-and-quantitative

Rogers, D., Tibben, L. & Ronald, S., 1996. Going backwards: Reverse logistics trends and practices. *Reverse Logistics Executive Council.*

Saunders, M., Lewis, P. & Thornbill, A., 2000. Research Methods for Business Studies. *FT Prentice Hall.*

Sriyogi, K., 2014. Reverse Logistics: A Comparative Study of LPG Agencies in Urban and Rural Areas. *Department of Industrial & Production Engineering, Guru Ghasidas Vishwavidyalaya.*

Sumali, P. & Vilas, N., 2014. Investigation of barriers of factors affecting the reveres logistic of waste management of practice of case study in Thailand. *Case study in Thailand.*

Surbhi,   S.,   2018.   *Key   Differences.*   [Online] Available   at: https://keydifferences.com/difference-between-primary-and-secondary-data.html

Tae, K. Y., 2016. Warehousing: Understanding the fundamentals and discovering innovative technological solutions for environmentally and economically improved management. *University of applied sciences.*

Udayangani, A., 2019. *Reverse logistics flow of gas cylinders* [Interview] (2 January 2019).

Vidgen, R., France, D., Powell, P. & Woerndl, M., 2004. Web service business transformation: collaborative commerce opportunities in SMEs. *Journal of Enterprise Information Management,* p. 372–381.

Vinay, K., 2014. *Interview method in research,* India: Slide share.

Wiki, 2018. *Wikipedia the Free Encyclopedia.* [Online] Available at: https://en.wikipedia.org/wiki/Data_collection

Wiki, 2018. *Wikipedia the Free Encyclopedia.* [Online] Available at: https://en.wikipedia.org/wiki/Questionnaire

Wilson, V., 2018. *Research Methods.* [Online] Available at: https://journals.library.ualberta.ca/eblip/index.php/EBLIP/article/view/22186/16560

APPENDICES

Appendix 1: Questionnaire

Technology Enabled Reverse Logistics as a Means of Reducing LPG Distribution Cost: the Case of a LPG Supplier in Sri Lanka

Dear Sir/Madam,

I am Nalin Pathirana, carrying out a research on "Technology Enabled Reverse Logistics as a Means of Reducing LPG Distribution Cost: the Case of a LPG Supplier in Sri Lanka".

This research is carried out to study current LPG cylinder distribution network and reverse logistics practices between LPG supplier and LPG cylinder distributors, to identify the technologies that can improve reverse logistics operations as well as to find out the impact of implementing technologies to improve the reverse logistics operations between LPG supplier and LPG cylinder distributors in both urban and rural areas to reduce the LPG cylinder distribution cost.

All the information will be used only for academic purposes and treated as strictly confidential and will not be released under any circumstances. Your kind co-operation and genuine response is greatly appreciated in making this research success and your individuality won't be identified.

Thank you in advance for taking the time to assist me in my educational endeavors. I recognise the value of your time and gratefully appreciate your efforts in completing this questionnaire.

Thank You.
Sincerely,
Nalin Pathirana

_____

Section 1

1)   How many years you are working in this Company?
   a)   Less than 1 year
   b)   1-3 years
   c)   3-5 years
   d)   Above 5 years

2) What is your gender?
   a) Male
   b) Female

3) What is the department that you are working?

   a) Logistics Department
   b) Security Department
   c) Operational Department
   d) Sales Department
   e) Finance Department

4) Reverse logistics practices stands for all operations related to the reuse of products and materials (e.g.: practices relating to collecting used LPG cylinders and re-use for LPG refilling)
   Indicate the extent to which your firm has implemented reverse logistics practices.

   a) Not at all
   b) Small extent
   c) Moderate extent
   d) Great extent
   e) Very great extent

5) What is the cylinder distribution/ collection method between LPG supplier and LPG distributor?

   a) Use of outsourced vehicles
   b) Use of company owned vehicles

6) How easy to work with the current LPG cylinder distribution and reverse logistics processes?

   Very Hard | | | | | Very Easy

7) What are the vehicles used to distribute and collect LPG cylinders?
   ....

46

8) What are the communication methods that used to communicate process? (E.g.; ordering/ refilling etc) Tick all that apply.

   a) Telephones
   b) Fax
   c) Email
   d) In person

9) What is the most used delivery method?

   a) Milk run distribution (Stock many filled cylinders in delivery vehicle and distribute to distributors in a single round trip)
   b) Separate delivery trips to distributors

10) How these relationships affect on each other?

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The Order Fulfillment Lead Time (OFLT) has significant relation with number of orders placed by distributors.					
Stock of refilled cylinders has significant relation with orders fulfilled within one day.					
Stock at hand vs. cost of maintaining finished inventories ratio has significant relationship.					

11) Generally where do you face problem in cylinder distribution system? (Please give short answers)

    …………………………………………………………………………

12) What are the most used information/ data analysis method in LPG cylinder operations between LPG supplier and distributor?

    a) Numerical analysis
    b) Tabular analysis
    c) Graphical representations
    d) Other   ………..

13) If there is a new IT solution with additional below functions, how likely will you use it in the reverse logistics process?

		Very Unlikely	Unlikely	Neutral	Likely	Very Likely
a)	Function to monitor the real-time cylinder movements and view stock availability at any given time					
b)	Quicker forecasting function with good graphical data illustrations					
c)	Function to see non-moving, fast moving and frequent stock out distributor points in real-time					
d)	Function for graphical illustrations of current cylinder order completions					
e)	Function to quickly respond by on cancelling or adding a delivery from stocks					

14) Current level of IT utilisation by the cylinder operations (This question is only for Operational Department employees)

		Very Low Utilisation	Low Utilisation	Average Utilisation	Higher Utilisation	Very High Utilisation
a)	Tools to maintain visibility over the process					
b)	Email / Skype communication					
c)	Transportation management					
d)	Warehouse / DC management					
e)	RFID in distribution network					
f)	Supplier relationship management					
g)	Customer order management					
h)	Supply chain planning					

15) How would you likely to implement a sophisticated and real-time IT system in the company for real-time monitoring of cylinder stocks and stock movements?

a) Very unlikely
b) Unlikely
c) Neutral
d) Likely
e) Very Likely

Section 2

OPERATIONAL PERFORMANCE.

Indicate to what extent your firm will experience an improvement in the following operational performance measures as a result of adopting new technological reverse logistics practices.

Operational Performance Measures	Not at all interested	Slightly interested	Moderately interested	Very interested	Extremely interested
Cost					
Reduced costs in purchasing					
Reduced cost in manufacturing					
Reduced costs of inventory					
Reduced transportation costs					
Reduced costs in waste management					
Improved productivity					
Quality					
Quality of cylinders and services offered to customers					
Quality of processes					
Number of returned cylinders					
Number of customer complaints					
Record accuracy					
Reduced scrap rate					
Speed					
Delivery speed of cylinders					
Customer issues resolved in time					
Processes completed in time					
Flexibility					
Ability to change cylinders depending on the customer's needs					
Ability of the firm to vary delivery time to demand					
Ability to increase production should there be an increase in demand					
Ability to offer different cylinder sizes					

Dependability					
Dependability of equipment and machines					
Product reliability					
Dependability of information gathered from reverse logistics flow					

Thank you for completing this questionnaire. I appreciate the time you have spent in providing me with feedback. For additional information about this survey, please do not hesitate to contact me. (Nalin Sampath, Email- nsampath.net@gmail.com) .