ADDIS ABABA UNIVERSITY SCHOOL OF COMMERCE

Department of Logistics and Supply Chain Management

Measuring Supply Chain Performance Using SCOR Model And Setting Strategic Alternatives: The Case of Ethio Telecom Corporate Commercial Supplies Store.

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Measuring Supply Chain Performance Using SCOR Model And setting strategic alternatives: The Case of Ethio Telecom Corporate Commercial Supplies Store.

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Declaration

I, Kedir Yimer Abegaz, announce that this research paper entitled ― Measuring Supply Chain Performance Using SCOR Model And setting strategic alternatives: The Case of Ethio Telecom Corporate Commercial Supplies Store is my own and I dare to say that it is my original research work. To this end, all sources of information that I used to produce the study are properly acknowledged.

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Abstract

Each organization for assessing the amount of utility and desirability of their activities, especially in complex and dynamic environments such as in telecom industry where obsolescence of technology becoming the headache of operators, determining and ranking the vital performance indicators to ensure consistent supply is compulsory. The aim of this paper is to measure the SCP of ethio telecom commercial supplies and to set an alternative strategy, which identifies and prioritizes Key Performance Indicators (KPIs) that a company should focus on them thereby to define the strategy found best in alignment of these KPIs to enable achieving organizational objectives. Next, performance indicators were listed and pair wise comparisons were accomplished by company's selected employees through SCP and standard Analytic Hierarchy Process (AHP) questionnaires. Mainly a hybrid of AHP and TOPSIS technique applied to minimize the weakness of individual performance of each and to capitalize the synergy effect of both in that from AHP to take weight determination feature and from TOPSIS the swift ranking capability. Hence, this research focused to illustrate relative importance of supply chain performance measurement metrics and setting of evaluation framework to guide strategists for the SC strategy selection and *development to enhancing profitability of the company and ensure business continuity with competitive environment. To do this qualitative and quantitative data was obtained from selected respondents which have direct link and involvement in the commercial supply pipeline. Based on the research, Supply Chain Operation Reference (SCOR) performance measurement model with pair-wise comparison of Analytical Hierarchy Priority (AHP) methodology and TOPSIS- Technique For Order Preference By Similarity To Ideal Solution are developed to enhance the performance measurement of the supply chain management system. In this paper, an AHP–TOPSIS–SCOR integrated approach for selection of the most suitable scenarios are introduced and the implementation process be explained with a primary data from the survey conducted. It involves the calculation of the closeness coefficients by means of Positive Ideal Solution (PIS), Negative Ideal Solution (NIS) and the separation distance di. The fundamental concept of this technique is that the chosen alternatives should have the shortest distance di to the positive ideal solution and the farthest distance from the negative ideal solution. accordingly the closeness index Ci^{+} is therefore the measure of the performance of the alternatives whose value range between '0' and '1' ; the more Ci close to 1, the more alternative performs best and vice versa. Alternatives are then ranked according to the computed closeness coefficients.*

In the study, candidates were assessed by three alternatives in accordance with fourteen decision criteria. From the study, the integration of TOPSIS with AHP method found to be extremely suited to evaluation and selection decisions regarding options for SC strategy selection. In the application, the criteria/and sub-criteria, which have the greatest effect on the strategy selection, are determined. The weighted sum model (WSM) was also applied to determine the delivery performance status of the case company with respect to the industry standard and that gives a good insight how is the case company performing its supply chain.

Key Words: *Supply chain performance measurement, Supply Chain Operation Reference (SCOR), Analytical Hierarchy Process (AHP), SCOR+AHP performance measurement framework, Technique For Order Preference By Similarity To Ideal Solution (TOPSIS), PIS, NIS, Weighted sum model closeness index (Ci), separation distance (di).*

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Acronyms

AHP-Analytical hierarchy process

ANP-Analytical Network Process

BSC-Balanced Scorecard

CI-Consistency Index

CR-consistency ratio

CTPAT-Customs Trade Partnership Against terrorism

DMAIC (Define–Measure–Analise–Improve and Control)

EDI-Electronic Data Interchange

EOQ -Economic Order Quantity

EPS-Ethiopian Postal Service

ERP-Enterprise Resource Planning

HR-Human Resource

IEM-Industrial Engineering and Management

IJOPM-International Journal of Operation & production Management

ITO-Inventory Turnover

LT-Lead Time

MAUT-Multi Attribute Utility Theory

MRO- Maintenance Repair Overhaul

PCM-Pairwise comparison matrix

POM-Production and Operation Management

PO-Purchase Order

PWC- Pairwise comparison matrix

PWCM- Pairwise comparison matrix

SCC-Supply Chain Council

SCM-Supply Chain Management

SCOR-Supply Chain Operation Reference

SCO-Supply Chain Orientation

SCPM-Supply Chain Performance Measurement

SC-Supply Chain

SPSS-Statistical Package for Social Sciences Software

TOPSIS-Technique For Order Preference By Similarity To Ideal Solution

WSM-weighted sum model

CHAPTER ONE

INTRODUCTION

1.1 Background of The Study

Since the past two decades competition is getting strong in global markets, not merely among companies holistically. According to simchi-levi et al., (2000), competition is fierce which is more aggravated by the introduction of products with short life cycles, and therefore the heightened expectations of customers; which in turn forced business enterprises to take a position in, and focus attention on, the extreme relationships with customers and suppliers. Current researches still support such studies which give practical evidence that the competition in global markets is fierce and is not between companies head to head in these days, rather it is among their supply chains. This is clearly supported in resent studies of Hove-Sibanda, R.I. David Pooe, (2018) stated as "In modern times, firms have come to appreciate that supply chains have become a critical source of competition, such that increasingly there is recognition that real competition is no longer between companies but between supply chains (Botes, Niemann & Kotez 2017:143; Roussel 2013:301)."

Officials are getting aware that, integration and management of key business processes across the supply line will determine the last word success of the only enterprise (van der vorst, 2000). Consequently, there's a requirement and a chance for a joint approach of chain partners towards the establishment of effective and efficient supply chains (Van der Vorst, 2004). In the times according to Trkman et.al. 2010, competition is not any longer between organizations, but among supply chains (SCs). Enterprises must compete against each other so as to survive (Li et.al. 2006; Trkman et.al. 2007). Because the global economy continues to grow, enterprises are not any more competing individually rather to believe their supply chain systems (Li et.al. 2006; Trkman et.al. 2007). performance measurement reflects the necessity for improvement in areas with unsatisfactory performance. Thus efficiency and quality are often improved. (Kocaoglu, Gulsun & Tanyas, 2011). Many methods and techniques are suggested over the years for SCM evaluation (Gunasekaran et al. 2004).

Traditional methods specialize in well-known financial measures, like the return on investment (ROI), net present value (NPV), the interior rate of return (IRR), and therefore the payback period (Gunasekaran et al. 2004). Unfortunately, evaluation methods that believe financial measures aren't compatible for newer generation of SCM applications(Gunasekaran et al. 2004). There is, however, a greater got to study the measures and metrics within the context of following reasons (Gunasekaran et al. 2004):

1. Lack of a balanced approach: Financial measures, which are required for examination by external stakeholders, are generally well developed. However, operational measures are typically ad hoc and lack formal structure (Gunasekaran et al. 2004). This is to insist that while financial performance measurements are important for strategic decisions and external reporting, day-to-day control of manufacturing and distribution operation is better handled with non-financial measures.

2. Lack of understanding on deciding on the number of metrics to be used: Quite often, companies have a large number of performance measures to which they keep on adding based on feedback from organization members and consultants, and fail to recognize that performance measurements can be better addressed using a good few metrics.

3. Lack of clear distinction between metrics at strategic, tactical, and operational levels: Metrics that are used in performance measurement influence the decisions to be made at strategic, tactical, and operational levels. It is clear that for effective management of supply chain, measurement goals must consider the overall scenario and the metrics to be used (Kocaoglu, Gulsun & Tanyas, 2011). Performance measurement in the context of a supply chain now becomes extremely important (Kocaoglu, Gulsun & Tanyas, 2011). The reason is evident: Organizations start looking at ways to improve their operational performance through a better integration of operations across subsequent echelons and separated functions in the value chain. The ability to measure the performance of operations can be seen as a necessity for improvement, and companies have endeavored to enhance their capabilities of their performance measurement systems over the last years. (Kocaoglu, Gulsun & Tanyas, 2011).

There are number of approaches to supply chain performance measurement. Most companies are still in the informal or functional stage where they focus on the performance of their own enterprise and measure their supply chain performance with financially oriented metrics (Kocaoglu, Gulsun & Tanyas, 2011). According to (Kocaoglu, Gulsun & Tanyas, 2011) , it is a pragmatic approach to begin with assessment of own enterprise performance in the supply chain, instead of directly pointing to extended enterprise measurement of performance which incorporates a company's suppliers and customers. Of all the approaches available, SCOR is the most comprehensive, well-recognized in industry and has been used by many companies to improve their supply chain performance (Kocaoglu, Gulsun & Tanyas, 2011).

1.2 Background of Ethio Telecom

At the era of Emperor Menelik II in 1894, tele communicating Addis Ababa with other towns is being networked and continued to expand satisfactorily in other directions from the capital. The Empire were interconnected the first experience phone conversation with higher official levels, with the assistants or operators at intermediate stations frequently acting as verbal human repeaters between the distant calling parties (official website of ethio telecom).

During the 117 years period from 1894 -2010, the company has passed different naming following its advancements and regime changes before it updates its current name- ethio telecom since 9 years ago on November 2010. Telecommunication service is dynamic in nature to the extent the customer bypasses the service provider in technological advancements globally. Meeting the required supplies is therefore a robust task which needs robust commitment in order to convey the service provider to the competitors' level of excellence.

(Gunter, 2001) provides a taxonomy of performance measures followed by a critical evaluation of measurement systems designed to evaluate the performance of supply chains. It argues that despite considerable advances in the literature in recent years, variety of important problems haven't yet received adequate attention, including: the factors influencing the successful implementation of performance measurement systems for

supply chains; the driving forces shaping their development over time; and, the matter of their continuing maintenance. It provides both a taxonomy of measures and delineates specific implications for future research.

In line with its ambition of connecting Ethiopia through information communication technology, providing telecommunication services and products, building reputable brand known for its customers, ethio telecom has the objectives of being a customer centric company by offering the best quality of services, meeting world-class standards and building a financially sound company.

To achieve these missions, the supply chain management has its roles and responsibilities to perform the planning and management of all activities involved in supply chain management activities. It also coordinates and collaborates with internal stakeholders and external partners to achieve the ambitious objectives of the company. As well articulated above that competition will depend on supply chains rather than organizations holistically and at the same time the upcoming liberalization, it is the right time for ethio telecom to know the performance status in terms of supply chain and set forth SC strategies and priorities to found itself competitive with the potential international competitors.

1.3 Problem Statement

According to the world bank report of 2018 on LPI, that Ethiopia is lower in the rank, 131 of 167 countries, in its seven year average from 2012-2018 assessment index. The report also states that logistics performance is strongly correlated with the quality of service. The products that the case company offering to its customers pass through this stream of SC system.

On top of this, most researches has been made on the performance measurement locally and globally are focusing on the manufacturing industry. This concept is well supported by (Habib, 2011): It is quite clear that, few and very few researchers conducted SCM in the service industries and education respectively. Most of them conducted SCM within the manufacturing industries. A lot is expected to be done in educational institutions to dig out more the concept of SCM (Habib, 2011).

The commodity aspect is not significantly assessed and this sounds and coincides with the global reports of the world bank. According to Ilkka Sillanpaa (2011) SCM has been studied a great deal in the industrial economics field of research. Researchers of SCM also because the public is curious about the published studies associated with improving cost efficiency, optimizing the entire SC, production control, stock management, agility, lean SCM and SC integration. Ilkka Sillanpaa (2011), in his study affirmed that there are only a couple of studies of performed in supply chain management field of research. when this is drilled down at local practitioners and academics, the model is not practiced in particular with AHP-TOPSIS integration.

World class telecom operators are expected to serve their customers with state-of-the art service delivery this undoubtedly will bring market shift from the current active supplier ethio telecom is serving now as a monopoly. To overcome this scenario, the company performance with respect to supply chain need to be measured and strategic and operational activities should be weighted so that the appropriate attention and focus will be given to retain the market share from the potential competitors.

The company in this case-study offers a wide spectrum of products almost all of them are procured from abroad at their finished state, for the telecom service it is granting. The present situation and challenges end in the necessity for action: first, improvement of transparency regarding logistics and SCM performance is paramount. Furthermore, the corporate must remember of the newest expectations and trends from the sell is working in with regards to logistics and SCM performance. Finally, so as to spot best practices and gaps, a comparison of the present performance, customer expectations, and market trends is required. The first component among the three that is the performance component represents the interior point of view and aims to make transparency by analyzing the logistics and SCM performance using appropriate performance metrics.

When coming to the company under my case study, as per my preliminary contact with the commercial supplies warehouse manager, and the respective supervisor, the warehouse do not have a clear strategy to follow, whether to meet all requests with a sense of responsiveness at any cost; or to fulfill demands but with reasonable time giving priority

for cost optimization. Hence the study intend to identify which strategy and the corresponding KPI (metric) is more important so that top management need to set one for a better performance and competitiveness.

1.4 Research objectives

1.4.1 General objectives

The main objective of the research is to study the existing supply chain system of ethio telecom commercial supplies store; to identify the most important strategy and identify SC strategy following this study to enable to set either a cost sensitive strategy, or giving more attention to the service excellence so that to follow the responsiveness strategy and based on it to identify the most important KPI among the metrics of each attribute

1.4.2 Specific objectives

In order to achieve the general objectives set forth, the following specific objectives have been raised and covered. These are:

- To identify KPI that most influence the supply chain processes by using the analytic hierarchy process.
- Enable to assess supply chain performance in relation to performance measurement indicators of the case company
- To asses how close/far is the delivery performance efficiency with respect to the industry standard
- To identify the **'as-is'** and the desired '**to-be'** of supply chain performance in the case company.
- To identify and set an alternative strategy that can support the best performance of the identified sub-criteria/KPI using AHP-TOPSIS integration

1.5 Research question

This case study research is aiming at understanding of the SC performance with a particular attention to the commercial store among the complex phenomena of ethio telecom SCM. In order to achieve the objective of this study is answering the results of this research questions that addressed here.

1 What is the current supply chain performance in hierarchy with respect to the criteria & sub-criteria?
2 Rating the current '**as-is'** vs the '**desired to be'** Supply chain performance attributes and identify the gap?
3 How close is delivery efficiency compared to the industry standard?
4 Which strategy alternative best suits to the company: whether customer focused, cost focused or a balance of the two?

1.6 Significance of the Study

- We can see the significance of the study from different perspectives. Firstly, the study will have significance for ethio telecom to identify the most important KPI so that the necessary resource allocation and attention will tilt accordingly. Following the identification of the KPIs to identify an alternative strategy the best suit with the KPIs. Hence this study will Serve as:
- evaluation framework to guide strategists for setting of SC strategy, and to adapt it to other MCDM & selection processes such as in product or supplier selection, recruitment, etc….
- Enhancing the hybrid effect of AHP-TOPSIS (taking weight allocation feature of AHP and easy ranking of TOPSIS) and minimizing the weakness arises from independent performance of each helps as a basis for future researchers.
- Breaking through & Practicing of SCOR application in service industries in particular for SCP measurement.

1.7 Scope of the study

Ethio Telecom is a huge organization and its service covers almost all weredas throughout the country. In connection to this the supply is distributed over all the geographical areas where the service is availed. For this the supply chain is relayed from corporate to each region and then to each wereda. If this study try to asses the performance of all the supply chain, frankly both time and finance will limit the researcher. For this reason the study is limited at corporate level but significantly spin around the supply center from which

almost all prepaid mobile customers and new subscribers get their supply from this corporate warehouse.

The study scope, otherwise the geography, is performance measurement of supply chain operational activities related to commercial supplies and based on the findings to develop a frame work for the remaining supply lines other than the mentioned product line.

Using an SCOR-AHP–TOPSIS integrated approach, the 5 major performance attributes: delivery reliability, flexibility, responsiveness, asset and cost, along with their respective will be measured for selection of the most suitable scenarios to enable the management take appropriate strategy and implementation process to run the business competitively.

1.8 Limitation of the study

The researcher base to conduct this research mainly taking a foot print of Melaku Debas (2018). This research uses SCOR as a measuring tool and AHP as analysis technique. AHP technique is of course a sufficient tool. Though the SCOR-AHP model is an ideal and common practice, the technique proposed to analyze the data, the integration of SCOR-AHP-TOPSIS, is uncommon in Ethiopian context in particular in service industry which the researcher trying to break-through mainly with the intention for academic contribution. In doing so there were challenge from respondents to complete the questionnaire though it was passed by giving briefing to each respondents by assigning representative from each department and the researcher effort to make the instructions self explanatory.

1.9 Definition of terms and concepts

This section describes some definitions that are important for this thesis. These definitions are discussed more in detail in chapter 2, 3 and 4.

Supply chain: is defined as a sequence of (decision making and execution) processes and (material, information and money) flows that aim to meet final customer requirements and take place within and between different supply chain stages. Dr. Ir. Jack G.A.J. van der Vorst(2004)

Supply Chain Management: SCM is the integrated planning, co-ordination and control of all business processes1 and activities in the supply chain to deliver superior consumer value at less cost to the supply chain as a whole whilst satisfying requirements of other stakeholders in

the supply chain. Dr. Ir. Jack G.A.J. van der Vorst(2004) **Supply Chain Cost**: Supply Chain Cost is the total cost in the Supply chain. Annelie Pettersson, (2008)

Supply chain efficiency: Supply chain efficiency is how well the resources in the Supply chain are utilized. Annelie Pettersson, (2008).

Rank reversal phenomenon, which means that the relative rankings of two decision alternatives could be reversed when a decision alternative is added or deleted.Y.-M.Wang, Y.Luo (2009)

Performance measurement is a means of evaluating how well organisations are managed and the value they deliver for customers and other stakeholders. Max Moullin, (2007).

Max Moullin, (2007). Linking performance measurement and organizational excellence: International journal of Health Care Quality Assurance, emerald publisher Vol. 20 No. 3, 2007 pp. 181-183.

1.10 Organization of the Study

The study was organized into five chapters. Chapter one discussed the background of the study followed by the statement of the research problem, continue with the research questions, research objective and scope of the study, then limitations and significance of the. Literatures and conceptual frameworks are explored more in chapter two. Chapter three contained the methodology used in the study. Chapter four presented analysis of data, research findings and discussions. Finally, chapter five provided the summary of the findings, conclusions and recommendations.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2. Introduction

In order to deal about Supply chain excellence, one has to be clear with the concepts of Supply chain, Supply Chain Management and its performance measurement. This chapter is devoted about Supply chain from a general perspective as well as the management of a Supply chain. Literatures will be extensively reviewed based on the concept of a supply chain, Supply chain management and measurement of its performance attributes to develop a framework and set an alternative strategy. Based on the literature, the appropriate performance metrics can be used to identify key metrics and competitive priorities of supply chain performance in achieving the target, to provide advice for the case organization.

The integration of analytic hierarchy process (AHP) and technique for order preference by similarity to ideal solution (TOPSIS) together are applied in strategy selection as the later followed by the former. As Kocaoglu, Gulsun & Tanyas, 2014 described, Supply chain operations reference model is used to model the linkage of the strategic objectives and operational metrics in a hierarchical way. The AHP according to, Kocaoglu, Gulsun & Tanyas, 2014, is described as to analyze this metric hierarchy and determine weights of the metrics, and TOPSIS method is used to make a normalization and ranking the available alternatives. Both AHP and TOPSIS show good potential for multiple criteria. While one ensures the consistency of the weighting process, the other provides an indication of how far the alternative is from the ideal solution (Hwang and Yoon 1981).

2.1 Theoretical Literature Review

2.1.1 concepts and evolution of supply chain Management

Supply chains requires the companies and the business organizations to design, make, deliver and use a product or service for their competence. Business depends on their supply chains to provide them with what they need to survive and thrive in the present cutthroat globalized environment; hence organizations have shown interest in the field. Studies shown that, the number of sessions containing the term “supply chain management”

evolves through time which rose from 13.55% at 1995 to 22.4% at the 1997 conference, just two years later (HABIB, 2011). It is more evidenced that, while SCM evolve and grew up, studies show a reduction of inventory (up to 60 %), shorter lead times (up to 50 %), and improved forecasting accuracy (up to 80 %) (Strahwald and Sucky 2018).

As per the indication of studies from Chopra,& Meindl 2007, SC efficiency stems from the fact that by analyzing the functioning of the supply chain they treated it as a kind of activity independent of logistics.

The continuous development of the SCM concepts is becoming noticeable. From these facts, it can be learned that there is a constant increase of the range of tasks and responsibilities, the range of complexity and dynamism of processes is growing, the scope and the way of exploitation and implementation of increasingly sophisticated tools resulting from technological and technical development in the field of operational, tactical and strategic operations in local, regional and global context (Bujak, 2014). Contemporary development and creating supply chains that are increasingly global in nature, results from changes in the following circumstances: economic, financial, organizational, international legal, technical and technological (Jerzy Mikulski,2014). Changes to these conditions, which have been running more or less dynamically, led to a gradual transformation of the traditional model of the functioning of the economy into a very dynamic network of links and dependencies (Jerzy Mikulski,2014).

Modern supply chain is illustrated by many features, few of them are:

- Responsively rapid, and ability to meet ever growing & changing demand,
- agility and ability to adapt to the optimum: cost-level of service,
- ability to optimal balance use of the resources of the company,
- ability to make use of all the available information.

Today, in the era of integration and internationalization as well as high-speed and dynamic changes, much attention is paid to searching new forms, ways and concepts of operation of supply chain which would meet current and future requirements, especially in the area of meeting customer expectations, and thus creating in this way a competitive advantage. Though it is difficult to identify and describe all concepts in this area, two of them are found to be crucial:

- move of aggressive struggle to the entire supply chain,
- growth in openness of the supply chain.

According to Bujak 2014, the technical and technological revolution which can be noticed since the turn of the centuries, shifted the way of collaborating of suppliers and customers, as well as other traditional links of supply chains. To align oneself with the booming market, organizations must seek opportunities to build a competitive advantage outside their organizations. The individual effort often turns out to be insufficient to fully meet customer expectations. To be in alignment with them, companies are forced to carry out joint activities together with their trading partners (Bujak, 2014). Hence it is not a matter of choice to measure the performance of the supply chain in a particular firm and know and make a comparison with the industry standard to understand with different partners in the supply chain world.

2.1.2. Supply Chain Performance Measurement & Performance Attributes

2.1.2.1 Performance Attributes: A performance attribute is a grouping or categorization of metrics used to express a specific strategy. An attribute directly is not measured ; rather it is used to set strategic direction For example: "The LX product needs to be leading the competition in reliability" and "The xy-market requires us to be among the top 10 agile manufacturers" (Supply Chain Council ,2012- version 11.0). Hence metrics measure the ability to achieve their respective strategic directions. When the researcher initiated to measure the performance of the case company one of the intention is to let the management know the current status and thereby set a strategic direction based on the concept: cost or customer focused. According to SCC,2012, SCOR recognizes 5 performance attributes and the researcher applied them to asses the current performance , compare with the desired to be and then set an alternative strategy to be followed by the case company.

Reliability

Reliability as an attribute addresses the ability to perform tasks in dependable manner. It focuses on the dependability of the outcome of a process. Metrics associated with this SC attribute include: On-time, the right quantity, the right quality. In SCOR hierarchy, key

performance indicator (level-1 metric) is Perfect Order Fulfillment. Reliability is a customer focused attribute.

Responsiveness

The Responsiveness as a component of SC attribute describes the speed at which how quickly tasks are performed. Responsiveness addresses repeated speed of doing business. Example of Responsiveness metrics are cycle time metrics. In SCOR hierarchy, one of the key performance indicator for Responsiveness is Order Fulfillment Cycle Time. it is a customer focused attribute.

Agility

The Agility attribute describes the ability to respond to external influences for changes occurring against the business; which means the ability to and speed of change. Among the external influences: unforeseen increases or decreases of demand, leaving out suppliers or partners from the business, disasters which occur unexpectedly, cyber attack or acts of terrorism, economic imbalance, labor related issues. The SCOR key performance indicators in this attribute are mainly Flexibility, Adaptability and Value-at-Risk. Agility is a customer focused aspect.

Cost

The Cost as a component of SC attributes, it describes the cost of operating the process. Typically operating costs include mainly as labor cost, material cost, transportation cost. In the SCOR hierarchy, the key performance indicators for Cost is Total Cost to Serve. Cost is categorized as an internal focused attribute.

Assets

The Asset Management Efficiency mostly termed as ‘Assets’ is a SC attribute that describes the ability to efficiently utilize assets. Asset management strategies in supply chain mainly focus inventory reduction and in-source vs. outsource. Example of metrics in this attribute include: Inventory days of supply and capacity utilization. In the SCOR hierarchy, the key performance indicators for Asset are: Cash-to-Cash Cycle Time, Return

on Fixed Assets. Asset Management Efficiency, same as cost, it is an internal focused attribute. When we see the 5 attributes with SCOR model, mainly falls in to two categories; either being agile and bring the expected responsiveness from customer perspective or being conscious on the internal operating cost and try to optimize it.

2.1.2.2 Metric: A metric is a standard for measurement of the performance of a supply chain or process. SCOR metrics are diagnostic metrics that can be compared to how diagnosis is used in a medical office. According to SCOR model revision 11.0 : SCC 2012, SCOR realizes three-four levels of pre-defined metrics:

- Level-1 metrics are the measures of the overall health of the supply chain performance. These metrics are also known as strategic level metrics and key performance indicators (KPI). These metrics helps in establishing realistic targets to support the strategic directions.

- Level-2 metrics are the measures for performance of the level-1 metrics. That's measuring the diagnostic relationship which helps to spot the basis cause or causes of a performance gap in level-1 metric.

- Level-3 metrics serve as measuring tool for level-2 metrics. The analysis of performance of metrics from level-1 up to level 3 is known as metrics decomposition, performance diagnosis or metrics root cause analysis. Metrics disintegration may be an initiative in identifying the processes that require further investigation. (Processes are linked from level-1 to level-3 metrics). Metrics disintegration is a first step in identifying the processes that need further investigation. (Processes are linked from level-1 to level-3 metrics).

When SCOR measurement is applied, it worth to note that, the way is in a cascading fashion. To measure the overall objective, necessarily one has to go down level 1 metric; and to measure the level1 further to go down and measure the detail activities below it is required in order to get the best feedback at grass root level.

In order to ensure balanced decision making and governance, Supply Chain Council recommends supply chain scorecards to contain at least one (1) metric for each performance attribute (SCOR model revision 11.0 : SCC ,2012).

Researchers and practitioners have found the SCOR Model a good reference that integrates most of the business processes of an organization in a cross-functional framework (Kocaoglu, Gulsun & Tanyas, 2014).

2.1.2.3 Performance measurement

Only when you can measure something and express it in numbers, you have good background and knowledge about it, otherwise, your knowledge about it is limited and unsatisfactory (Nedaa Agami, Mohamed Saleh and Mohamed Rasmy,2012). Performance measurement therefore describes the feedback on operations which are geared towards customer satisfaction, strategic decisions and objectives; more over they further point out that performance measurement reflects the need for improvement in operational areas which are referred to as bottlenecks in performance measures (Nedaa Agami, Mohamed Saleh and Mohamed Rasmy,2012). The need of performance measurement is not debatable, but what one must be curious is to identify the right attribute to be measured that can qualify the efficiency and effectiveness and the best metric to yard with.

If a company decides to use cost as the only measurement of its Supply chain performance this will probably result in a Supply chain operating under minimum cost, but leading customer response at high risk, or lack of flexibility (A Pettersson - 2008). The researcher of this paper has therefore to identify the focus area whether the case company need to be cost focus or agile or in what balance to manage. Performance measurement gives a way to identify the success and possibility of management strategies and facilitating the understanding of the situation. Performance measurement is helpful in the improvement of SCM (Lishan Kang, Zhichua Cai,Xuesong Yan, Yong Liu 2008). Performance measurement issue is raised: to identify gaps based on customer feedback and to tally the result in alignment with business strategy. This is elaborated below in Ittner (2003).

Ittner (2003) argues that strategic performance measures must be allied with the firm's plan & strategy and/or value drivers. Under this approach, performance is hypothetically

enhanced when ‘‘measurement gaps’’ between the firm’s strategic priorities and measurement practices are lessened (Ittner *et al.* 2003) (Ilkka Illanapaa, 2011). Performance is anticipated to be lower when the planned performance measurement system places either less or more emphasis on a measurement practice than the level expected by the firm’s strategy and value drivers. (Ittner *et al.* 2003) (Ilkka Illanapaa, 2011)

2.1.3 Supply chain performance measurement systems

According to (Peterson, 2008) quoting Christopher (1998) mention three ways of performance measurement systems as: Balanced score card (BSC) model, Supply Chain Operation refence (SCOR) model & bench making are the three methods that are practically applied for performance measurements within the industry. In this paper measurement will base SCOR hierarchical structure. The structure enable to asses attributes and their KPI beneath it in that the KPI at lower level tells the attribute’s health, and the attributes health tell us how efficient is the main goal (attribute) hierarchically. Since the structure is hierarchical, an AHP technique found to be best suit to analyze the level of importance of each KPI and each attribute.

Research on supply chain management (SCM) can be broadly classified in to three categories, namely, operational, design and strategic. Though there are many analytical and numerical models have been proposed to handle operational and design issues, formal models for strategic planning are scarcely practiced. The supply chain operation reference (SCOR) model, established by supply chain council, is an advanced planning tool that allows senior managers to simplify the complexity of SCM. It is determinedly rooted in industrial practices and is poised to become an industrial standard that enables next generation SCM (Huan, Sheoran and Ge Wang -2004).

2.1.4 key metrics and competitive priorities of performance attributes

The SCOR model, in different literatures, explained as hierarchical, if we see in the below SCOR ladder, level II has 4 attributes merging flexibility and responsiveness while in other are separated and are 5 attributes. This in turn influence the level III (the sub-criteria) are ranging from 10-15 depending on the case company practical activities. For this research

14 sub-criteria are identified to be measured. The SCOR model endorses 12 performance metrics which fall in to four categories.

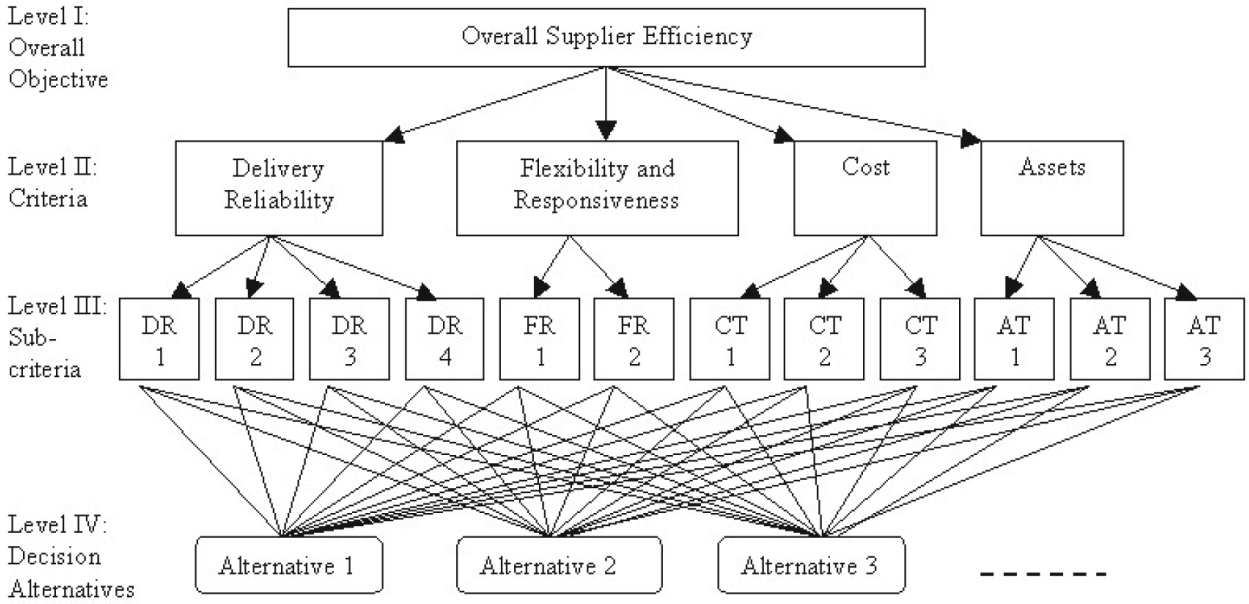


Fig 2.2 network optimization using AHP and SCOR metrics. Source : Supply chain management: an international journal volume 9, number 1, 2004 (Samuel H. Huan, Sunil K. Sheoran and Ge Wang -2004)

The SCOR model is hierarchical with three levels. each process element in level 1 can be decomposed to level 2 process elements. Same apply, for each level 2 process element contains level 3 process elements. The SCOR model can have three levels as well in which case further decomposition of sub-criteria are exempted and only the criteria are measured to select the available alternatives based on their weight. The researcher recommend if sub-criteria can be further decomposed in to subpart of each so that the more decomposed, the more reliable the measure values are.

In SCOR-model, each process element has its own performance metrics. level 1 metrics are primary and high level measures that may contain multiple SCOR processes. Metrics at level 1 are not necessarily linked to a SCOR level 1 process (plan, source, make, deliver,

and return). but, it is worth noting that the metrics are intended to be hierarchical as the process elements (Kocaoglu, Gulsun & Tanyas, 2014).

On the top of SCOR hierarchy, the strategy map enables to decompose objectives in the strategic world; while on the down side of the hierarchy, SCOR metrics provide a very good basis for transforming strategic objectives into supply chain operations of different levels.

2.1.5 supply chain performance measurement & SCOR framework

2.1.5.1 SCOR processes

Supply chains have grown into efficient chains with using latest tools and technologies. Intending to increase service excellence, supply chain sellers, had a need to use a standard model to ground their operations and thereby to measure their performance. In order to achieve a competitive advantage and enhance organizational performance of the companies, SCOR model is established by Supply Chain Council (SCC), to measure performance of the chain. It provides standard terminology which can be used for deciding, arranging and implementing supply chain processes (Delipinar & Kocaoglu, 2016).

Mainly SCOR model bases its objective to improve alignment between the market and the strategic response of a supply chain, on the assumption that the better the alignment, the better the bottom-line performance. Since SCOR model aims on bringing alignment between market place and strategic response, it must focusses on how the 5 attributes : SC reliability, SC responsiveness, SC Flexibility, SC cost and Asset management, bring excellence using SCOR processes : plan make, deliver, and return. In the past the problem has been that different metrics were practiced to measure the performance at different levels. Market researchers and corporate strategies use entirely different language to describe the market place and the supply chain activities. The excellence of the SCOR model is, its ability to provide a standard format to facilitate communication. It is a useful tool for the upper management of a firm to design and configure its SC to achieve desired performance. (Huan, Sheoran and Ge Wang -2004).

SCOR model has several processes. These processes are named as plan, source, make deliver and return (Delipinar & Kocaoglu, 2016).

Plan: It is starts by analyzing the information and forecasting market trends of goods and services. Marketing and finance departments apply planning process as desired timeline by monthly and yearly reports.

Source: It is simply a procurement system with procurement standard. Source evolves different steps such as search, negotiation and evaluation agents to amend supplier selection, negotiation, and evaluation.

Make: It is the production of goods not only in terms of time but also about production frame and batch.

Deliver: It is element of the processes, which entails the conveying of finished goods and services to reach planned or actual demand.

Return: It is processes, returning the goods or receiving the product Trkman et al (2010) Delipinar, Kocaoglu (2016)

Each process is analyzed and implemented around three components: business process reengineering, benchmarking, and best practices analysis (Supply-Chain Council 2007, p. 1). Among which SCOR recommends the use of business process re-engineering techniques to capture the current state of a process and then ascertain the "to-be" state based on business process templates for plan, source, make, deliver, and return. Benchmarking is used to determine target values for operational performance metrics for the "to-be" state of the processes (M.Lanbert,L.Croxton, and Gracia-douglas, 2005). The third component, best practices analysis, seeks to identify management practices and software solutions used successfully by similar companies that are considered top performers. The identification of the best business practices needed to support the "to-be" state of the processes becomes the roadmap for implementation (Loh Shyong Woei (2008)

In the beneath table SCOR refers to as a SCOR card. It shows the SC performance attributes, corresponding set of metrics and the benchmark data for a theoretical company. This paper when intend to measure SC performance using this model, has the intention to

notify the case company to identify the as-is and to point out the desired to-be based on their corresponding metrics.

As Table 2.2 : shows the performance attributes, a set of metrics and the benchmark data for a hypothetical company to serve as a bench mark.

Table **2.2:** Supply Chain scorecard benchmarking

Supply Chain SCORcard				Industry Benchmarks			
	Overview Metrics	SCOR Level 1 Metrics	Actual	Parity	Advantage	Superior	Value from Improvements
EXTERNAL	Supply Chain Reliability	Delivery Performance to Commit Date	50%	85%	90%	95%	
		Fill Rates	63%	94%	96%	98%	
		Perfect Order Fulfillment	0%	80%	85%	90%	$30M Revenue
	Responsiveness	Order Fulfillment Lead Times	35 days	7 days	5 days	3 days	$30M Revenue
	Flexibility	Supply Chain Response Time	97 days	82 days	55 days	13 days	Key enabler to cost and asset improvements
		Production Flexibility	45 days	30 days	25 days	20 days	
INTERNAL	Cost	Total SCM Management Cost	19%	13%	8%	3%	$30M Indirect Cost
		Warranty Cost	NA	NA	NA	NA	NA
		Value Added Employee Productivity	NA	$156K	$306K	$460K	NA
	Assets	Inventory Days of Supply	119 days	55 days	38 days	22 days	NA
		Cash-to-Cash Cycle Time	196 days	80 days	46 days	28 days	$7 M Capital Charge
		Net Asset Turns (Working Capital)	2.2 turns	8 turns	12 turns	19 turns	NA

Source: SCOR: Supply-Chain Reference Model ILIM, Institute Of Logistics And Warehousing Ainia, Technological Centre, p-9

Standard SCOR process which is known mainly with plan, source, make, deliver, return are used to assess supply chain performance based on this this supply chain activities are defined in four levels. The below table illustrates that shows these levels with Details (Prakash, Sandeep, Gunjan Soni, A.P.S. Rathore, 2013)

Level 1.	**Level 2.**	**Level 3.**	**Level 4.**
It tells about the scope and over all goal desired to be attained and called the	A Company‘s supply chain can be ―configured-to-order‖ at	It is known as the index layer which defines a company‘s ability to	This is an implementation level (Decompose process element), this is used by Companies to implement

target layer for the SCOR.	Level 2 and it is termed as criterion level or the rule layer	compete successfully in its chosen markets	SCM practices and able to identify alternatives that are unique to their organizations.(B**ryan Cristian)**

Table 2.3: SCOR levels of process (Adapted from supply chain council) source : Surya Prakash, Sandeep, Gunjan Soni, A.P.S. Rathore (2013)]

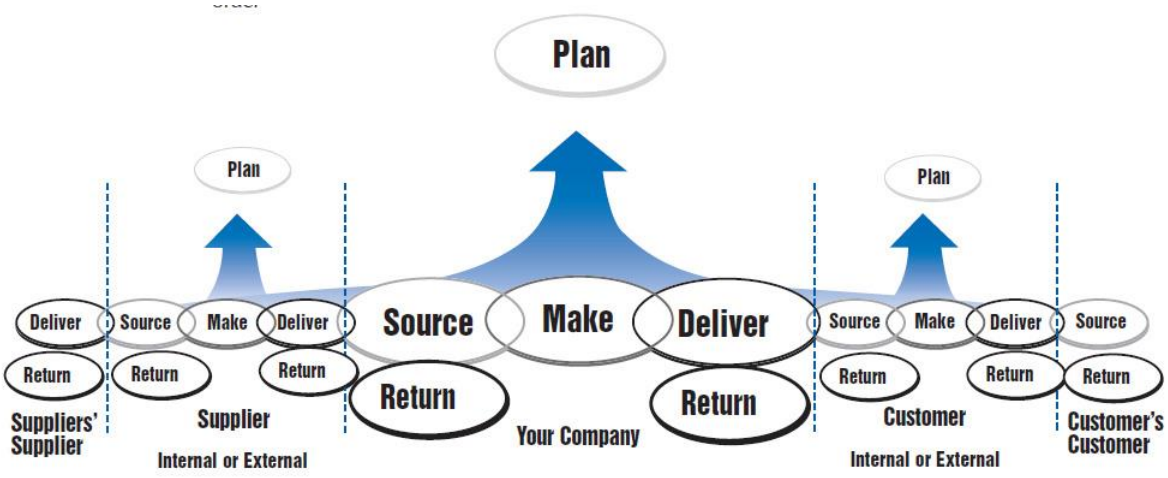


figure 2.3 SCOR Model (Supply Chain Council : SCOR 9.0 Overview Booklet, 2008 (source: A Literature review Gul Esin Delipinar, Batuhan Kocaoglu 2016)

2.1.5.2 SCOR model and Structure

SCOR is a reference model.

By way of an overview, the SCC booklet, Supply-Chain Operations Reference model: Overview of SCOR Version 5.0, describes three broad goals of the reference model as follows:

1. Capture the current status performance "as-is' and come up to the desired "to-be" state.

2. Quantify the operational performance of similar companies in similar industry and based on found own internal targets catching on "best-in-class" results, and

3. Characterize the management practices and software solutions that result in "best-in-class" performance (Paul Harmon, 2002)

According to Strahwald and Sucky, 2018, SCOR is structured in four levels and in alignment with the six supply chain processes: plan, source, make, deliver, return, and enable. This developed framework enables the company under consideration to design their processes and benchmark their performance against other supply chains. Based on that, the company can develop a roadmap to advance their performance vis-à-vis the given benchmarks.

The SCOR reference model consists of 4 major sections: SCOR model revision 11.0 (SCC,2012)

• Performance: Standard metrics to describe process performance and define strategic goals (SCC,2012)

• Processes: Standard descriptions of management processes and process relationships (SCC,2012)

• Practices: Management practices that produce significant better process performance (SCC,2012)

• People: Standard definitions for skills required to perform supply chain processes (SCC,2012- revision 11.0).

The aim of this paper is on how to measure the Performance of supply chain hence the researcher disregards the last three and consider only:

performance

The performance component of SCOR comprises of two types of elements: Performance Attributes and Metrics/measurement system. The former one is a grouping of metrics/measurement system used to express a strategy. As an attribute By itself cannot be measured; rather is used to set strategic direction. The SCOR model is not only useful if a company want to develop a supply chain system, but also has more importance as a cross functional framework for evaluating and improving enterprise wide supply chain

performance particularly for the case company type whose service is widely spread also over the nations territory. business strategies in supply chain can be expressed are: 'Superior performance for Reliability' expressed by Perfect Order Fulfillment or 'Advanced performance for Agility'. Metrics is the measurement system and measure the ability of a supply chain to achieve these strategic attributes.

The SCOR model performance measurement system when synchronized will tell practitioners where their focus are to be either customer focused or cost saving based on the sub-criteria.

Reliability, Responsiveness and Agility are considered customer focused. Cost and Asset Management Efficiency are considered internal-focused (SCC,2012). All SCOR metrics are grouped within one of the performance attributes (SCC,2012).

Performance Attribute	Level-1 Strategic Metric
Reliability	• Perfect Order Fulfillment -RL.1.1 (SCC,2012)
Responsiveness	• Order Fulfillment Cycle Time -RS.1.1 (SCC,2012)
Agility	• Upside Supply Chain Flexibility -AG.1.1(SCC,2012) • Upside Supply Chain Adaptability -AG.1.2 (SCC,2012) • Downside Supply Chain Adaptability -AG.1.3 (SCC,2012) • Overall Value At Risk -AG.1.4 (SCC,2012)
Cost	• Total Cost to Serve -CO.1.001 (SCC,2012)
Asset Management Efficiency	Cash-to-Cash Cycle Time -AM.1.1 (SCC,2012) • Return on Supply Chain Fixed Assets-AM.1.2 (SCC,2012) • Return on Working Capital -AM.1.3 (SCC,2012

Table 2.5- The SCOR Level-1 Metrics Source SCC,2012

The SCOR metrics are organized in a hierarchical structure (Yanliang Wang,2017). SCOR describes level-1, level-2 and level-3 metrics. The relationships between these levels is diagnostic of the lower to the upper that is level-2 metrics serve as diagnostics for level-1 metrics level 3 metrics as diagnostics for level 2 and so on (Yanliang Wang,2017). This means that by looking at the performances of the level-2 metrics, it can explain performance gaps or improvements for level-1 metrics (Yanliang Wang,2017). This type of analysis of the performance of a supply chain is referred to as metric decomposition or root-causing (SCC,2012). Similarly level-3 metrics serve as diagnostics for level-2 metrics (SCC,2012). The level of a metric is included in the codification of the metric itself (SCC,2012).

The codification & naming the respective metrics was introduced in SCOR 9.0 to ensure companies may adopt SCOR measurement system without the need to rename their existing one (SCC,2012). The combination of alphabetic and numeric coding starts with the SC performance attributes: RL for Reliability, RS for Responsiveness , AG for Agility ,CO for Cost, and AM for Asset Management (SCC,2012). Each metric starts with the beginning of the respective two-letter code, followed by a number just to refer the level, followed by a unique identifier. For instance: the metric 'Perfect Order Fulfillment' is designated to be RL.1.1 - a level-1 metric within the Reliability attribute.

Note: The second number in the ID -- for example the 4 for RL.2.4 -- does NOT indicate any kind of priority, importance, or other meaning.

2.1.6 Integration of SCOR -AHP-TOPSIS

With its inception in 1960 by SCC, SCOR model integrates the well-known concepts of business process-re-engineering, benchmarking, and process measurement into a cross-functional framework, which contains:

- standard descriptions of management process functionality (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004.);

- a framework of relationship functionality (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004.);
- a standard metrics to measure process performance functionality (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004.);
- management practices that produce best in class performance functionality (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004.); and
- standard alignment to software features and functionality (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004.)

Network modeling tools use optimization techniques to generate optimal solutions with respect to one or a set of objective functions while satisfying certain constraints (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004). The aim of using this hybrid model is to gain the cumulative advantage of these two effective methods by minimizing the weaknesses. From a user perspective, the optimization technique used, whether they are traditional operations research methods (such as linear programing or dynamic programing) or emerging computational intelligence techniques (such as genetic algorithm), are irrelevant in decision making. Rather, determining the right objective function(s) is the most important task (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004). practically, management of an organization are continuously in need to optimize their supply chain performance. However, this objective is not measurable and cannot be used by network modeling tools to generate a solution.

There are two ways of handling melti-criteria objectives in conventional optimization, namely, the weighted sum and preemptive optimization (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004). The first approach requires determination of comparative importance of different performance metrics; while the second approach requires determination of absolute priority (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004). In both cases, decisions are made without considering the available solutions (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004). In supply chain decision making, e.g. supplier selection, a firm usually has a number of alternatives (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004). Intuitively, a more appropriate objective function can be

developed if the performance of these alternatives can be measured and taken in to consideration. (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004).

The metrics identified in SCOR level are measured & weighted indicating their hierarchy. This weight rather taken as measurement weight, it will be used as input for TOPSIS for further analysis and complementing the critics in AHP. The below diagram illustrates the idea. Following that the steps for both techniques is detailed.

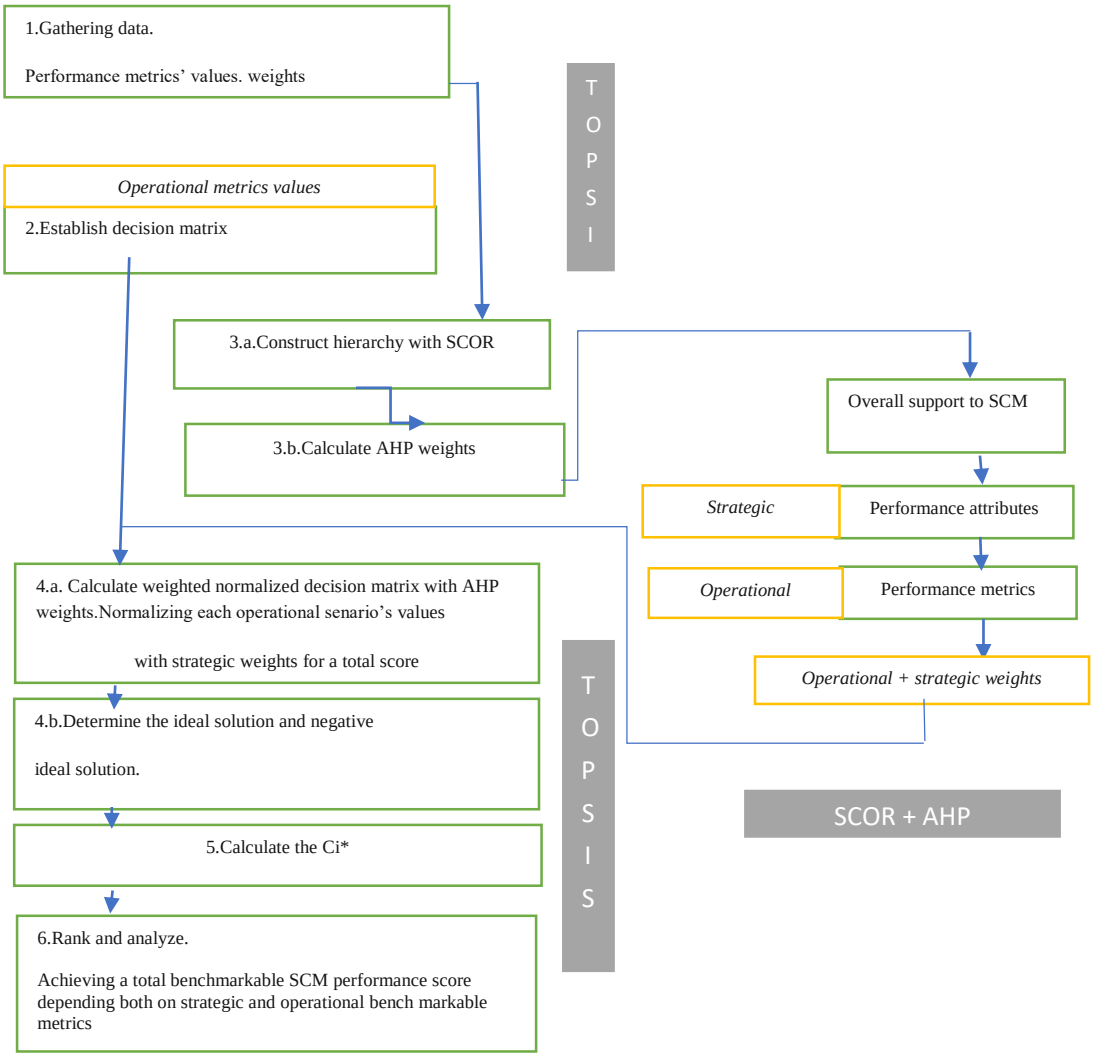


Figure 2.4 Illustration of SCOR-AHP-TOPSIS Integration; source: journal of intelligent manufacturing, February- 2011; A SCOR based approach for measuring a benchmarkable SC.

Chan and Qi (2003), explained that there is no systematic grouping of the different performance measures in the existing literatures (Kocaoglu, Gulsun, & Tanyas , 2014)

Based on SCOR, we can construct metric hierarchy for each strategic objective, thus achieve the decomposition of strategy into operational metrics at different levels. Figure 2.4 above illustrates the whole picture of the link from a strategy mapping to SCOR based metric network. On the top, the strategy map enables to decompose objectives in the strategic world; while on the downside, SCOR metrics provide a very good foundation for translating strategic objectives into supply chain operations of different levels.

Though the AHP is used for MCDM problem extensively, it is still often criticized by some scholars for the following shortcomings (Cheng 1999; Chan 2003; Mikhailov 2004):

• The AHP method is largely used in nearly crisp decision applications.

• The AHP makes use of an unbalanced scale of estimations.

• The AHP does not take into account the uncertainty and risk in assessing the alternative's potential performance because it assumes the relative importance of criteria affecting alternative's performance is certain.

• Ranking of the AHP is not imprecise enough (Kocaoğlu, Gülsün & Tanyaş, 2014)

• The independent assessment, selection and preference of decision makers brings large impact (Kocaoglu, Gulsun, & Tanyas, 2014)

For this reason, the researcher prefers to integrate the concept of TOPSIS with the AHP to overcome some of above disadvantages in the proposed model. This integrated approach applies AHP and TOPSIS algorithms to develop a collaborative decision and evaluation processes and the following steps, see Fig. 2.4. The integrated approach shown in Fig. 2.4 comprises three stages. The first is the TOPSIS; the second, the SCOR based AHP; and finally, the integrated calculation of different scenario's total performance SCOR's with a TOPSIS combined methodology (Kocaoglu, Gulsun, & Tanyas, 2014)

2.1.6.1 Principles And Steps Of AHP Methods

AHP was established to reflect the way people normally behave and feel. It is an important multi criteria decision making tool that can decompose a complex problem into a muti-level hierarchical structure of : objectives, criteria, sub-criteria and alternatives. AHP's hierarchic structure reflects the natural tendency of the human mind to sort elements of a system into different levels and to group like elements in each level which can facilitate decision maker's easy understanding from human factor point of view. similarly the SCOR model is also a hierarchical model that have of different process levels (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004). Therefore, this integration seems natural to apply AHP with SCOR metrics to provide an overall objective function in this case an overall supply chain efficiency, for network optimization.

The analytical hierarchy process (AHP) proposed by Saaty (1980), which, involves the following steps:

AHP STEPS

problem decomposition and hierarchy construction. The top level of the hierarchy is the overall objective, say, overall supply chain efficiency (Saaty,1980). The next level is the criteria Saaty,1980).

Determine alternatives. These are alternatives up on which the analysis will be made, e.g. different suppliers under consideration, are constructed and added to the lowest level of the hierarchy up which to ladder up hierarchically (Saaty,1980). when there is scenario to be aligned with the metrics, the AHP merely enables to put the metrics with priority one over the other as to the management for decision making & setting a strategy. In this paper just to enable whether to be customer focused or cost focused.

Pair-wise comparison: aims at determining the relative importance of the elements in each level of the hierarchy (Saaty,1980). It starts from the second level and ends at the lowest level(Saaty,1980). The decision maker needs to express his/her preference between each pair of the elements.

Weight calculation. This practically leading to identify the relative importance of attributes by Mathematical normalization methods.

Consistency check. A consistency ratio (CR) is calculated. If it is greater than 10 percent, then the decision maker is not consistent in making the pair-wise comparison. Adjustment is required if consistency found to be >0.1. One feature of this method is that the researcher is able to check if the respondents are replying to the questionnaire in consistence manner or not. For instance in simple mathematics if A>B and B>C, necessarily A>C; this will be checked with this method, and if not fulfilled the respondents are not consistent and thereby adjustment is required.

Hierarchical synthesis. In order to give the alternative options based on the weight obtained the calculated priority weights at different hierarchy levels are integrated at this step

Determine priority of all alternatives. The alternative with the highest overall priority weight is chosen (Samuel H. Huan, Sunil K. Sheoran and Ge Wang 2004).

2.1.6.2 Principles And Steps Of TOPSIS Methods

The TOPSIS method as one of the multicriteria decision making technique is based upon the concept that the best alternative should have the shortest distance to the ideal solution. It takes a decision matrix of AHP as input for data evaluation but uses given relative weights as the representation of preference information.

A relative advantage of TOPSIS when compared with other similar techniques is its ability to identify the best alternative swiftly (Parkan and Wu 1997). TOPSIS has been comparatively tested with a number of other multi-attribute methods. TOPSIS was found to perform almost as well as multiplicative additive weights and better than AHP, (Saaty 1977) in matching a base prediction model. As a drawback, TOPSIS experiences rank reversal proportionately when there are few criteria. On the other hand, when there are many criteria, TOPSIS differed more from simple additive weight results, and it also affected more with diverse sets of weights. Hence TOPSIS performed less accurately than AHP on both selecting the top ranked alternative and in matching all ranks in this set of simulations because while AHP has a means to assign relative weight of attributes, TOPSIS use equal weighting method that lead to less accuracy; but their integration fill this gap and lead to profound result.

In this study the TOPSIS applied to normalize the values that have different units and rank the alternatives set. Here AHP is implemented to determine criteria weights of the identified KPIs then enable to carry the strategic weights to operational metrics and used in normalization from which continuing TOPSIS procedures, achieved the final ranking of the different scenarios.

The concepts of TOPSIS when expressed in a series of steps is:

TOPSIS STEPS

Step 1. It begins by establishing the decision matrix (Chen and Tzeng 2004; Tsai et al. 2008)..

Step 2. Having the decision matrix in step 1 then normalize it. Normalizing the performance matrix means unifying it in to unit of matrix entries (Chen and Tzeng 2004; Tsai et al. 2008).

Step 3. Create the weighted normalized decision matrix by multiplying the weight of each attribute obtained from AHP with the normalized value (Hwang and Yoon 1981),

Step 4. Determine the ideal solution ($Ai*$) and the negative ideal solution(Ai^{-}).

Step 5. Calculate the distance between ideal solution($Si*$)and negative ideal solution (Si-) for each alternative. Using the n-dimensional Euclidean distance.

Step 6. Calculate the relative closeness ($C*i$) to the ideal solution of each alternative.

Step 7. Rank the preference order, where $0 \leq Ci* \leq 1$. That is, an alternative i is closer to $A*$ as $Ci*$ approaches to 1(Chen and Tzeng 2004; Tsai et al. 2008). A set of alternatives can be preferentially ranked according to the descending order of $Ci*$ (Chang 2010), (Kocaoglu, Gulsun, & Tanyas, 2014]

2.1.7 Methods for performance measurements

The three well known performance measurement methods within in the industry are Balanced scorecard, SCOR model and benchmarking (Peterson, 2008). These methods are also frequently discussed in the academical world to (Peterson, 2008).

1. Balanced score card (BSC)

The Balanced Scorecard as a framework for performance measurements in many organization; the case company under consideration in this study is also apply this method. There is no distinct definition of what measurements that shall be included in the scorecard, rather it depends in the internal processes of each case company and even among departments with in the same company. According to Peterson, 2008. BSC has four general categories:

- measure financial performance
- measure Customer experience
- measure internal performance
- Learning & growth

Internal performance includes quality, response time and cost measures (Peterson, 2008). The learning category includes employment aspects such as skill development, retention and information technology (Peterson, 2008).

2. Bench marking

Benchmarking is a process for comparison in contrast to the best practice. It is important with common metrics that can be used in competing companies. According to Peterson 2008, benchmarking has five basic purposes as described by Splendolini (1992):

- Strategy: both long and short term plan of an organization
- Forecasting: predict trends
- New ideas: stimulate new thoughts
- Process comparisons
- Setting objectives and targets: base them on best practice (Peterson, 2008).

Benchmarking as applied in both external and internal comparison; the external one can be used to compare the own company with competitors or with companies that have high performance while the internal one can be used to compare different departments within a company (Peterson, 2008).

3. SCOR model

The purpose for this particular model which is the concern of the study is:

1. It enables to have a standard language across the SCM industry
2. facilitate external benchmarking
3. establish a basis for analyze of Supply chains
4. compare the current Supply chain with the target for the future (Peterson, 2008).

SCOR is more discussed under section 2.1.6.2 (SCOR model and structure)

2.1.8 Conceptual Framework

According to Wilson et al., 2015, a conceptual framework is a figurative or written material, one that, "explains either graphically or in description form, and the main things to be studied is, concepts, or variables and the presumed relationship among them. As stated in Tsegaye 2018 , quoted from Jabareen, 2009, conceptual framework is defined as a network, or "plane," of linked concepts that together provide a complete understanding of a phenomenon.

Considering the different practices of supply chain management and measurement of supply chain performance, this study adopts 12 performance metrics: 1. Delivery performance, 2. Fill rate, 3. Order fulfilment lead time, 4. Perfect order fulfilment, 5. Supply chain responsiveness, 6. delivery order time flexibility, 7. delivery order size flexibility, 8. material cost, 9. Labor cost, 10. Transport cost, 11. Cash to cash cycle time (Rolf G. Poluha – 2014), 12.Inventory days of Supply, 13.Asset turns. 14.Overall value at risk.

The criteria: delivery reliability, flexibility and responsiveness, assets and cost will be measured by the 14 metrics then will yield the alternatives which will tell us the most focus area to the concerned management hierarchy.

In this paper, operational performance will be measured in each priority by asking respondents how they value the respective performances which are termed as sub-criteria in the diagram. The effect of supply chain management will then be evaluated in each of these operational performance dimensions to set the alternatives.

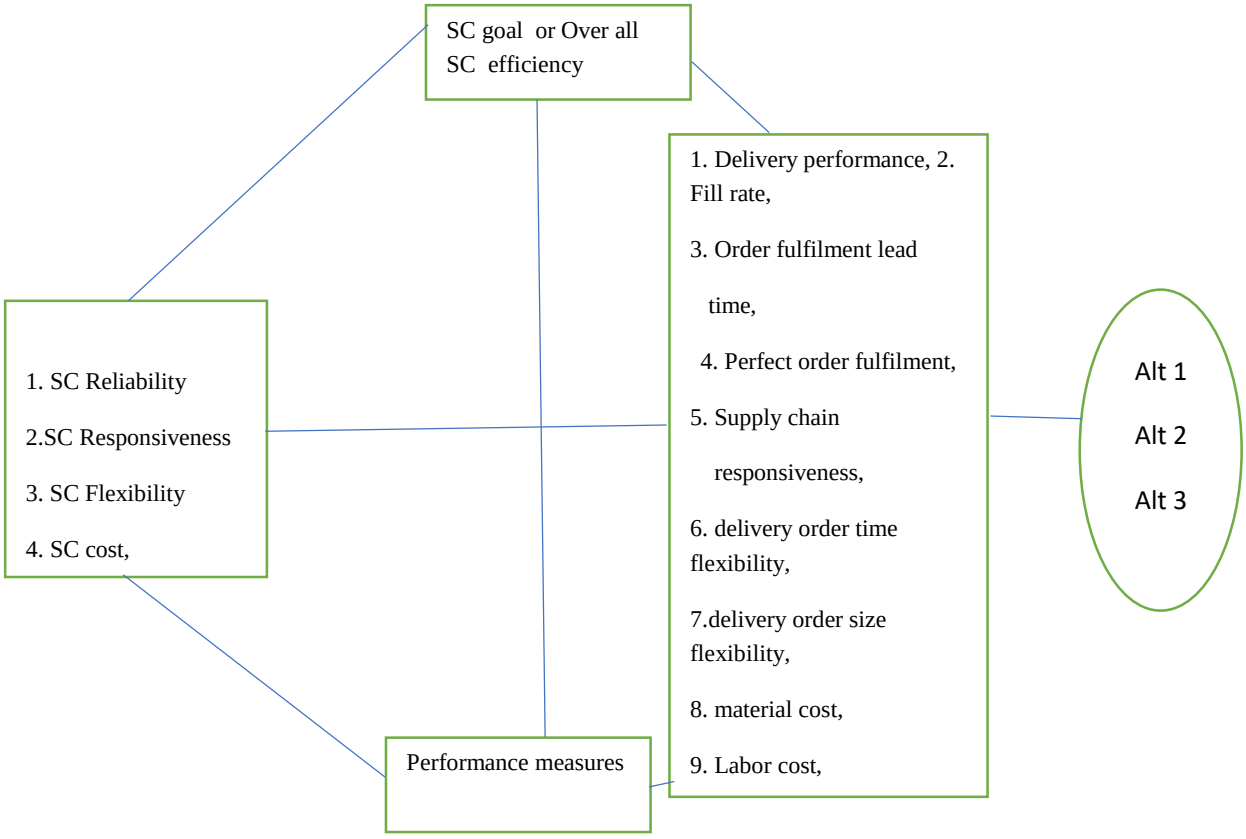


Figure 2.5:conceptual frame of Measuring Performance attributes (Criteria); source: adapted from Journal of Business Management and Research (JBMR) ISSN 2250-2343 Vol.2, Issue 1, Sep 2012 pp 50

2.2 Empirical Literature Review

Empirical studies about bench marking done by Mishra & Sharma, (2014) reach in the following conclusion: In order to attain competitive positioning, a firm can benchmark its own profile with that of its competitors in order to ascertain & to know its position in terms of supply chain attributes such as SC length, inefficiency and capital productivity. In such empirical studies, the benchmarking and performance measurement using selected metrics help to examine the causes/entities in supply chain network that cause low SCM performance. For instance, the use of DMAIC in supply chain network helps to identify the entity, i.e. supplier which may lengthen the supply chain.

Companies that exercise SCM practices manage the flow of their supply chain length and hence enhance their efficiency ratio and increase overall capital productivity than those who do not exercise it. As per studies conducted by Mishra & Sharma, 2014, for SCM companies, the measures of supply chain length and inefficiency ratio in a case company had average, i.e. 97.933, 0.061 lesser than those without SCM, i.e. 146.66, 0.0833, respectively. Also, the average of overall capital productivity is more, i.e. 8.488 with SCM as compared to 4.866 without SCM (Mishra & Sharma, 2014). Thus, adoption of SCM practices by companies promote efficient management of supply chain which can lead to enhanced competitive advantage and improved organizational performance (Mishra & Sharma, 2014). From this empirical study, measuring is by far better than those do not practice measuring their supply chain performance, as the feedback of customers satisfaction let them know their status of service excellence.

In the study of Illkka Sillanapaa **(**2011**)** key elements for the SCP measurement framework in Manufacturing Industry were defined as time, profitability, order book analysis and managerial analysis.

In **order book analysis** of Illkka Sillanapaa, (2011) study, a review of the production plant's completed output and delivery reliability of different time zone/years are reviewed. SCM can be also measured from the point of view of outcome, in which case profitability of completed products is measured. In the same study the costs of the SC are also observed. Measuring SC of a production plant places its footing on order book analysis.

The other sector of order book analysis is quality of the product and especially variations from predesignated. One has to find the midway in quality of the products and the set quality standard. It does not compensate to manufacture high quality good because the costs will in that case rise. On the other hand, producing low quality goods does not pay back as repairing the reclamations is costly.Furthermore, with degraded quality one can easily damage a good partnership with a customer. There must be a balance of product quality with customer satisfaction so long as the required level service is attained which help to the customer from expensing unnecessarily ; and to the manufacturer to catch the

market share. Measuring product quality is a necessity because it helps to identify in which stage of production, quality is compromised & errors occurred.

In Time :Time-based measuring , SC performance is conducted by measuring the time taken for different operations from production till delivery up the final customer which are expressed as the delivery cycle & accuracy, production time. The SC is also measured by analyzing the entire SC and its different sectors. At the end, the functionality of the attested measuring systems is analyzed in measuring the case SC.

According to Illkka Sillanapaa, (2011**)** one of the cornerstones of customer satisfaction is on-time delivery. On-time delivery means an order that is completed exactly at the right time; not an order completed ahead of time nor an order that was completed behind the schedule either. On-time delivery has been placed as an indicator also for the whole consolidated corporation of the case company. Satisfaction to the esteemed customer is directly related to meeting the promises them. When a perfect delivery time is realized, it will help to lead the production effectively and establish the projections for loading of production. On-time delivery reflects the operational culture of the production plant well; while a perfect delivery time depends mostly on leading the company operations, management and especially SCM.

Delivery reliability of the orders is measured with the help of the operation control system. The shipment is also recorded into the system. In delivery reliability, the dates of promised time of delivery from sales and the dispatched order are compared. The delivery is in time if the dates match. The production must not be completed too early since in this case storing will cause problems and capital is unnecessarily bound to the production process. Furthermore, customers would like to avoid receiving the products too early because prefabricated products are often taken directly to the customers' production process. Hence delivering goods beforehand raises a need for warehousing and increases the amount of customers' capital bound to production.

Managerial analysis : according to the study Illkka Sillanapaa, (2011) it is an analysis by persons participated in the SC or people supervising the effectiveness of SCM from the outside. In this analysis measurement the purpose is to reach into conclusions regarding

the overall SC and avoid partial optimization. Analysis is also conducted with help of time- and cost efficiency-based indicators of the SC.

Profitability It is worth important to note for a company manufacturing prefinished products, the source of efficiency from the point of manufacturing can be measured with its low cost production. The profit directed at the order describes cost-efficiency best (Illkka Sillanapaa, 2011).

From the research conducted by Strahwald and Sucky, (2018), delivery compliance and customer-specific performance criteria, like the number of shipments and the fill rate, have to be integrated into the overall performance measurement of the company with the intent of incorporating the customer's point of view. With respect to number of shipments, it particularly focuses on the improvement of delivery performance in terms of the overall time it takes that is the lead times and keeping the promised time that is on-time performance. According to Gunasekaran et al. (2004), however, these metrics are not functioning at strategic or tactical level rather limited at the operational level.

The study underwent by Strahwald and Sucky, (2018) determined a cross functional metric, i.e., lead time, to increase transparency along the supply chain processes. The performance assessment in Strahwald and Sucky, (2018) from an internal point of view already indicated some potential bottlenecks in terms of lead times. The study as part of a strategic program aims to upscale the supply chain processes by improving lead times and becoming a more reliable supplier. This requires the creation of transparency to identify performance gaps and develop improvement ideas to close these gaps (Strahwald and Sucky, (2018).

Summarizing the empirical studies assessed, the following points are marked-Mishra and Sharma, (2014), see SCPM from competitors point of view, in that a firm can benchmark its own profile with that of its competitors and the study is limited to measurement of sc length, inefficiency and capital productivity; from the point of view of Illkka Sillanapaa, (2011), SCP measurement is performed from four aspects:

- Order book analysis-which focusses on measuring quality of product and especially its deviation from the quality,

- Time based analysis is the measuring of delivery cycle, delivery accuracy, production time and its subdivision in to operational time Illkka Sillanapaa, (2011),
- Managerial analysis-the measurement is aimed to draw conclusion regarding the entire SC
- Profitability-which describes cost efficiency analysis.

From Strahwald and Sucky (2018) study point of view, the SCPM focus is from two perspectives- delivery compliance and customer specific performance criteria to improve flexibility of distribution on one hand and; describing maturity model which states measurement of one SC area first and expand from there using SCOR model as a conceptual basis to describe the process maturity of the SC activities plan, source make and deliver.

Hence analyzing the different studies performed in the different time zones with an average of 4 years different, the latest conducted on 2018, none of them tried to assess the 5 major SCP measurement attributes identified in theoretical literature review at a time. Hence this study will try to fill the gap and will perform the measurement without where competitors stand rather taking the industry benchmarks which are set in the theoretical literature review.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the research methodology used to do the study. It describes the research design, research approaches, data analysis tools and techniques employed to answer the research questions. According to Kothari (2004), Research methodology is a means to solve the research problem. This chapter describes details about the research approach, research design, sample size and sampling techniques, data source, data collection instruments, data analysis, reliability and validity of the study, model specification and finally ethical considerations.

3.2 Research Approach

Since SCOR has 4 levels that is from the 5 attributes (level 1) to metrics of each attribute (level 3 and 4) that is from general to specific under each attribute advancing in a prepared and controlled questionnaire data collection, the quantitative approach is more convenient for this study. This quantitative research type of approach is used to quantify the findings by way of generating numerical data and relies to responses to pre-formulated questions. As almost all the data analysis is turned to quantitative type, it is most appropriate approach. The study examines the supply chain performance of ethio telecom and identify the most important supply chain attribute and sub-criteria then finally identify & propose an alternative supply chain strategy using AHP-TOPSIS integrated method. The method triangulated by applying the TOPSIS only method for comparative validation.

3.3 Research Design

The purpose of this study is to measure performance of ethio telecom supply chain management using SCOR model and identify the performance, prioritize the metrics per the data collected and reach with the finding and recommendation on the best practices.

Accordingly this research helps to precisely define and measure the supply chain performance of the case company, under a defined population and stratified random

sampling of five categories and/or departments. Hence descriptive research design is found to be appropriate and applied. Further also it is explanatory in that it is used to asses the uncovered areas of SCOR-AHP-TOPSIS technique application in service industries in particular SCM. The WSM-weighted sum model is also equivalently applied for the non-pair wise comparison questions by which the most important attribute and the current and desired to supply chain performance attributes gaps are measured.

3.4 Data Collection Methods and Sources

3.4.1 Questionnaires

The primary instrument applied to collect data for this study was mainly questionnaire. The questionnaire is almost entirely newly designed getting some highlight from previous research conducted by Melaku Debas, (2018) in the SCOR-AHP method and analyzed through WSM and AHP-TOPSIS methods. The **questionnaires** were appropriate and most useful to gather relevant and deep information for the researcher. To enable the researcher obtain the required data and information, respondents were briefed with cluster to have them good understanding of how they could support in feeding the data as required, as the applied AHP method was less practiced at in the service industry. Hence the questionnaire released to the selected departments among those who participated in this questionnaire from a total population size of 165.

3.4.2 Direct Observation

Another means of data source is direct observation. It was very helpful to assess the existing supply chain system and performance measurement and of course it was the very reason which initiate the researcher to conduct the research in the area. In this research direct observation is used as a means to assess the existing supply practice on scheduled and unscheduled requests and how the SCD support the core business and keep the supply line uninterrupted in the case company.

3.5 Research Population and Sampling

The research is about measuring supply chain performance basing SCOR as a model in ethio telecom commercial supplies. Thus, the population in the current study is defined as

the stakeholders in the commercial supplies who play a role in the value chain. In ethio telecom SC division currently there are 165 permanent employees who have direct role, on the commercial supply chain at head quarter level : commercial sourcing, strategy and supply relation , non technical stores, custom clearance, distribution management and sales support department from sales division who have direct link for the supply of these goods to retail in market.

According to Kothari (2004), when the field of inquiry is large, considerations of time and cost almost invariably lead to a selection of respondents i.e., selection of only a few items. Considering the respondents to be as representative as possible, the researcher plan to use stratified random sampling method from probability sampling technique to select respondents from the target population.

Hence sample size for the questionnaire is taken from each respondent section, and to determine the total sample size to be taken with the below standard formula:

Size of Sample = $n = \frac{N}{(1+N(e2))}$

Where N=size of population

n = size of sample

e = margin of error

At 90% confidence level (to have a genuine random sampling relevant population), e = 1-0.90 = 0.1

Tabular view of sampling plan is shown in the table below:

SN	Working unit	Number of employees	Sample size	remark
1	Commercial sourcing section	10	4	Sourcing department
2	Supply strategy and relation /SSRM/	43	17	SSRM
3	Support warehouse	45	18	Non-technical stores

4	Distribution management	25	10	Logistics department
5	Shipment and custom clearance section	16	6	Logistics department
6	Retail logistics section	11	4	Sales support department
7	SC management members	15	4	Logistics department
	Total	**165**	**63**	

Table 3.1 Tabular view of sampling plan

3.6 Data Analysis and Interpretation Tools

The data collecting instrument, as mentioned above, was mainly questionnaire which include open-ended and close-ended questions as questionnaire are simple to administer and relatively inexpensive to analyze.

Different means of tools to analyze and interpret collected data from a survey are employed for the collected questionnaires, the process of tabulation was carried out and percentage was also used as a statically tool to analyze the data. There are application tools used for the analysis of quantitative data, some of which are broader in scope and well detailed in chapter four. The following ones are some of the application packages:

- **Microsoft Excel -** this software progrma is used for mathematical manipulation of the data collected from the case company and for recording information about the maintenance activities based on the nature of data.
- **Analytic Hierarchy Process (AHP)**: AHP is an MCDM technique developed by Saaty for assessing and selecting alternatives according to a set of selected criteria based on the elements of the hierarchy related to any evaluation index of the decision problem (Tian, 2016, Zhang, 2016 Jia, 2016, Xu, 2016 and Wang, 2016).

It is a structured technique used to organizing and analyzing complex decisions within the supply chain or any field. AHP was used as weighting method for the criteria and sub-criteria. The respondents were asked to compare every two criteria and give points between

1 to 9, the highest value in comparison is given to the most important criteria/sub-criteria in the pair.

Deployment of AHP in real-life decision making involves successive comparisons between every two alternatives, criterion by criterion, according to a 9-point scale as presented in table 3.2. If an alternative Ax is preferable to an alternative Ay, then the value of the comparison scale indicates the intensity of relative importance of Ax over Ay, assigned by the decision maker (Voronin, 2007).

Intensity of Importance	Verbal Judgment of Preference
1	Equally importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate values between adjacent scale values

Table 3.2: Scale of comparisons of the AHP ((Source: adopted from **Firoozeh Haddadi and Tahere Yaghoobi (2014))**

- **Technical for Order Preference by Similarity to Ideal Solution (TOPSIS)**: The fundamental concept of this technique is that the chosen alternatives should have the shortest distance to the positive ideal solution and the farthest distance from the negative ideal solution (C.prakash and M.K. Barua, 2015)
- **AHP-TOPSIS Integration:** a systematic hybrid of **AHP** and **TOPSIS** multicriteria decision method used to assess performance of alternatives (Tian, Zhang, Jia, Xu, and Wang, 2016)
- **Weighted sum model (WSM):** WSM is the score of the best alternative, from N number of decision criteria obtained by multiplying actual value of each criterion, a_{ij} with the weight of the j^{th} criterion W_j. (Bangweon Song and Seokjoong Kang, 2016)

Thus, this study is based on quantitative research method as well as qualitative research approach since it involves multi-dimensional characteristics of supply chain performance measurement metrics, and the performance measures are interrelated each other. The **Supply Chain Operation Reference (SCOR)** concept with **Analytic Hierarchy Process (AHP) ,** the AHP with Saaty's nine scale ratings of pair-wise comparison method in turn integrating with **TOPSIS** for weight determination and getting the best alternative collaboratively helped the researcher to get the most important KPI and the best **strategy** for supply chain efficiency in order to provide the case company with the managerial decision-making.

3.7 Scale Reliability and Validity

3.7.1 validity

Validity of a measure is the degree to which any measurement approach or instrument succeeds in describing or quantifying what it is designed to measure (Jonatan Weiner, DrPH, 2007). It is the degree to which the measurement device, in this case, the measuring questions in the questionnaire, provides sufficient coverage of the research investigative questions. To maintain the validity of the instruments, specificity was kept which enable the researcher to verify the accuracy and power of the test of the questions that can be compared with the industry standard are carefully designed. The finding was in alignment with the standard as most of the questionnaires were developed based on careful review of literatures whilst some of the questionnaires were adopted from previous researches. In addition, a sensitivity test is done for comparison in that the sensitivity test indicate a slight change in the weight of the pairwise comparison brings a significant rank difference among attributes. The sensitivity test was done an exchange of the pair wise comparison of attributes weight which were obtained during the questionnaire, accordingly the rank of the attributes whose pairwise comparison interchanged give similar shift of the SC attributes rank. Pilot testing of questionnaires was conducted to obtain a feedback from the respondent on validity and responses were collected and questionnaire was adjusted subsequently.

Real result			Sensitivity test result		
attributes	weight	Rank	attributes	weight	Rank
RL	0.4282	1	RL	2	0.2630
AG	0.0733	4	AG	4	0.1190
RS	0.3029	2	RS	1	0.4343
AM	0.0468	5	AM	5	0.0462
CO	0.1489	3	CO	3	0.1376

3.7.2 Reliability

According to Weiner, DrPH, (2007) Reliability of a Measure refers to the degree to which a measurement technique can be depended upon to secure consistent results upon repeated application. Reliability is consistency of measurement or stability of measurement over a variety of conditions in which basically the same results should be obtained. This is ensured, in this research, in that comparative validation test is performed to verify the AHP-TOPSIS integration method applied as the main tool for alternative strategy selection is compared with TOPSIS only method and the result found similar. On the other hand, the weighted sum model (WSM) result indicate the SC performance attributes hierarchy obtained using this method found again similar with the AHP-TOPSIS integrated method result. Hence both the WSM and the AHP-TOPSIS integration method are reliable as consistency is respected with different way of measurement giving similar result. More over the consistency index (CI) value check which is applied in AHP is also kept below 10% for all criteria and sub-criteria pair wise comparison methods, hence reliability is further triangulated.

Integrated AHP-TOPSIS method	TOPSIS method

	closeness index	Rank	closeness index	Rank
A1	0.764939867	2	0.534803779	2
A2	0.099904452	3	0.296146981	3
A3	0.80895888	1	0.647672218	1

Another consistency check was done to compare the WSM and AHP technique result as the below table depicts, the result show similar ranking, hence the applied techniques and questionnaire are said to be reliable.

AHP weight			WSM weight		
attributes	weight	Rank	attributes	weight	Rank
RS	0.3029	2	RS	2	0.213
RL	0.4282	1	RL	1	0.241
CO	0.1489	3	CO	3	0.193
AG	0.0733	4	AG	4	0.187
AM	0.0468	5	AM	5	0.1376

3.8 Ethical Consideration

Ethics was particularly significant components throughout the research procedures and if failed to be taken into account, it could lead to misinterpretation or even invalid conclusions. The research respondents' willingness to fill the questionnaires was respected and verbal consent and briefing was done while distributing the questionnaire papers. Hence, this paper did not go under any form of bias or change, and the researcher respected the code address issues such as honesty, objectivity, respect for intellectual property, social responsibility, confidentiality, non-discrimination and so on.

CHAPTER FOUR

DATA ANALYSIS, REASEARCH FINDINGS AND DISCUSSION

4.1. Introduction

Under this chapter the analysis and interpretation were carried out based on the data collected through questionnaire from four departments (i.e. Logistics, Sourcing, Supply strategy and relation Management (SSRM) and sales support) which work along the chain of the commercial supply line. Based on the methodologies, research design and tools of the proposal, the data was analyzed. The data was meant to get a sample of 63 respondents from the 165 population in the supply line. But the researcher, getting a highlight from the pilot test result and consulting literatures about survey response rate distributed 84 questionnaires. according to Baruch and Holtom (2008) response rate might be as low as 52 % of the expected respondents. However, considering this is too much conservative and taking effort to convince respondents to give reasonable time and at the same time giving personal briefing on how to respond, the required 63 is able to be attained.

4.2. Demographic data presentation and analysis

Observing the demographic trend or characteristics of the sample population before starting the data analysis is useful to make the analysis more meaningful for the reader. This part of the questionnaire requested limited amount of information related to personal and demographic status of respondents.

The purpose of demographic analysis in this research is to describe the characteristics of the sample such as proportion of male and female in the sample, department of respondents, academic qualification of respondents and experience of respondents. Accordingly, these variables are summarized and described in tables 4.1 and 4.2 below.

Table 4.1demographic profile

Variable	Frequency	Percent	cumulative

Gender of respondents			
Male	32	51%	51%
Female	31	49%	100%
Total	63	100%	
Education level			
Certificate Diploma	3	5%	5%
First degree	41	65%	70%
2nd degree and above	19	30%	100%
Total	63	100%	
work unit			
Logistics	34	54%	54%
Sourcing	4	6%	60%
Supply Strategy and Relation Management	17	27%	87%
sales support	4	6%	94%
SC mgt member	4	6%	100%
Total	63	100%	
work Experience			
below 1 year	2	3%	3%
1-3 year	2	3%	6%
4-6 year	11	17%	24%
above 6 years	48	76%	100%
Total	63	100%	

As table 4.1 depicts, the gender distribution of respondents covers 51 % of male and 49 % of female, this indicates that both genders were fairly involved in the study.

The study sought to find out the education level of respondents and the responses were analyzed as: majority (65%) of the respondents had first degree level of education followed by 30% of the respondents who had second degree and above level of education and only 5% who had diploma level of education. This indicates that the respondents had sufficient levels of education to understand and respond to the issues sought by the study.

The study sought to know the various work units that the respondents belongs to ascertain whether they had relevant knowledge in their area of specialization. The responses were analyzed, and the results are shown in the table and the result implied that 54% of the respondents were from logistics department followed by Supply Strategy and Relation Management department (27%) , sourcing and sales support departments take a share of 6% each. For general overview, the researcher decides to take 6% of the SC management. This implies that the respondents were able to understand the different supply chain activities as the lion share is directly from the logistics department and the remaining departments involved have a direct link for the commercial supplies.

The research wanted to find out the years the respondents has been with the corresponding departments in the case company. The responses were analyzed, and the results are shown in the table and the study findings revealed that majority of the respondents (76%), had a work experience of above 6 years whereas 17.0% had a work experience of between 4 to 6 years. only 6% had below 3 years of work experience as indicated in table 4.1. This shows that majority of the respondents had served for a considerable period of time which implies that they were in a position to give credible information relating to the study.

4.3 Response Rate

Table 4.2 Response rate and sampling

Respondents status	frequency	remark

Questionnaire distributed *		84	number of enrolled=sample size/estimated response rate
Returned	75		
eligible	63	Best and neatly completed 63 questionnaires selected	
incomplete	7	rejected as incomplete	
* estimated response rate is to be75%; hence to get the 63 sample (n), enrolment (N), is estimated to be 84 with the formula; N=n/0.75 (Baruch and Holtom (2008)).			

As per table 4.2, a total of 84 questionnaires were distributed to logistics, sourcing, supply strategy and relation management, and sales support departments, employees of ethio telecom. Out of the 84 questionnaires, 75 were returned to the researcher which represents a response rate of 89.3%. This is done after consulting literatures and to keep the sample size of 63 determined, estimating response rate to be75%. Hence to get the researcher get the desired result; sample (n), enrolment (N), is estimated to be 84 with the formula; N=n/0.75 (Baruch and Holtom ,2008). Among the distributed questionnaires, 75 are returned, taking neatly completed 63 questionnaires for further consideration, the remaining 12 ones are rejected as incomplete.

4.4 The State of Supply Chain Performance in Ethio Telecom- the 'as-is' and the desired 'to-be'

One of the objective of the study was to identify the **'as-is'** and the desired '**to-be'** of supply chain performance in the case company. To get the response in this regard two separate questions were presented to the respondents : one is to identify the current performance- the **'as-is'** and the second one to know the desired - the '**to-be'** strategy to bring best performance in the commercial supply chain practice at head quarter level. A StaNine-standard nine Satty scale 1 = Equally importance;

3= Moderate importance; 5=Strong importance; 7=Very strong importance; 9=Extreme importance (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016). Where 2,4,6,8 are Intermediate values between adjacent scale values (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016).

In the identification of the current highest performance strategy by enabling the respondents to choose a 5 point scale ; 5 for the highest rate and 1 for the list rated value, the analysis of the data was done using with the corresponding value given for each five strategic options as indicated in table 4.3 below . the result depicts that delivery reliability is the first ranked attribute of et SC practices, with 24.1% , followed by SC responsiveness strategy 21.3% , the last one are Flexibility and AM efficiency strategy with18.7% and 16.6% value respectively. Cost is given at the mid point with 19.3% of the respondents rating.

Since most of problems encountered actually are complex with multi attributes, the decision-making methods to attenuate errors, in doing so are the topic of the many studies (Bangweon Song and Seokjoong Kang, 2016). the foremost well-known and simplest multicriteria decision-making method is that the WSM- weighted sum model (Bangweon Song and Seokjoong Kang, 2016). If there are M alternatives and N criteria, then the best alternative is the one that satisfies the following expression (Bangweon Song and Seokjoong Kang, 2016):

$$A_{\text{WSM}} = \max \sum_{j=1}^{N} aij\, wj \text{ , for } i = 1, 2, 3, \ldots, M \qquad (1)$$

Where AWSM is that the WSM score of the only alternative, N is that the amount of decision criteria, aij is that particular value of the ith alternative in terms of the jth criterion, and wj is that the load of the jth criterion (Bangweon Song and Seokjoong Kang, 2016)

Based on this formula, the ‘as-is’ and the ‘desired to be’ performances and assessments are measured and weighted.

Table 4.3 Hierarchical result of '**as-is**' SC performance

#	attribute/rated	1	2	3	4	5	weighted average	%	Rank	
a	Delivery Reliability strategy		4	20	20	19	3.857	24.1%	1	RL
b	SC Flexibility strategy	10	10	20	16	7	3.000	18.7%	4	AG
c	Cost sensitive strategy	7	14	11	22	9	3.092	19.3%	3	CO
d	Asset Management Efficiency strategy	13	19	11	14	6	2.656	16.6%	5	AM
e	SC responsiveness strategy	8	7	14	19	15	3.413	21.3%	2	RS
						sum	16.018	1		

The second point of this objective was to know the respondents desired SC strategic option to bring excellence in the commercial SC line of the case company and the result was obtained as seen in table 4.4 below.

Table 4.4 Hierarchical result of desired '**to be**' of SC strategy

#	atribute	count	weighted average	% value	Rank	
a	Delivery Reliability strategy	20	8.700	21.03%	1	RL
b	SC Flexibility strategy	8	8.625	20.85%	3	AG
c	Cost sensitive strategy	7	7.750	18.73%	4	CO
d	Asset Management Efficiency strategy	15	7.600	18.37%	5	AM
e	SC responsiveness strategy	13	8.692	21.01%	2	RS
	sum	63	41.367	100%		

The '**desired to-be'** result of the study reveals that more or less it tallies with the current performance shown above; in that in both cases delivery reliability (RL) and Responsiveness (RS) are 1st and second with almost equivalent importance of 21.03% and

21.01% respectively. The 3rd important performance attribute is SC flexibility (AG) scored 20.85% weight while CO and AM are the last important performance attributes scoring 18.73% and 18.37% respectively. When summarizing the over all result we can observe that the **desired to-be** result is found to be more customer focused with a total weight of 62.89% as RL, RS, and AG are all customer focused attributes, while CO and AM the last two results are cost focused.

4.5 Supply Chain Performance in Ethio Telecom- Delivery performance efficiency.

4.5.1 Supply Chain Response time in days

The study sought to determine the delivery performance of the case company in comparison with the industry standard. The findings of the study in this regard is shown in table 4.5i

Table 4.5 commercial supplies SC response time in days

SC response time result in **days**		count	%	cumulative	rank
A	1-13 (Superior)	10	16%	16%	4
B	14-55 (Advantage)	17	27%	43%	2
C	56-83 (Parity)	20	32%	75%	1
D	above 83	16	25%	100%	2
	sum	63	100%		

As revealed from table 4.5, the supply chain response time starting from giving order till receiving to the warehouse including distributing to the final customer in the case company SC practice is from 56-83 days . According to the majority of respondents (32%) survey result, compared to the industry standard, the case company supply chain practice is at parity sate which tells us a lot to be done to draw it in to advantage and superior state. The result also reveled that though the majority is at parity, quite significant weight is given that indicate even less than parity . if we sum up the last two results more than half of the respondents (57%) measure it as below advantage or the other way only 43% are either advantage or superior.

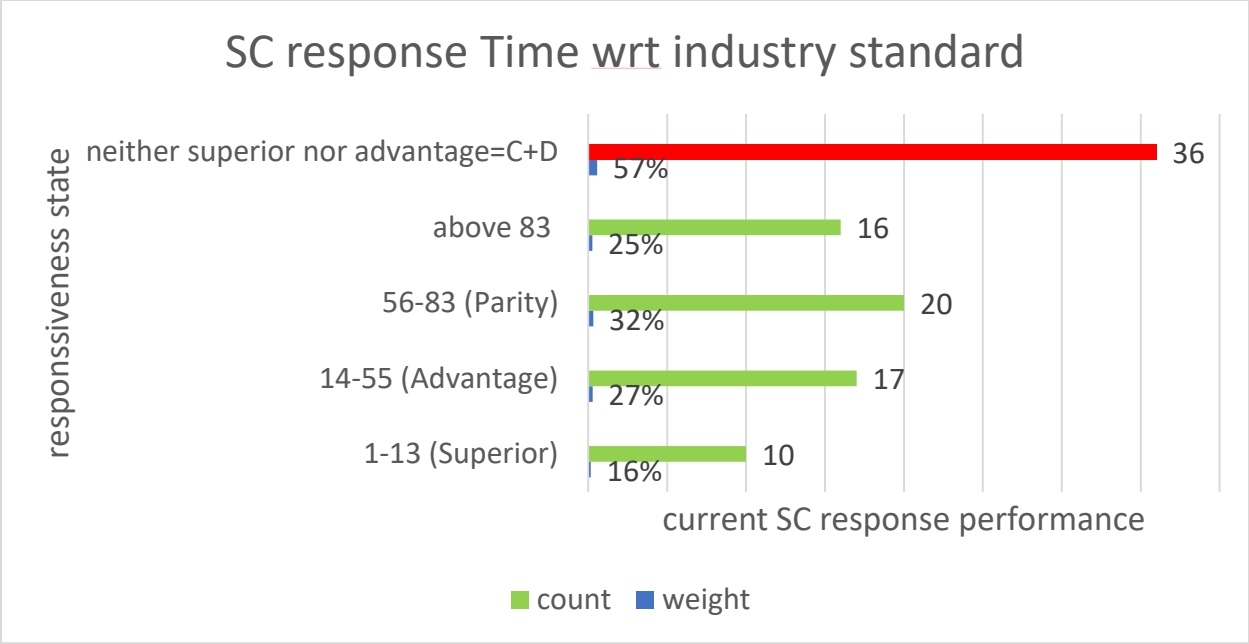


Figure 4.1 SC response performance of ethio telecom commercial supplies w.r.t. industry standard

4.5.2 Order Fulfilment Lead Time in days

The study sought to determine the order fulfilment performance of the case company in comparison with the industry standard. The study findings are as shown in table 4.6i

Table 4.6i commercial supplies order fulfilment Lead time I n days

Order fulfilment Lead time for commericial supplies		count	%	rank
A	<3 (Superior)	16	25%	3
B	4-5 (Advantage)	19	30%	2
C	6-7 (Parity)	21	33%	1
D	above 7	7	11%	4
	sum	63	100%	

The result shown in table 4.6 reveals that same as the SC response time the order fulfilment lead time result is at the third option from 6-7 days. This means according to 33% of the

respondents response order is fulfilled from 6-7 days counted from their request. According to the result, though the majority is at parity, unlike the SC response time this one is quite better because if we sum up parity and above 89% of the respondents result indicates either at parity, advantage or superior. Taking the result above parity more than half (56%) are at either advantage or at superior state. Hence the delivery lead time is quite better that the SC response time and not much difficult to draw it in to superior.

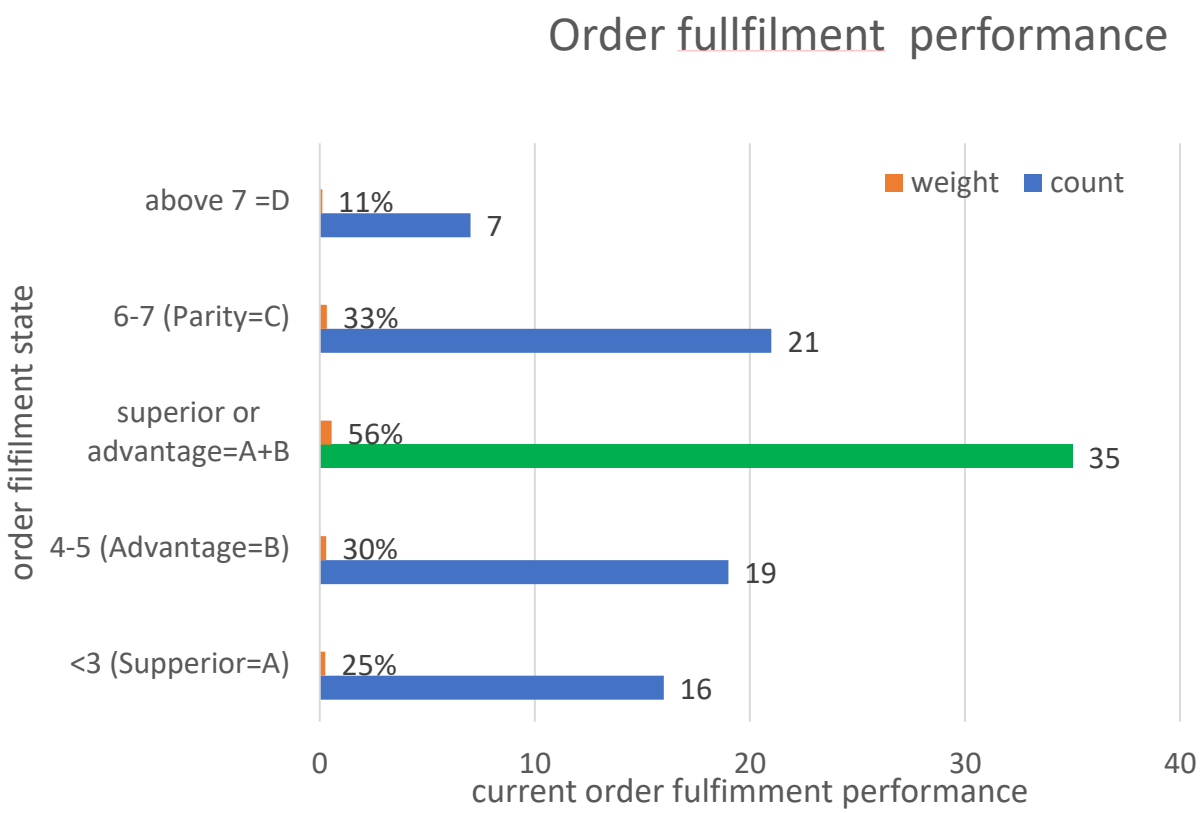


Figure 4.2 order fulfillment performance of ethio telecom commercial supplies wrt industry standard

4.6 Pairwise Comparison assessment to Identify the most Important supply chain performance Attributes and KPIs

Analytic Hierarchy Process (AHP) and Fuzzy AHP are multi criteria decision making methodologies which are widely used in many real problems. The AHP expresses the relative importance of criteria by pairwise comparisons and converts the values of pairwise comparisons to priorities (Haiqing Zhang, Aicha Sekhari, Yacine Ouzrout, Abdelaziz

Bouras ,2014). Fuzzy sets theory can appropriately handle uncertainty and imprecision issues. It can better describe vague demands or capacities with tolerance than probability distributions. It is also a sophisticated technique to solve real problems when data is subject to imprecision. Haiqing Zhang, Aicha Sekhari, Yacine Ouzrout, Abdelaziz Bouras (2014).

Consistency check: To make sure the priorities of each criterion are accurate and sensible in either AHP or Fuzzy AHP, the consistency of Pairwise Comparison Matrix (PCM) with crisp or fuzzy elements must be achieved. For the PCMs which fail the consistency test, the decision-makers must redo the ratios. To be able to facile employ AHP or Fuzzy AHP, a strategy should be proposed to repair the inconsistency information of PCMs.

4.6.1 Pairwise Comparison of supply chain performance criteria / level 2/ and priority of importance (rank) determination

The analytic hierarchy process (AHP) has advantages that the whole number of comparisons can be reduced via a hierarchy structure and the consistency of responses verified via a consistency ratio. However, at the same time, the AHP has disadvantages that values vary according to the form of hierarchy structure and it is difficult to maintain consistency itself among responses. If the number of comparisons can be reduced, a comparison within a single level is optimal, and if comparison can be made while the priority among entities is maintained, consistency may be automatically maintained. (Bangweon Song and Seokjoong Kang, 2016) Thus, in this study, the researcher applied a method of assigning weights, with the commonly known hierarchy structure of AHP and pairwise comparison but complements the disadvantages of AHP using TOPSIS.

This method has advantages that the number of comparisons can be reduced and also consistency is automatically maintained via determination of priorities first on multiple entities and subsequent comparisons between entities with adjoined priorities (Bangweon Song and Seokjoong Kang, 2016).

The study sought to determine the most important criteria of the case company hierarchically and assigning weights for each using AHP. For this study the AHP

comparison scale is used as indicated in table 4.7 Then the study findings are as shown in table 4.9

Table 4.7. AHP scale for combinations.

Numerical scale	Definition
1	Two activities contribute equally to the objective
3	Experience and judgement slightly favor one over another
5	Experience and judgement strongly favor one over another
7	An activity is strongly favored and its dominance is demonstrated in practice
9	9Importance of one over another affirmed on the highest possible order
2, 4, 6 and 8 Used to represent compromise between the priorities listed above	
Reciprocals ($1/a_{ij}$) A value attributed when activity i is compared to activity j becomes the reciprocal when j is compared to i	

Source : Tian, Zhang, Jia, Liu1, Xu and Wang (2016), pp4.

Table 4.8. Random consistency index (RIk).

k	1	2	3	4	5	6	7	8	9	10
RIk	0	0	0.6	0.9	1.1	1	1.3	1.4	1.5	1.49

Source : Tian, Zhang, Jia, Liu1, Xu and Wang (2016), pp4.

The data obtained based on the combination scale are analyzed step by step using AHP and detailed below from tables 4.9 -4.12 and summarized as below.

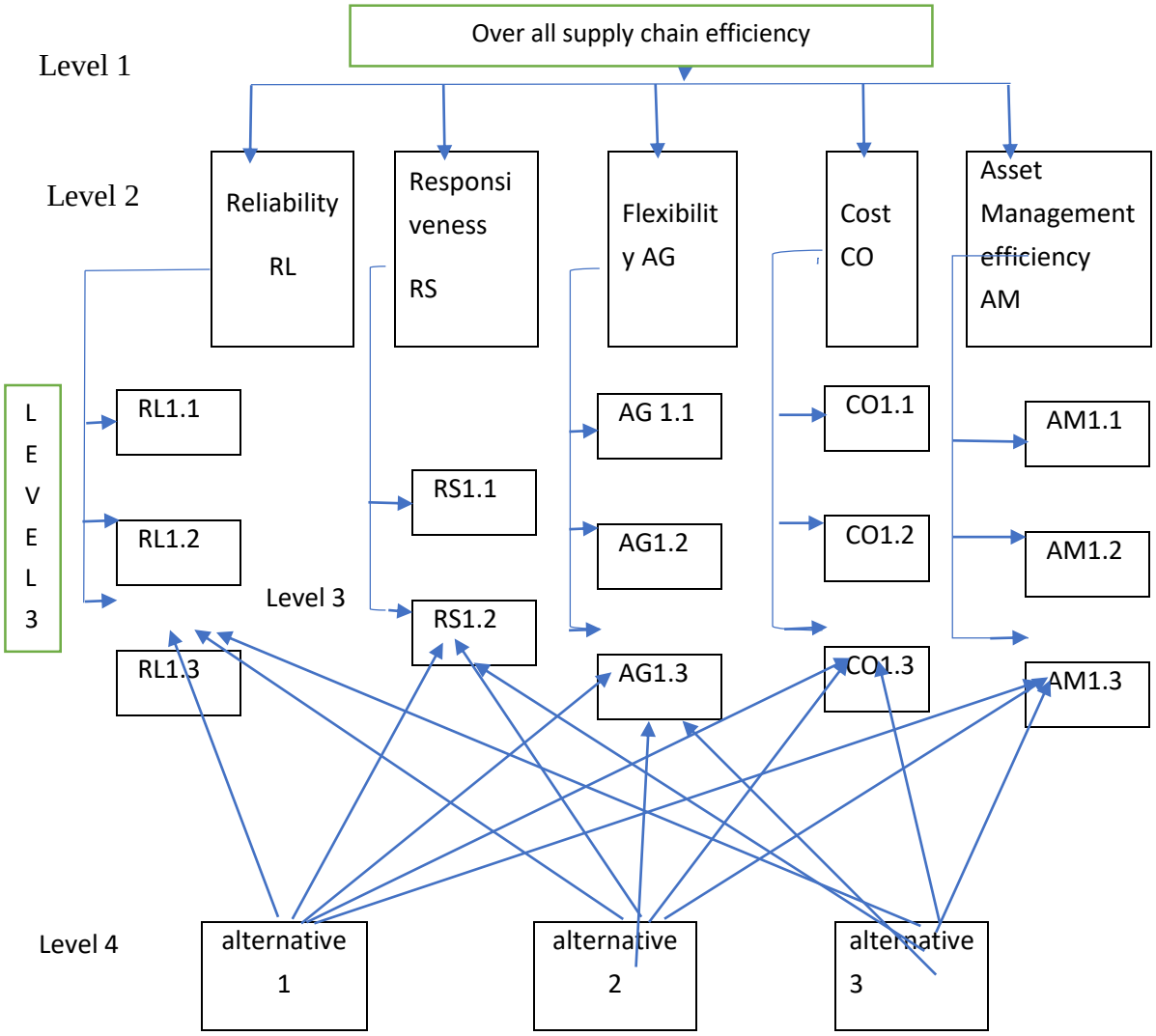
AHP

AHP is an MCDM technique developed by Saaty for assessing and selecting alternatives according to a set of selected criteria based on the elements of the hierarchy related to any evaluation index of the decision problem. The principle is to decompose factors affecting the complex issues and categorize these factors into different levels in a hierarchical

structure – the target layer, the rule layer and the index layer, that is, goal level, criterion level and factor/attribute level in this article. Then, it rates layer by layer through a comparison between two factors. It also provides a methodology to calibrate the numeric scale for the measurement of quantitative as well as qualitative performances. Tian, Zhang, Jia, Liu1, Xu and Wang, (2016)

The below hierarchical structure as adopted from Supply chain management: an international journal volume 9, number 1, 2004 (Samuel H. Huan, Sunil K. Sheoran and Ge Wang -2004) helps to understand the SCOR-AHP integration.

Figure 4.3 network optimization & hierarchy structure using AHP and SCOR metrics; as adapted (from) Source : Supply chain management: an international journal volume 9, number 1, 2004 (Samuel H. Huan, Sunil K. Sheoran and Ge Wang -2004)



Code	Description	Code	Description
RL1.1	Delivery performance to commit date	CO1.1	Cash-to-cash cycle time
RL 1.2	RL1.2 Fill rate/Orders delivered in full/	CO1.2	Inventory days of supply
RL1.3	RL1.3 Perfect order fulfilment	CO1.3	Asset turns/ability to generate sales from its assets/
RS1.1	SC responsiveness	AM1.1	Material cost
RS1.2	Order fulfilment lead time	AM 1.2	Transport cost

AG 1.1 Delivery Order Size Flexibility AM1.3 AM 1.3 Labor cost

AG 1.2 Delivery Order Time Flexibility
AG 1.3 Over all value at risk

step1	build PWC decision matrix

In the AHP analysis the first step is to develop a comparison matrix in which a cell in the matrix is the summarized result of the respondents majority weight.

$$A = \begin{array}{c} \\ A1 \\ A2 \\ . \\ . \\ Am \end{array} \begin{array}{c} \begin{array}{cccc} C1 & C2 & \ldots\ldots & .C3 \end{array} \\ \begin{bmatrix} a_{11} & a_{12} & \ldots\ldots & a_{1i} \\ a_{21} & a_{22} & \ldots\ldots & a_{2i} \\ & & & \\ & & & \\ a_{j1} & a_{j2} & \ldots\ldots & a_{ji} \end{bmatrix} \end{array} \quad (2)$$

According to Tian, Zhang, Jia, Liu1, Xu and Wang, (2016),Matrix A is a comparison matrix in which every element aij (i, j=1, 2, ., k) expresses the individual preference of expert regarding alternative Ai compared to alternative Aj. Thus, the matrix in comparison of A can be expressed as:

$$A=[a_{ij}],\ i=1, 2, \ldots, k;\ j=1, 2, \ldots, k \quad (3)$$

$$a_{ij}>0;\ a_{ji}=1/a_{ij},\ i=1, 2, \ldots, k;\ j=1, 2, \ldots, k \quad (4)$$

step1	Table 4.9 build PWC decision matrix				
	RS	RL	CO	AG	AM
RS	1	1/3	5	4	6
RL	3	1	3	5	6
CO	1/5	1/3	1	3	4

AG	1/4	1/5	1/3	1	2
AM	1/6	1/6	1/4	1/2	1
sum	4.617	2.03	9.58	13.5	19

step 2	Normalizing the matrix & calculate the criteria weight

Normalizing means each cell, aij, is divided by the column sum of the criteria for each cell and the below value is obtained.

step 2	Table 4.10 Normalizing the matrix & calculate the criteria weight						
	RS	RL	CO	AG	AM	sum	c. weight
RS	0.2166065	0.164	0.52	0.296296	0.315789	1.514366	0.3029
RL	0.6498195	0.492	0.31	0.37037	0.315789	2.140826	0.4282
CO	0.0433213	0.164	0.1	0.222222	0.210526	0.744352	0.1489
AG	0.0541516	0.098	0.03	0.074074	0.105263	0.366632	0.0733
AM	0.0361011	0.082	0.03	0.037037	0.052632	0.233824	0.0468

step 3	compute weighted normalized matrix and the lambda max value (ʎmax)

Computing the weighted normalized value is multiplying each cell aij with the corresponding criteria weight obtained in step 2.

step 3	Table 4.11 compute weighted normalized matrix the lambda max value						
C.weight	0.3028732	0.428	0.15	0.073326	0.046765		
	RS	RL	CO	AG	AM	sum	average
RS	0.3028732	0.143	0.74	0.293306	0.280589	1.763841	5.8237
RL	0.9086195	0.428	0.45	0.366632	0.280589	2.430617	5.6768

CO	0.0605746	0.143	0.15	0.219979	0.187059	0.759205	5.0998
AG	0.0757183	0.086	0.05	0.073326	0.09353	0.377831	5.1527
AM	0.0504789	0.071	0.04	0.036663	0.046765	0.242485	5.1852
						Lambda max (ʎ max)	5.3876

ʎ max=5.3876

step 4	checking consistency

In some situations due to the difficulty of mapping decision-makers and due to their level of commitment to check the comparison whether they keep a mathematical principles: if A>B and B>C, it has to keep A> C, or in-consistency of the comparison is observed. To verify this consistency checking is done.

The inconsistency of matrix A can be obtained by the consistency ratio CRA=CIA/RIk, where consistency index CIA=(ʎ max-n)/(n-1). If CR<0.1, the judgement matrix is acceptable, otherwise, it is considered inconsistent. Random consistency index Rik depends on the size of the matrix A. It can be acquired from Table 4.8 (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016)

N=5, five by five criteria

Lambda max (ʎ max)= 5.388, from table 4.11

CIA=(ʎ max-n)/(n-1) [(5.388-5)/(5-1)]=0.097 (5)

CRA=CIA/Rik [0.097/1.12]=0.087 (6)

The result shown that CR is <0.1 , which means it is consistent.

step 5	Determine the corresponding weight of the measured SCP attributes & rank their order of importance for the SC efficiency

Table 4.12 , ranking of the SC performance attributes and their corresponding weight

attribute	weight	Rank
RS	30%	2

RL	43%	1
CO	15%	3
AG	7%	4
AM	5%	5

From step1- 5 using AHP analysis, the corresponding weight of each criteria is finally obtained, and the result is hierarchically seen. From this we can see that SC reliability with objective weight of 0.43, followed by SC responsiveness. Form this we can see that if 1st and 2nd ranked attributes are summed up it constitutes objective weight 0.73 (73%), this means the result revealed the customer focused attributes are outweighed than the cost focused SC attributes. At the same time the result tallies with Table 4.3. This can be taken as one way of reliability confirmation for the study.

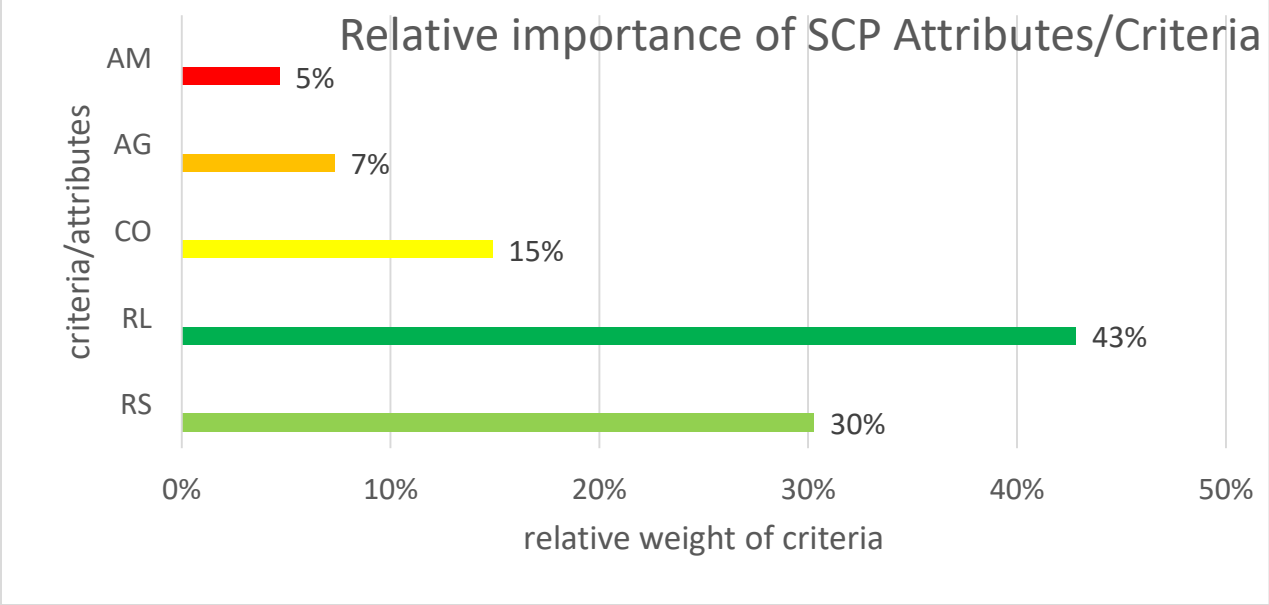


Figure 4.4 relative weight/importance of SCP Attributes/Criteria

4.6.2 Pairwise Comparison of supply chain performance sub criteria/level 3/ and priority of importance (rank) determination

In order to get the sub criteria/KPI/ with most important value among the KPIs, first the sub criteria local weight shall be calculated (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016) ; that is the 3rd level in figure 4.3 will be weighted using same steps as in 4.6.1, which is done for the criteria that is level 2 in figure 4.3.

The weight to be calculated in this step will be the local weight, to differentiate from the global weight; local weight is the weight share only from the given criteria . for example in figure 4.3 if one take AM-the weights of AM1.1, AM 1.2, AM 1.3 will share the percentage or objective weight with respect to AM; while global weight is the weight share of each sub criteria with respect to all criteria weight more clearly seen in table 4.25; Hence the weighting step for the sub-criteria will be done as :

Following same step in 4.6.1 as done for the 5 main attributes/criteria, now the turn is finding the weight of each sub criteria which are structured in level 3 of figure 4. 1

Weighting of RL-Reliability sub criteria.

The data is obtained from the PWC of the respondents response and seen as in the below matrix

step1	Table 4.13 build PWC decision matrix

	RL1.1	RL1.2	RL1.3
RL1.1	1	5	7
RL1.2	1/5	1	3
RL1.3	1/7	1/3	1
	1.342857	6.333333	11

step 2	Normalizing the matrix & calculate the criteria weight

Table 4.14 normalized decision matrix of Reliability

Sub C.	RL1.1	RL1.2	RL1.3	SUM	local wt
RL1.1	0.744681	0.789474	0.636364	2.170518	0.723506

RL1.2	0.148936	0.157895	0.272727	0.579558	0.193186
RL1.3	0.106383	0.052632	0.090909	0.249924	0.083308

step 3	compute weighted normalized matrix and the lambda max value (ʎmax)

Computing the weighted normalized value is multiplying each cell a_{ij} with the corresponding sub criteria weight obtained in step 2.

Table 4.15 weighted decision matrix of Reliability

Wt	0.723506	0.193186	0.083308		
Sub C.	RL1.1	RL1.2	RL1.3	SUM	AVERAGE
RL1.1	0.723506	0.96593	0.583155	2.272592	3.141082
RL1.2	0.144701	0.193186	0.249924	0.587811	3.042719
RL1.3	0.103358	0.064395	0.083308	0.251061	3.013655
				ʎmax	3.065819

ʎ max=3.065819

step 4	checking consistency

Applying equation (5) and (6)

CI= [(3.065819-3)/(3-1)]= 0.032909

CR=CI/Rik =0.05674, Since CR is < 0.1 , the comparison is consistent.

step 5	Determine the corresponding weight of the measured subcriteria & rank their order of importance for the given criteria-Reliability.

The local weight value of each sucriteria from step 2 and their corresponding, rank is as below

Table 4.16 local weight and rank of sub criteria in Reliability

Sub c.	local weight	rank
RL1.1	0.723506	1st
RL1.2	0.193186	2nd
RL1.3	0.083308	3rd

Weighting of AG-Flexibility/Agility sub criteria.

Same step applied for Reliability, now the PWCM and the corresponding result is indicated for Flexibility.

Table 4.17 PWCM of sub criteria in Flexibility/Agility

	AG1.1	AG1.2	AG1.3
AG1.1	1	4	8
AG1.2	1/4	1	5
AG1.3	1/8	1/5	1
sum	1.375	5.2	14

Table 4.18 Weight , Rank and CR of sub criteria in Flexibility

Sub C.	L. weight	Rank
AG1.1	0.689311	1
AG1.2	0.243756	2
AG1.3	0.066933	3
CR	0.082441	CR<0.1

***Weighting of RS*- Responsiveness sub criteria**

This one is easier with AHP perspective as the comparison is only a pair, inconsistency could not be an issue. With same reason the random index for n=1 and 2 from table 4.20 is 0 hence consistency is 100%.

Table 4.19 PWCM of sub criteria in Responsiveness

	RS1.1	RS1.2
	5	1

R	L. weight	Rank
RS1.1	0.833333	1
RS1.2	0.166667	2
CR	0	CR<0.1

Table 4.20 Weight , Rank and CR of sub criteria in Responsiveness.

***Weighting of AM*- Asset Management efficiency sub criteria**

Same step applied for Reliability, now the PWCM and the corresponding result is indicated for Asset Management efficiency (AM).

	AM1.1	AM1.2	M1.3
AM1.1	1	1/7	1/8
AM1.2	7	1	1/3
AM1.3	8	3	1
sum	16	4.142857	1.458333

Table 4.21PWCM of sub criteria in Asset (AM)

	L. weight	Rank

AM1.1	0.060899	3
AM1.2	0.302484	2
AM1.3	0.636617	1
CR	0.091332	CR<0.1

Table 4.22 Weight , Rank and CR of sub criteria in Asset (AM).

***Weighting of CO-* Cost sub criteria**

Same step applied for Reliability, now the PWCM and the corresponding result is indicated for Cost(CO).

	CO1.1	CO1.2	CO1.3
CO1.1	1	1/3	2
CO1.2	3	1	3
CO1.3	1/2	1/3	1
sum	4.5	1.666667	6

Table 4.23 PWCM of sub criteria in Cost (CO)

	L. weight	Rank
CO1.1	0.251852	2
CO1.2	0.588889	1
CO1.3	0.159259	3
CR	0.046469	CR<0.1

Table 4.24 Weight , Rank and CR of sub criteria in Cost(CO).

According to Tian, Zhang, Jia, Liu1, Xu and Wang, 2016, the two important steps of weighting the importance using AHP: 1) establishing the pairwise comparison matrices and 2) factor importance degree and consistency ratio test as done independently for each

sub criteria from table 4.16 to 4.24, the global weight determination is done. The global weight determination is performed by multiplying the local weight of sub criteria with the corresponding criteria weight share and the rank (degree of importance) is determined as table 4.25.

SC attribute (criteria description)	SC attribute (criteria weight) =X	Sub criteria code	Sub criteria local weight=Y	Sub criteria Global weight, Z=(X*Y)	Rank
Reliability (RL)	0.428	RL1.1	0.7235	0.30978	1
		RL1.2	0.1932	0.08272	4
		RL1.3	0.0833	0.03567	8
Flexibility (AG)	0.073	AG1.1	0.6893	0.05054	5
		AG1.2	0.2438	0.01787	11
		AG1.3	0.0669	0.00491	13
Responsiveness (RS)	0.303	RS1.1	0.8333	0.25239	2
		RS1.2	0.1667	0.05048	6
Asset Mgt (AM)	0.047	AM1.1	0.0609	0.00285	14
		AM1.2	0.3025	0.01415	12
		AM1.3	0.6366	0.02977	9
Cost (CO)	0.149	CO1.1	0.2519	0.03749	7
		CO1.2	0.5889	0.08767	3
		CO1.3	0.1593	0.02371	10

Table 4.25 Factor weight and rank on over all goal

From table 4.25, it can be seen that RL1.1-delivery performance to commit date ; RS1.1-SC responsiveness , CO1.2-transport cost, RL1.2-fill rate/order fill rate/ and AG1.1-Delivery order size flexibility have large importance on the over all SC efficiency ranked

from 1 to 5 respectively. This tells us particular attention need to be drawn to these KPIs better than others as they account for 78 % Of the total weight and if we zoom in from 1to 3 ranked KPIs they constitute quite significant share (65%) unlike the last five ranked KPIs which contribute only 6% of the total weight among the 14 factors/Sub criteria/ from the over goal of SC efficiency.

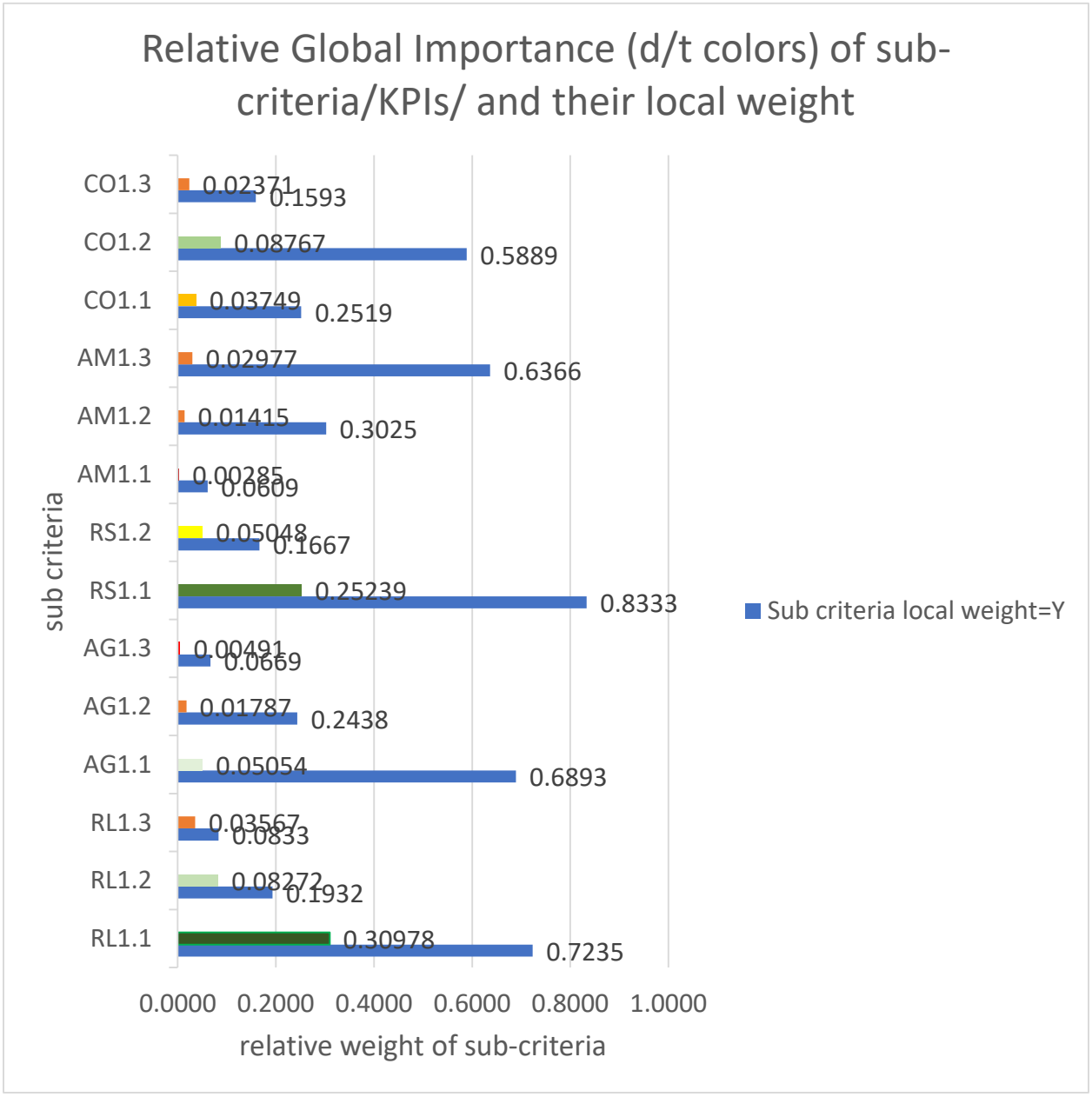


Figure 4.5 relative global importance of all KPIs (in comparison out of their respective attributes)

4.7 Determination of Alternative strategy that can best fit to the KPIs /level 4

The study sought to determine the best alternative in ethio telecom commercial supplies that can enhance the KPIs under consideration as indicated in questionnaire 7. The study findings are as shown in table 4.26. This section presents the alternatives than can be in alignment with the KPIs and hence that alternative determine the best strategy for the commercial supplies under the case company using TOPSIS method.

TIOPSIS is an MCDM method to obtain the optimal solution, which is first proposed by Hwang and Yoon and has the following steps (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016).

The steps per (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016):

Step 1. build a ranking decision matrix, refer equation (2)

Step 2.compute the normalized decision matrix $Y=[\ yij\ ]$

For the benefit attribute or factor, the normalized value is expressed as

$$Yij = \frac{xij - minxij}{Max\ xij - min\ xij} \quad (7)$$

$(i=1, 2, \ldots, m;\ j=1, 2, \ldots, n)$

For the cost attribute or factor, the normalized value is expressed as

$$Y_{ij} = \frac{max\ x_{ij} - x_{ij}}{Max\ x_{ij} - min\ x_{ij}} \quad (8)$$

$(i=1, 2, \ldots, m;\ j=1, 2, \ldots, n)$

Step 3: computing weighted normalized matrix

$$Z=(zij)_{m\ x\ n} = (w_j y_{ij})_{\ m\ x\ n}$$

$$= \begin{bmatrix} w_1y_{11} & w2y12 & \ldots. & w_ny_{1n} \\ w_1y_{21} & w_2y_{22} & \ldots. & w_ny_{2n} \\ \ldots\ldots & \ldots\ldots & \ldots\ldots & \\ w_{1y}m_1 & w_2y_{m2} & \ldots. & w_ny_{mn} \end{bmatrix} \quad (9)$$

where the weight denoted by wj

Step 4: compute positive ideal solution (PIS), and negative ideal solution (NIS) and they are denoted as: PIS=max z_{ij} (10)

NIS-min z_{ij} (11)

Step 5: calculate the distances of each alternative to the positive ideal solution **di**$^{+}$ and the distances of each alternative to the negative ideal solution **di**$^{-}$

They are expressed as :

$$\mathbf{di}^{+} = (\sum^{n}{}_{j=1} (z_{ij}-z_j^{+})^2)^{0.5} \quad (12)$$

$$\mathbf{di}^{-} = (\sum^{n}{}_{j=1} (z_{ij}-z_j^{-})^2)^{0.5} \quad (13)$$

where i=1,2,….,m. for both cases

Step 6:The closeness index C^{+}_i for each alternative A_i is computed based on positive and negative-ideal solutions. It is expressed as :

$$C^{+}_i = \frac{d^{-}_I}{d^{+}_i + d^{-}_i}, \quad i=1,2,3….m \quad (14)$$

clearly, C^{+}_i is a value between 0 and 1

Before detail practical analysis is conducted the concept of the variables PIS/NIS, di^{+} /di^{-} and the Ci^{+} are need to be clarified well. Accordingly, the PIS and NIS are the ideal best and ideal worst solutions respectively for which the PIS-positive ideal solution is a solution which is required to be maximum for benefit criteria and inversely the minimum value is required for cost criteria. The di^{+} and di^{-} are the separation measure of the distance of an alternative from the PIS and NIS respectively. That is the di^{+} is the separation from ideal best solution whose value is required to be minimal as it tells how much it approaches to the ideal best one; whereas the di^{-} is the separation distance from the NIS or ideal worst solution whose value is required to be maximal, as it tells us how far from the worst result.

The relative closeness index is finally calculated with respect to positive ideal solution. Hence the closeness index Ci^{+} is therefore the measure of the performance of the alternatives whose value range between ‘0’ and ‘1’ ; the more Ci close to 1, the more

alternative performs best and vice versa. The fundamental concept of this technique is that the chosen alternatives should have the shortest distance di to the positive ideal solution and the farthest distance from the negative ideal solution.

Based on the questionnaire result, the score of each alternative is listed in table 4.26

sub-criteria	**A1 Alternative 1**	**A2 alternative 2**	**A3 alternative 3**
RL1.1	4.49	3.57	3.98
RL1.2	4.27	3.77	3.91
RL1.3	3.63	3.77	4.26
AG1.1	4.11	3.73	4.19
AG1.2	4.10	3.71	3.98
AG1.3	3.53	3.65	3.59
RS1.1	4.37	3.64	3.94
RS1.2	4.10	3.41	3.80
AM1.1	3.70	3.74	3.66
AM1.2	3.94	3.61	3.80
AM1.3	3.48	3.60	3.79
CO1.1	3.74	3.87	3.87
CO1.2	3.55	3.72	4.00
CO1.3	3.61	3.59	3.98

Table 4.26 score of each **KPI** for strategy alternatives.

Where :

A1-Alternative 1: refers to customer focused strategy

A2- Alternative 2: refers to cost focused strategy

A3- Alternative 3: refers to optimal balance of customer and cost focused strategy

The table above (4.26), performance score of each KPI for the listed alternatives, is obtained from the questionnaire result. Referring (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016), each sub-criteria result is assessed independently and the steps as clearly indicated in section 2.1.6.2. As per the literature discussion in chapter two (Kocaoglu, Gulsun & Tanyas, 2014), and (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016), the end result of TOPSIS is to know the relative closeness to the ideal solution of each alternative and to rank/decide the optimal alternative based on the closeness index weight-the larger the weight the best the alternative.

4.7.1 Sub Criterion Assessment To Determine Alternative strategy that can best fit to the KPIs

1. Alternative Evaluation for Sub Criteria - Reliability(RL)

Accordingly applying the steps for TOSIS and using table 4.26 to extract the summarized respondents result, a **decision matrix** is established, for **RL-reliability** to calculate the closeness index:

Step 1 build a ranking decision matrix,

	RL1.1	RL1.2	RL1.3
A1	4.49	4.27	3.63
A2	3.57	3.77	3.77
A3	3.98	3.91	4.26

Table 4.27 Reliability sub criteria decision matrix for alternative assessment

Step 2.compute the normalized decision matrix Y= $[\, y_{ij} \,]$

As Reliability is a benefit attribute, its highest value is desired hence we use equation (7), and the result is

1.0	1.0	0.0
0.0	0.0	0.2

1.0	1.0	1.0

Table 4.28 normalized matrix of RL-sub criteria for alternative assessment

Step 3 &4: Compute the weighted normalized decision matrix, PIS and NIS

Multiplying the normalized value with the weight of each sub criteria, which we obtain from table 4.25 in section 4.6.2

weight	0.3089	0.08248	0.0356
	RL1.1	RL1.2	RL1.3
A1	0.309	0.082	0.000
A2	0.000	0.000	0.008
A3	0.309	0.082	0.036
PIS	0.31	0.08	0.04
NIS	0.00	0.00	0.00

Table 4.29 weighted normalized matrix with PIS and INS of RL sub criteria for alternative assessment.

Step 5 & 6: calculate the distances of each alternative to the positive ideal solution $\mathbf{di}^+$ and the distances of each alternative to the negative ideal solution $\mathbf{di}^-$ and the closeness index $\mathbf{C_i}$

	d_i^+	d_i^-	$d_i^-+d_i^+$	C_i	Rank	
A1	0.04	0.32	0.36	0.900	2	C_1^+
A2	0.32	0.01	0.33	0.024	3	C_2^+
A3	0.00	0.32	0.32	1.000	1	C_3^+

Table 4.30 distance of each alternative to PIS & NIS and the closeness index of RL sub criteria

The closeness index also called the factor performance score, of the three framed alternatives are measured against each sub-criteria and the result indicates A3 be the highest score or performance with value 1 followed by A1 =0.900 and A2= 0.024. Thus

A3-alternative 3 is optimal for Reliability sub criteria as indicated in the questionnaire section7, is the alternative with a mid way between customer focused and responsiveness. It is chosen for reliability, which means RL is both customer focused and responsiveness.

2. Alternative Evaluation for Sub Criteria - Flexibility (AG)

using same table 4.26 to extract the summarized respondents result, a **decision matrix** is established, for **AG-Flexibility** to calculate the closeness index:

Step 1 build a ranking decision matrix,

sub-criteria	**A1 Alternative 1**	**A2 alternative 2**	**A3 alternative 3**
AG1.1	4.11	3.73	4.19
AG1.2	4.10	3.71	3.98
AG1.3	3.53	3.65	3.59

Table 4.31 Flexibility sub criteria decision matrix for alternative assessment

Step 2.compute the normalized decision matrix Y= $[\ y_{ij}\ ]$

As Flexibility is a benefit attribute, its highest value is desired hence we use equation (7), and the result is:

0.8	1.0	0.0
0.0	0.0	1.0
1.0	0.7	0.5

Table 4.32 normalized matrix of AG-sub criteria for alternative assessment

Step 3 &4: Compute the weighted normalized decision matrix, PIS and NIS

Multiplying the normalized value with the weight of each sub criteria, which we obtain from table 4.25 in section 4.6.2

weight	0.051	0.018	0.005

	AG1.1	AG1.2	AG1.3
A1	0.042	0.018	0.000
A2	0.000	0.000	0.005
A3	0.051	0.012	0.002
PIS	0.051	0.018	0.005
NIS	0.000	0.000	0.000

Table 4.33 weighted normalized matrix with PIS and INS of AG sub criteria for alternative assessment.

Step 5 & 6: calculate the distances of each alternative to the positive ideal solution **di**$^{+}$ and the distances of each alternative to the negative ideal solution **di**$^{-}$ and the closeness index C_i

	d_i^+	d_i^-	$d_i^-+d_i^+$	C_i	Rank	
A1	0.010	0.045	0.055	0.818	2	C_1^+
A2	0.054	0.005	0.059	0.084	3	C_2^+
A3	0.006	0.052	0.058	0.897	1	C_3^+

Table 4.34 distance of each alternative to PIS & NIS and the closeness index of AG sub criteria

The closeness index also called the factor performance score of the three framed alternatives are measured against each sub-criteria and the result indicates A3 be the highest score or performance with value 0.897 followed by A1 =0.818 and A2=0.084. Thus A3-alternative 3 is optimal for Flexibility sub criteria

3. Alternative Evaluation for Sub Criteria - Responsiveness (RS)

using same table 4.26 to extract the summarized respondents result, a **decision matrix** is established, for **RS-Responsiveness** to calculate the closeness index:

Step 1 build a ranking decision matrix,

sub-criteria	A1 Alternative 1	A2 alternative 2	A3 alternative 3
RS1.1	4.37	3.64	3.94
RS1.2	4.10	3.41	3.80

Table 4.35 Responsiveness sub criteria decision matrix for alternative assessment

Step 2.compute the normalized decision matrix Y= $[y_{ij}]$

As Responsiveness is a benefit attribute, its highest value is desired, hence we use equation (7) and the result is:

1.0	1.0
0.0	0.0
0.4	0.6

Table 4.36 normalized matrix of RS-sub criteria for alternative assessment

Step 3 &4: Compute the weighted normalized decision matrix, PIS and NIS

Multiplying the normalized value with the weight of each sub criteria, which we obtain from table 4.25 in section 4.6.2

weight	0.2524	0.05048
	RS1.1	RS1.2
A1	0.252	0.050
A2	0.000	0.000
A3	0.105	0.028
PIS	0.25	0.05
NIS	0.00	0.00

Table 4.37 weighted normalized matrix with PIS and INS of RS sub criteria for alternative assessment.

Step 5 & 6: calculate the distances of each alternative to the positive ideal solution **di**$^{+}$ and the distances of each alternative to the negative ideal solution **di**$^{-}$ and the closeness index **C**$_{i}$

	di+	di-	di-+di+	Pi	Rank	
A1	0.000	0.257	0.257	1.000	1	C_1^+
A2	0.257	0.000	0.257	0.000	3	C_2^+
A3	0.149	0.109	0.258	0.421	2	C_3^+

Table 4.38 distance of each alternative to PIS & NIS and the closeness index of RS sub criteria.

The closeness index also called the factor performance score of the three framed alternatives are measured against each sub-criteria and the result indicates A1 be the highest score or performance with value 1.00 followed by A3 =0.421 and A2=0.000. Thus A1-alternative 1 is optimal for Responsiveness sub criteria.

4. Alternative Evaluation for Sub Criteria - Asset management efficiency (AM)

using same table 4.26 to extract the summarized respondents result, a **decision matrix** is established, for **AM- Asset management efficiency** to calculate the closeness index:

Step 1 build a ranking decision matrix,

sub-criteria	**A1 Alternative 1**	**A2 alternative 2**	**A3 alternative 3**
AM1.1	3.70	3.74	3.66
AM1.2	3.94	3.61	3.80
AM1.3	3.48	3.60	3.79

Table 4.39 Asset management sub criteria decision matrix for alternative assessment

Step 2. compute the normalized decision matrix Y=[y_{ij}]

As Asset is a benefit attribute, its highest value is desired, hence we use equation (7) and the result is:

0.5	1.0	0.0
1.0	0.0	0.4
0.0	0.6	1.0

Table 4.40 normalized matrix of AM-sub criteria for alternative assessment

Step 3 &4: Compute the weighted normalized decision matrix, PIS and NIS

Multiplying the normalized value with the weight of each sub criteria, which we obtain from table 4.25 in section 4.6.2

weight	0.003	0.014	0.030
	AM1.1	AM1.2	AM1.3
A1	0.001	0.014	0.000
A2	0.003	0.000	0.012
A3	0.000	0.008	0.030
PIS	0.003	0.014	0.030
NIS	0.000	0.000	0.000

Table 4.41 weighted normalized matrix with PIS and INS of AM sub criteria for alternative assessment.

Step 5 & 6: calculate the distances of each alternative to the positive ideal solution **di**$^{+}$ and the distances of each alternative to the negative ideal solution **di**$^{-}$ and the closeness index **C**$_{i}$

	di+	**di-**	**di-+di+**	**Pi**	**Rank**	
A1	0.030	0.014	0.044	0.323	3	C_1^+
A2	0.023	0.012	0.035	0.3443	2	C_2^+

A3	0.007	0.031	0.037	0.826	1	C_3^+

Table 4.42 distance of each alternative to PIS & NIS and the closeness index of AM sub criteria.

The closeness index also called the factor performance score of the three framed alternatives are measured against each sub-criteria and the result indicates A3 be the highest score or performance with value 0.826 followed by A2 =0.344 and A1=0.323. Thus A3-alternative 3 is optimal for Asset management efficiency sub criteria.

5. Alternative Evaluation for Sub Criteria - Cost (CO)

using same table 4.26 to extract the summarized respondents result, a **decision matrix** is established, for **CO- Cost** to calculate the closeness index:

Step 1 build a ranking decision matrix,

sub-criteria	**A1 Alternative 1**	**A2 alternative 2**	**A3 alternative 3**
CO1.1	3.74	3.87	3.87
CO1.2	3.55	3.72	4.00
CO1.3	3.61	3.59	3.98

Table 4.43 Cost sub criteria decision matrix for alternative assessment

Step 2. compute the normalized decision matrix Y=[yij]

As cost is a costly attribute, its lowest value is desired, hence we use equation (8) and the result is:

1.0	1.0	1.0
0.0	0.6	1.0
0.0	0.0	0.0

Table 4.44 normalized matrix of CO-sub criteria for alternative assessment

Step 3 &4: Compute the weighted normalized decision matrix, PIS and NIS

Multiplying the normalized value with the weight of each sub criteria, which we obtain from table 4.25 in section 4.6.2

weight	0.037	0.088	0.024
	CO1.1	CO1.2	CO1.3
A1	0.037	0.088	0.024
A2	0.001	0.054	0.023
A3	0.000	0.000	0.000
PIS	0.000	0.000	0.000
NIS	0.037	0.088	0.024

Table 4.45 weighted normalized matrix with PIS and INS of CO sub criteria for alternative assessment.

Step 5 & 6: calculate the distances of each alternative to the positive ideal solution $\mathbf{di}^{+}$ and the distances of each alternative to the negative ideal solution $\mathbf{di}^{-}$ and the closeness index $\mathbf{C_i}$

	di+	**di-**	**di-+di+**	**Pi**	**Rank**	
A1	0.098	0.001	0.099	0.0115	3	C_1^+
A2	0.059	0.049	0.108	0.4535	2	C_2^+
A3	0.000	0.098	0.098	1	1	C_3^+

Table 4.46 distance of each alternative to PIS & NIS and the closeness index of CO sub criteria

The closeness index also called the factor performance score of the three framed alternatives are measured against each sub-criteria and the result indicates A3 be the highest score or performance with value 1.00 followed by A2 =0.454 and A1=0.012. Thus A3-alternative 3 is optimal for Cost sub criteria.

4.7.2 Over All Alternative Assessment to Determine the Strategy That Can Best Fit To The goal (AHP-TOPSIS integration).

Based on each sub criterion comparison matrices done in 4.7.1, the closeness indices are obtained for the 5 criteria. The judgment matrix composed of closeness index **C,** which is obtained by **TOPSIS** method, and the weight vector for each criterion **W**, which is obtained by **AHP** method, and then the judgement result vector **F** is expressed as in table 4.47-4.49: (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016)

Accordingly the over all judgment matrix **C** aggregating the independent Closeness indices together and analyzing via TOPSIS is:

C=

	A1	A2	A3
RL	0.900	0.024	1.000
AG	0.818	0.084	0.897
RS	1.000	0.000	0.421
AM	0.323	0.344	0.826
CO	0.0115	0.45351	1

Table 4.47 aggregated closeness indices matrix of the criteria

The weight vector for the criterion level **W,** from table 4.25 for each criteria,

W=

RL	AG	RS	AM	CO
0.428	0.0733	0.303	0.047	0.149

Table 4.48 the weight vector for each criterion

The result vector value , **F** is expressed as

F=**C** X **W** =

A1	A2	A3
0.7649	0.0999	0.8090

Table 4.49 over all performance of each alternative

The result **F**, denote the overall performance for each alternative: the over all closeness index for alternative 1 is 0.7649, the over all closeness index for alternative 2 is 0.0999, the over all closeness index for alternative 3 is 0.8090, that is, A3>A1>A2.

The TOPSIS successfully rank alternatives in any MCDM. AHP-TOPSIS framework was proposed for evaluating and ranking of supplier alternatives Emrah Onder, Sundus Dag (2013)

The results of pairwise comparison of the 5 criteria /SCP attributes/ show that Reliability and Responsiveness are most important criteria with 73.11% of the total weight, for the company to evaluate to supply chain strategy. Based on this, alternative 3 has the highest priority weight. An important finding here is that the proposed model is more reflecting the relation of how the selection criteria affect the selected alternative strategy and at the same time what is more important for the strategy among the selection criteria. Using multi criteria decision techniques in this particular case AHP and TOPSIS methods provides a useful approach for the case Company for selecting the best strategy. This strategy evaluation framework will give direction and help the company in establishing a process for strategy setting among alternatives. The main purpose of this paper is to measure the SCP of ethio telecom and in connection to this to indicate an alternative strategy in particular to lay a ground of AHP and TOPSIS integration methods to identify important KPIs for the Company commercial supply process.

The result tells us alternative 3 is the best strategy to be followed, for the case company commercial supply chain over all goal (level 1 in figure 4.3) and the listed KPIs, to be found in its best performance status thereby to attain supply chain efficiency.

4.8 comparative validation

The article in Sage journal (Tian, Zhang, Jia, Liu1, Xu and Wang, 2016) performs the comparison of the AHP-TOPSIS with TOPSIS, for automotive design assessment, for validity and sensitivity test analysis conducted on variations in criteria weights. That means in this section TOPSIS method result will be conducted and the result to be compared with the AHP-TOSIS result obtained in section 4.7.2 and the result must keep the alternative rank A3>A1>A2, though their value might not be exactly same since criteria weight in the former case would be estimated to be equal, while in the latter we obtained the exact criteria weight using AHP method.

A relative advantage of TOPSIS is the ability to identify the best alternative quickly (D.L. OLSON, 2004). TOPSIS is attractive in that limited subjective input is needed from decision makers (D.L. OLSON, 2004).

. It is quite close in accuracy except in equal weights were applied. Obviously, the key to accuracy in TOPSIS method is to obtain accurate weights (D.L. OLSON, 2004).

4.8.1 comparison of the obtained result with TOPSIS method

Applying same method and procedure done in 4.7.1 we shall indicate for one of the sub-criteria, and indicate the end result for the remaining sub criteria for comparison purposes.

Taking **Reliability-RL**

Step 1 build a ranking decision matrix,

This data is same with the AHP-TOPSIS one and hence the normalizing procedure also take same.

	RL1.1	RL1.2	RL1.3
A1	4.49	4.27	3.63
A2	3.57	3.77	3.77
A3	3.98	3.91	4.26

Table 4.50 copy of 4.27 Reliability sub criteria decision matrix for alternative assessment comparison test

Step 2. compute the normalized decision matrix Y=[yij]

As Reliability is a benefit attribute, its highest value is desired hence we use equation (7), and the result is

1.0	1.0	0.0
0.0	0.0	0.2
1.0	1.0	1.0

Table 4.51 copy of 4.28 normalized matrix of RL-sub criteria for alternative assessment comparison test

Step 3 &4: Compute the weighted normalized decision matrix, PIS and NIS

Multiplying the normalized value with the **weight** of each sub criteria, now the difference in data stars here since we can't take the weight of table 4.25 which was obtained through AHP method, rather the weight is equally assigned for each sub criteria here.

weight	0.333333	0.333333	0.333333
	RL1.1	RL1.2	RL1.3
A1	0.333	0.333	0.000
A2	0.000	0.000	0.073
A3	0.150	0.090	0.333
PIS (d_j^+)	0.333	0.333	0.333
NIS (d_j^-)	0.000	0.000	0.000

Table 4.52 copy of 4.29 weighted normalized matrix with PIS and INS of RL sub criteria for alternative assessment comparison test.

Step 5 & 6: calculate the distances of each alternative to the positive ideal solution $\mathbf{di}^+$ and the distances of each alternative to the negative ideal solution $\mathbf{di}^-$ and the closeness index $\mathbf{C_i}$

	d_i^+	d_i^-	$d_i^-+d_i^+$	C_i	Rank	
A1	0.333	0.471	0.804738	0.585786	1	C_1^+
A2	0.539	0.073	0.61148	0.119281	3	C_2^+
A3	0.305	0.376	0.681333	0.552456	2	C_3^+

Table 4.53 distance of each alternative to PIS & NIS and the closeness index of RL sub criteria comparison test

The closeness index also called the factor performance score, of the three alternatives are measured against each sub-criteria and the result indicates A1 be the highest score or performance with value 1 followed by A3 =0.5525 and A2= 0.1193. Thus A1-alternative 1 is optimal for Reliability sub criteria.

Following similar procedures for all sub-criteria as performed for reliability slimily the closeness indices of the remaining will be : Agility C_1^+= 0.561, C_2^+= 0.414, C_3^+ =0.681 in which case A3 is optimal , with A3>A1>A2.

Slimily, the closeness indices of responsiveness is C_1^+= 1.00, C_2^+= 0.0, C_3^+ =0.488 in which case A1 is optimal, with A1>A3>A2.

Slimily, the closeness indices of Asset Management efficiency is C_1^+= 0.500, C_2^+= 0.4788, C_3^+ =0.5172 in which case A3 is optimal, with A3>A1>A2.

Slimily, the closeness indices of cost is C_1^+= 0.02743, C_2^+= 0.4684, C_3^+ =1.000 in which case A3 is optimal, with A3>A2>A1.

When this is aggregated similar to its counter comparison table 4.47, $C_{c,}$ (C comparison) to differentiate from C actual, it is expressed as:

$\mathbf{C}_{c,}$=

	A1	A2	A3
RL	0.585786	0.119281	0.552456
AG	0.560802	0.414214	0.680615
RS	1	0	0.488123
AM	0.5	0.478807	0.517167
CO	0.02743	0.468434	1

Table 4.54 comparison aggregated closeness indices matrix of the criteria

$\mathbf{W_c}$= 0.2 for each 100 equally divided by 5 criteria;

Thus, the overall judgement/evaluation result/ vector $\mathbf{F_c}$ is expressed as

$\mathbf{F_c} = \mathbf{C_c}$ X $\mathbf{W_c}$

A1	A2	A3
0.534804	0.296147	0.647672

Table 4.55 over all performance of each alternative- comparison

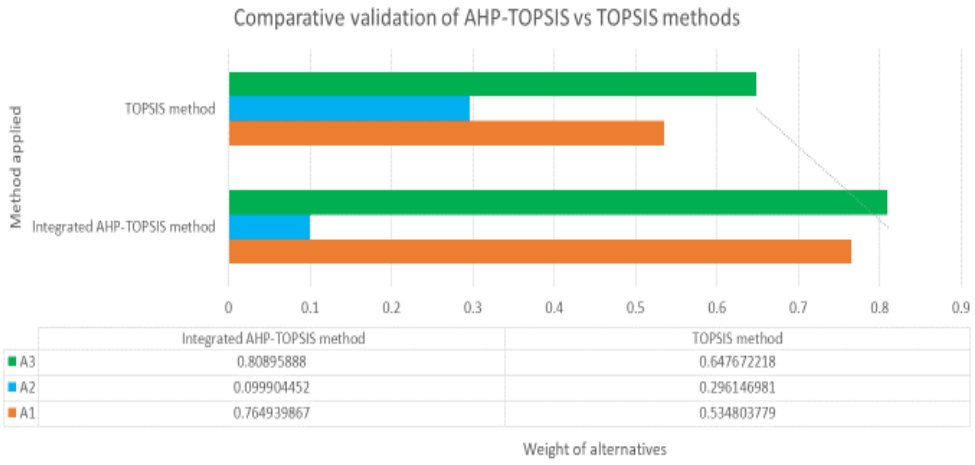
Compared with table 4.49 that the result here is A3 is optimal value followed by A1, and A2 the last option. **A3>A1>A2,** which exactly tally with the result obtained by AHP-TOPSIS method.

Table 4.56 clearly depicts the result for ease of understanding.

	Integrated AHP-TOPSIS method		TOPSIS method	
	closeness index	Rank	closeness index	Rank
A1	0.764939867	2	0.534803779	2
A2	0.099904452	3	0.296146981	3
A3	0.80895888	1	0.647672218	1

Table 4.56 comparison result of alternatives in integrated AHP-TOPSIS and TOPSIS methods

This validity is performed with TOPSIS only technique for comparison purpose. The comparison test result shown that Alternative 3 has the highest performance followed by Alternative one , and finally Alternative two with the least performance result in both cases. The result confirmed that A3>A1>A2 same as the AHP-TOPSIS integrated technique. From this, we can say that the adopted technique, AHP-TOPSIS, method is reasonable, feasible & valid for this research and of similar type of researches with multicriteria decision (MCD) options.



4.8.2 Sensitivity Analysis

In addition, to further test the effectiveness of the adopted method, sensitivity analysis is conducted by adjusting the **values of importance** of the main criteria obtained from AHP procedures (Tian, 2016 Zhang, 2016 Jia, 2016 Liu1, 2016 Xu2016 and Wang, 2016). Accordingly sensitivity check is conducted in this paper merely by changing only one **value of importance** (weight) in the comparison table 4.9 which was obtained from

respondents response. As you can see table 4.57 RS is 3 times of RL while in the collected data (table 4.9) the inverse is true, RS was one third of RL keeping the value for the rest of the cells constant. Now same procedure is applied as that of 4.6.1. to check consistency ratio, and verify the weight change in each criteria.

step1	Table 4.9 build PWC decision matrix				
	RS	RL	CO	AG	AM
RS	1	1/3	5	4	6
RL	3	1	3	5	6
CO	1/5	1/3	1	3	4
AG	1/4	1/5	1/3	1	2
AM	1/6	1/6	1/4	1/2	1
sum	4.617	2.03	9.58	13.5	19

step1	build PWC decision matrix				
	RS	RL	CO	AG	AM
RS	1	3.00	5	4	6
RL	0.33	1.00	3	5	6
CO	0.20	0.33	1	3	4
AG	0.25	0.20	1/3	1	2
AM	0.17	0.17	0.25	0.5	1
	1.95	4.70	9.58	13.5	19

Table 4.57 PWC decision matrix of the five attributes/criteria for sensitivity checking.

	Table 4.11 weighted normalized matrix & the lambda max value						
C.weight	0.3028732	0.428	0.15	0.073326	0.046765		

	RS	RL	CO	AG	AM	um	average
RS	0.3028732	0.143	0.74	0.293306	0.280589	1.763841	5.8237
RL	0.9086195	0.428	0.45	0.366632	0.280589	2.430617	5.6768
CO	0.0605746	0.143	0.15	0.219979	0.187059	0.759205	5.0998
AG	0.0757183	0.086	0.05	0.073326	0.09353	0.377831	5.1527
AM	0.0504789	0.071	0.04	0.036663	0.046765	0.242485	5.1852
						Lambda max (ʎ max)	5.3876

ʎ max=5.3876

step 4	checking consistency

CR=0.087, it is consistent

The sensitivity tested weighted normalized matrix is evaluated and expressed as in table 4.58

weight	0.4569887	0.277	0.14	0.076976	0.047337		
attributes	RS	RL	CO	AG	AM	um	average
RS	0.4569887	0.83	0.71	0.307903	0.284024	2.589243	5.6659
RL	0.1523296	0.277	0.43	0.384878	0.284024	1.524163	5.5107
CO	0.0913977	0.092	0.14	0.230927	0.189349	0.745984	5.2491
AG	0.1142472	0.055	0.05	0.076976	0.094675	0.388586	5.0482
AM	0.0761648	0.046	0.04	0.038488	0.047337	0.243616	5.1464
					ʎ max value		5.324

Table 4.58 weighted normalized matrix & the lambda max value-sensitivity test

Using equation (5) and (6) consistency ratio

For N=5, five by five criteria

Lambda max (ʎ max)= 5.324, from table 4.58

CI=(ʎ max-n)/(n-1) [(5.324-5)/(5-1)]=0.081 (5)

CR=CI/Rik [0.081/1.12]=0.072 (6)

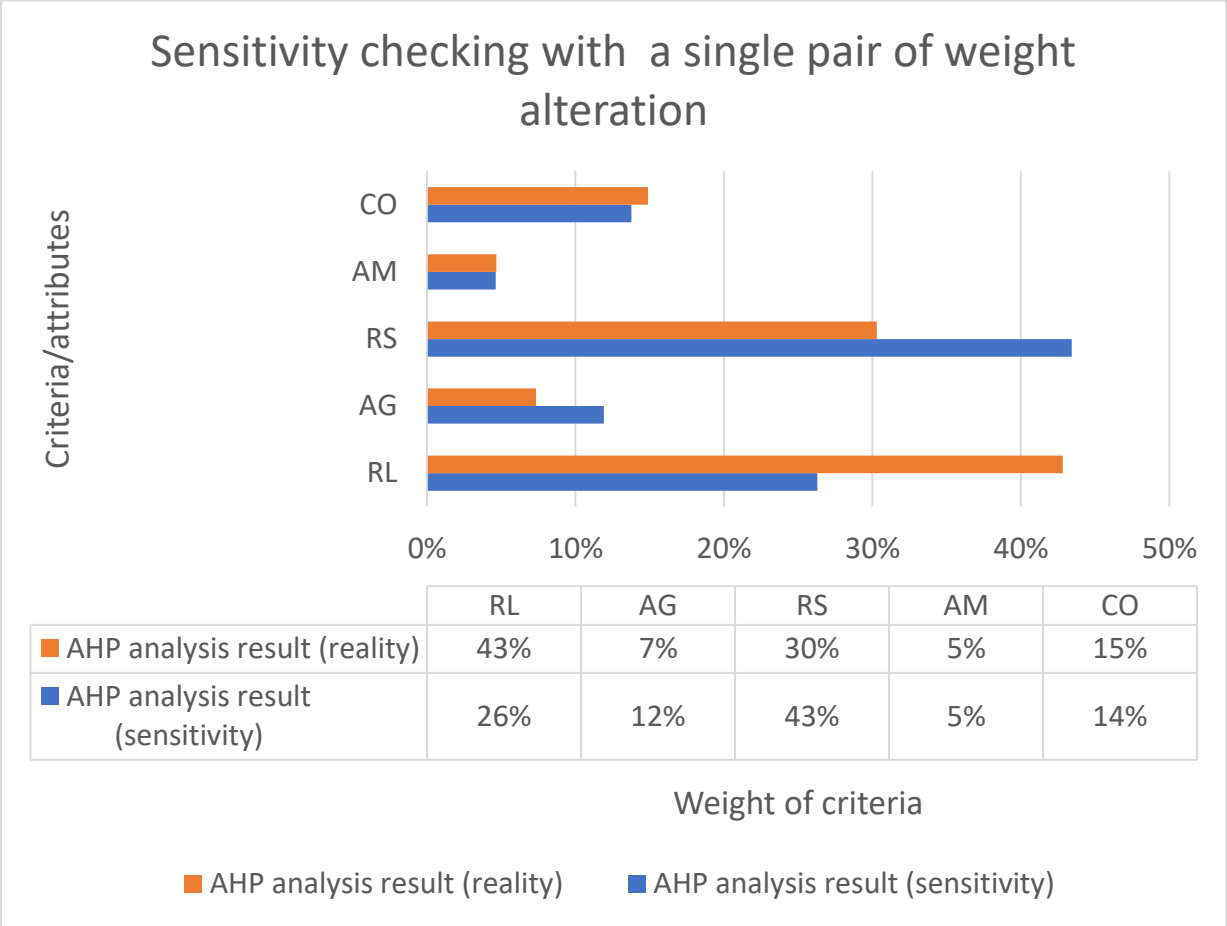
The result shown that CR is <0.1 , which means it is consistent.

The AHP result indicates us that comparing table 4.11 and 4.58 as aggregated, the weight comparison table is expressed as in table 4.59 and the weight of importance is vary between the two criteria (RS and RL) whose importance was reverted as indicated in table 4.57, which is now in the sensitivity the first ranked criteria become RS, merely by shifting the importance of the pair wise comparison value from the real data, at the same time it is inconsistent as CR value is greater than 0.1

	with real date		data altered for sensitivity checking	
criteria	AHP Analysis result (weight)	Rank	AHP Analysis result (weight)	Rank
RS	0.302873	2	0.456989	1
RL	0.428165	1	0.276582	2
CO	0.14887	3	0.142116	3
AG	0.073326	4	0.076976	4
AM	0.046765	5	0.047337	5

Table 4.59 computed weighted normalized matrix & the lambda max value -sensitivity checking

Sensitivity analysis shows that the results of the integrated AHP-TOPSIS approach are quite sensitive to the weight assigned to the PWC for the criteria. The result shows that the assessment of decision makers is a very critical step to evaluate KPI and alternative strategies and thereby the overall goal of attaining efficient supply chain.



	RL	AG	RS	AM	CO
AHP analysis result (reality)	43%	7%	30%	5%	15%
AHP analysis result (sensitivity)	26%	12%	43%	5%	14%

4.9 The Developed Framework Advantage

The SC industry focused on reducing the cost, and not merely the cost of merchandise but timely delivery means a lot in this industry either getting in the market in the right time or saving the firm from being obsolete while in the pipeline. The proposed model hence will have great opportunity to commercial supplies, and the core businesses of the company such as marketing and the core network function in ethio telecom.

The developed of SCOR+AHP+TOPSIS integration has gone through from level1-level 4 can also be applied in wider variety supply line of supply chain to analyze its supply chain performance measurement metrics. The proposed chain helps ethio telecom to understand

how the AHP pairwise comparison five steps -the criteria/level 2/ importance (weight) determination in section 4.6.1; the AHP pairwise comparison five steps -the sub criteria/level 3/ importance (weight) determination in section 4.6.2 and; the 6-steps determination of alternative strategy /level 4/ using AHP-TOPSIS integration in section 4.7 repeat over and over again for all types of stock items in ethio telecom Supply chain and at the same time in other companies both in similar and other industries taking this frame as a springboard. The following major benefits will be gained from the developed supply chain performance model:

1. As evaluation framework To Know the Distance to Target/goal: An evaluation framework to guide strategists for the SC strategy is defined and developed, that is, evaluation criteria/factor for SCP is defined and its evaluation framework is presented. The target of the case company must beat in order to differentiate itself from others, at the same time will let to know how far is it is from that target. setting the target is perhaps one of the most important benefits in that it enables to identify where the company must get to for the supply chain to lead the competition, and how far have to go.

2. To Develop a Sustainable Supply Chain strategy: A common mistake in managing daily backlog is working on a vague set of tasks consuming one's brain capacity and wasting precious time. However a clear strategy set here can help to avoid such confusion. A supply chain strategy should support and align with that of business generally. So for example, if greater product availability offering plan is required than the competitors, it definitely require to establish a different set of supply chain strategy to compete successfully on product pricing, on quality or service excellence. In order to achieve this, the strategy that are aligned with the over all business goal which are indicated by their respective importance/weight from the survey have great contribution in this regard.

3. To Reduce the Supply Chain Operating Costs: This include both decreasing of purchasing /ordering/ cost and holding inventory as the strategy enable you way of managing the supply chain. For instance the optimal balance of cost vs customer

satisfaction put the company at holding optimal inventory level that if possible to bring to JIT-just in time inventory level or if this could not applicable at least will fall on not much or not less stock level. That has a double side advantage in cost reduction; from now and then ordering and from bulk stock at warehouse as the balanced strategy supports both.

4. To Identify the Metrics that Matter & Build a Baseline for Continuous Improvement: Whether you need to improve cost, service or other aspects of supply chain performance, the supply chain performance attributes are a great way to identify, set, and work toward continuous improvement goals. You may not wish to focus in your entire supply chain at a time, but perhaps have a need to improve performance in discrete functions, which are separated and identified by the survey, such as Reliability and Responsiveness from the main criteria and delivery performance to commit date from reliability, SC responsiveness from Responsiveness, transportation cost from cost attributes is able to be identified as important criteria and KPIs.

5. To Improve company productivity: Sticking to the rule of "task cohesion" will unblock the company and set clear expectations toward the actual volume of work that have to be undertaken. This again obtained from the importance of identified KPIs in that to give the focus to the level of their weight by which they can contribute to the supply chain excellence and thereby to achieve productivity. Though there are no shortcuts to success, productivity frameworks and tools can enable to accomplish more in less time, thus maximizing time, investing additional energy in the long-term strategy.

6. An integrated AHP-TOPSIS approach is adopted to select the optimal scheme for SC strategy alternatives selection, which makes full use of quantitative analysis and weight allocation features of AHP and the better ability of scheme selection of TOPSIS (Samuel H.Huan, Sunlink, Sheoran & Ge Wang, 2004).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

SC efficiency is one of the important components of SCM, and it is a complex decision-making problem including multiple influencing factors. To do so, this work involved a multi-criteria decision-making problem to identify an alternative strategy for an efficient supply chain. In doing so, first, based on an extensive review of literature on the subject area, 14 evaluation factors/sub-criteria's are determined and grouped into five main criteria: SC Reliability, : SC Flexibility, : SC Responsiveness, Asset Management efficiency and Cost; which, according to literatures sub-grouped in to either customer facing or internal facing/cost focused. The strategies presented for alternatives emanated from this concept adding a mid-way between the two that is optimal balance of either customer or cost.

The objectives of the study when summarized were to identify KPI that most influence the supply chain, to assess the delivery performance efficiency in comparison to the industry standard, to identify the **'as-is'** and the desired '**to-be'** of supply chain performance thereby to know the gap, to examine and identify an alternative strategy that can support the best performance of the identified sub-criteria/KPI in ethio telecom commercial supplies. This chapter provides the summary of findings with respect to the study objectives, conclusions and recommendations of the study as well as limitations and suggestions for future research.

5.2 Summary of Findings

The study was attempt to identify KPI that most influence the supply chain processes by using the analytic hierarchy process in ethio telecom commercial supplies, to evaluate supply chain performance in relation to performance measurement indicators of the case company and taking bench marks of the industry standard from literature. The study was also attempted to identify the '**as-is'** and the desired '**to-be'** of supply chain performance in the case company. The study tried to explore detail important concepts and framework

in relation to the research objective in particular to identify an alternative strategy that can support the best performance of the identified sub-criteria/KPI using AHP-TOPSIS integration. It included review of related literatures deeply regarding the AHP-TOPSIS integration, as well as theoretical and empirical literature reviews in relation to this concept.

Data for the study was obtained through distribution of questionnaires to a pre-determined sample of employees in ethio telecom. To get the predetermined sample of 63 respondents a total of 84 questionnaires were distributed to . this figure was chosen from consulting survey response rate of literatures and getting a highlight from pilot test conducted. According to Baruch and Holtom (2008) response rate might be as low as 52 % of the expected respondents.

The first two objectives of the study was to identify KPI that most influence the supply chain processes & to evaluate supply chain performance in relation to performance measurement indicators of the case company by using the analytic hierarchy process. In order to get the sub criteria/KPI/ with most important value among the KPIs, first the sub criteria local weight was computed using AHP method and attain its global weight by adjusting the weight of the criteria under which it is structured in the SCOR hierarchy. The study revealed that delivery performance to commit date (RL1.1=30.97%), SC responsiveness (RS1.1=25.24%) and transport cost (CO1.2=8.77%) constitute the lion share in importance from one to third with a total of 64.78% in aggregate. As the weight of the sub-criteria explained is global weight which is streamed from the main criteria, the result revealed that the two most important criteria: Reliability (RL) and Responsiveness (RS) which hold RL1.1 and RS 1.1 respectively as a constituent confirmed us the first and second with an aggregate weight of 73.11%. This is clearly indicated in table 4.25.

The third objective of the study was to asses the delivery performance efficiency taking the industry standard as a bench mark. In this scenario the delivery performance is examined in to two separate processes presented to respondents: with respect to over all supply chain response time in days which cover from request for quotation (RFQ) till delivery of the goods in the designated warehouse passing through procurement process and manufacturing if any and shipment process of the supplier; and the order fulfillment lead time in days which constitutes the response of the warehouse/store to fulfill the order of the customer (internal or

external customer) including sorting, packaging, picking and loading on vehicle. For this analysis, the most well-known and simplest multicriteria decision-making method the WSM (weighted sum model) is used and accordingly majority of the respondents as measured by WSM, the SC practice of ethio telecom commercial supplies is found to be at parity with a value of 32% of the result. The finding for the order fulfilment lead time as part of the second objective shown that 33% of the respondents response is 6-7 days which lay on at parity, however there is quite significant number which reveals a result in a better performance than parity, which is 30% at advantage (4-5 days) and 25% at superior performance which is less than 3 days . when we sum up these two , that is a performance less than 5 days in general, the result tells us 55% of the respondents result is either at superior or advantage . Hence order fulfilment practice is quite good and should be maintained and little effort is enough to keep in superior if in worst case to be in advantage.

The fourth objective of the study was to identify the **'as-is'** and the desired '**to-be'** of supply chain performance in the case company. With similar analogy of the third objective two types of response was sought to analyze this objective: one is o identify the current performance- the **'as-is'** and the second intends to analyze the desired SC strategy to be followed- desired '**to-be'**. Here also the WSM method is applied. The result revealed in the identification of the current highest performance strategy by enabling the respondents to choose a 5 point scale ; 5 for the highest rate and 1 for the list rated value. The result depicts that delivery reliability is the first ranked attribute of ethio telecom commercial supplies SC practices, with 24.1%, followed by SC responsiveness strategy 21.3% , the last one: Flexibility and AM efficiency strategy with18.7% and 16.6% value respectively. Cost is given at the mid point with 19.3% of the respondents rating.

The '**desired to-be'** result of the study reveals that more or less it tallies with the current performance shown above; in that in both cases delivery reliability (RL) and Responsiveness (RS) are 1st and second with almost equivalent importance of 21.03% and 21.01% respectively. The 3rd important performance attribute is SC flexibility (AG) scored 20.85% weight while CO and AM are the last important performance attributes scoring 18.73% and 18.37% respectively. When summarizing the overall result we can observe that the **desired to-be** result is found to be more customer focused with a total weight of

62.89% as RL, RS, and AG are all customer focused attributes, while CO and AM the last two results are cost focused.

The fifth objective of the study was to examine and identify an alternative strategy that can support the best performance of the identified sub-criteria/KPI using AHP-TOPSIS integration. As obtained and declared in objective one, the first step to be performed was to identify the KPIs and to value the alternatives against each sub-criteria. Accordingly each sub-criteria taking its weight from the AHP result as input was evaluated with TOPSIS for alternative selection independently to be aggregated later to get the best strategy which can lead to the SC efficiency. As per aggregated over all alternative assessment, the result revealed that the wight vector **W** obtained from AHP multiplied by the closeness index **C,** the alternatives A1=0.7649, A2=0.0999, **A3= 0.8090.** The result tells us alternative 3 is the best strategy to be followed, for the case company commercial supply chain overall goal. This is tested for TOPSIS only evaluation method taking the weights of each sub criteria to be equal and the result confirmed same except alternative weight differ which is naturally expected as the weight taken is equal in the comparison case.

5.3 Conclusion

From the study we can learn that efficiency and responsiveness-cost focused vs customer focused strategies analyzed are not repelling forces. Sourcing from abroad in particular from far east/China which have a lion share of global market, has impact on the SC response time which is by far less (only 43% is either at superior or advantage) compared to order fill rate (internal efficiency) which is 55% either at superior or advantage and that reach 89 % if we incorporate the result at parity. This means delivery performance is highly impacted that emanates from the long lead time. For this the case company need to think of options that can alleviate the suffering from the long lead time.

Competition is more global and fiercer than ever. For others, the market requires more and more service quality that means a company needs the ability to react quickly to market opportunities in order to stay ahead or keep up with competition in this case responsiveness is a necessity. From the study it can be seen that that customer focused and cost focused

are not repelling forces. Hence the result obtained from the survey which is the optimal balance strategy can best fit and support the case. but in order to perform this strategy well the SC response time that can be affected from the long lead time should be adjusted accordingly. Hence the alternative strategy selection tells the case company to be as responsive as required, as efficient as possible.

For the selected strategies to be effectively implemented, the survey identified the most important KPIs and the SC attributes. From the result Delivery reliability responsiveness and cost are the first three in their order and the RL 1.1-delivery performance to commit date, RS 1.1 SC responsiveness and CO 1.2 transport cost which are stream from the top three SC attributes are identified as the most KPIs. Hence Sticking to the rule of "task cohesion" will unblock the company and set clear expectations toward the actual volume of work that have to be undertaken. This again is in line with the alternative strategy result obtained.

The desired to be result and the current SCP of the case company commercial supplies store was assessed to see if it is in line. In the current SC performance PWCM result, reliability and responsiveness followed by cost, agility and Asset management efficiency are stood 1st to 5th in this order. The comparison result of the desired SCP also puts Reliability and responsiveness as the top two. Only slight difference on the 3rd result, that is cost pushed by Flexibility to 4th while other remain same. That means the current and desired to be SCP of ethio telecom commercial supplies is more or less synchronous. By applying AHP and TOPSIS methodologies, the weighting of criteria and an ideal solution by order preference is selected; and on its way quite a good and simple framework for ranking of performance indicators is developed for the case company.

5.4 **Recommendation**

Thus based on the findings, the study recommends the following:

The findings of the study shown that delivery performance to commit date (RL1.1=30.97%), SC responsiveness (RS1.1=25.24%) and transport cost (CO1.2=8.77%) constitute the lion share in importance from one to third with a total of 64.78% in aggregate;

and the two most important criteria: Reliability (RL) and Responsiveness (RS) constitute 73.11% of the total weight in aggregate which means equivalent amount of attention is need to be these criteria and the corresponding sub-criteria as they significantly influence the SC performance of the case company.

In addition, the study confirmed that the **as-is'** and the desired '**to-be'** result of the study confirmed that more or less the current SC performance result tally with the desired to be result and the desired to be result entirely indicates the external attributes/customer related attributes need to draw attention with 62.89 % of the time in order to be more efficient in the commercial supply chain of the case company.

The other point of the study , the delivery performance issue in one way or another, delivery performance indicates or not far from parity, that means it doesn't excel and seems not strong enough with competitors in particular the SC response time. This is observed from the research most of the goods are from foreign source and the predisposing factors are being dependent on foreign supplies. Hence it is recommended to focus on import substitution so that the supplier inefficiency, the foreign exchange permit shortage and the long distance from offshore supplies taking exaggerated lead time will be minimized. This case has double effect on one side it minimizes logistics cost significantly, and on the other side it enhance SC responsiveness and hence good customer satisfaction. The result of this ensure and endorse the alternative strategy to be followed, the fifth objective of the study, that is optimal balancing of customer and cost.

Further, the study identified an alternative strategy among the alternatives A1 (Customer focused strategy), A2 (cost focused strategy) and A3 (optimal balance of cost and customer focused. From the over all assessment, the third alternative that is the balance of both the customer and the cost must be equally considered. Hence in order to attain this, managing inventory at optimal level will help to compromise warehouse and transport costs on one side and ordering costs and order fulfilment responsiveness on the other side. Therefore it is recommended to have inventory management at optimal and thereby to come to in a '**just in time'** system in order the third alternative best support and to be at best efficient level in the SC of the case company.

5.5 Limitations of the study and suggestions for future research

The limitation to be mentioned in this study which are left for future research are: Firstly, probably the pair-wise comparison of the applied methodology seems not precise enough to capture exactly the judgements of decision maker. Regarding this point a great dedication is made by the researcher to reduce the inconsistency by assigning volunteer representatives for each group of department respondents, that can give briefing. Though the case is so, this issue was the point to be mentioned as limitation of the study because Among the 84 questionnaires distributed, there were some respondents whom the researcher didn't contact directly nor reps are committed enough to them for briefing, in that case the response in particular for the PWC was not valid and rejected. The researcher, in this regard, want to advise in the future methods to be developed which can filter out uncertainties in order to capture exact judgement of decision makers.

The study focused on the SCP of commercial supplies and at HQ level, hence in order to give a big picture of the SC practice of ethio telecom, the researcher recommend for future researchers to widen the scope taking this research as a base of spring. The AHP-TOPSIS integration is a hybrid MCDM technique to asses performance alternatives and the resultant effect of the two methods yield a strong method to be developed, hence the method is highly advised to be developed not to be limited in the supply chain, rather to be applied to any other selection problem involving multiple and conflicting criteria such as in human resource to select competent personnel, in procurement to select the best product & supplier, in IT to select the best software solution and so on.. of Ethiopian context.

Though the commercial supply take the majority of the supply of the company market, being the research scope is on commercial supply line at corporate level limits the study not to show the SC coverage of the company under the case study. The other limitation is that the target population is only the staffs are under consideration but to have a full picture response, the assessment/questionnaire should address from customers and suppliers' perspectives.

Hence as a recommendation, future research who is interested in this area in particular who is in need of enriching this study, the researcher advises the following:

1. Try to cover the supply chain of the company both from item dependent store , that is from commercial supply line to all the supplies stores of the case company;
2. To cover the geographical regions on which the SC of the company addresses as a market to see the performance of the company supply chain,
3. The questionnaire and/or the assessment is advised to sample all stakeholders of the supply chain with sufficient coverage from each such as suppliers, customers, and staffs should be incorporated for the response

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Appendix

Questionnaire to be filled by respondents of selected employees of ethio telecom

Dear Participant,

I am a postgraduate student at Addis Ababa University School of Commerce and I am conducting a study to Measure the performance of supply chain management of ethio telecom commercial supplies in particular at HQ level. The purpose of the questionnaire is to collect primary data to conduct the study for the partial fulfillment of Master of Arts in logistics and supply chain management. This is purely for academic purpose and the information you provide will be kept strictly confidential. Hence, I kindly request you to fill the questionnaire genuinely. Thanks in advance for your cooperation.

General Instruction

- writing name is not mandatory
- you may mark (√) or (x) to indicate your answer
- I am in touch with following address:

Telephone: 09 11 50 31 10
Email : kedira2z@gmail.com

Section A: General Information

1. Gender: ☐ Male Female ☐

2. Education level:

Diploma level ☐ First degree level ☐ Second degree and above level ☐

3. Your work unit:

logistics ☐ sourcing ☐ SSRM ☐

sales ☐ out of et (specify)……..

4. Work experience in your work unit:

Below 1 year ☐ 1-3 years ☐ 4-6 years ☐ Above 6 years ☐

Section B. Questionnaires

5. Questions intended to identify the **'as-is'** and get the desired **'to be'** based on respondents' response:

5.1. In your opinion, to have a corporate success in the supply chain which of the following strategy must be at highest priority? While you choose your priority from **(a)-(e), below**, please rate your choice of priority from **9,8,7,…1** in front of your choice.

(a). Depend on always getting products/requests to customers on time-**Delivery Reliability strategy**

(a) **Delivery Reliability strategy**	1	2	3	4	5	6	7	8	9

(b). Depend on being able to scale up or scale down for volume of demand or frequency of request to meet customer demand with a minimum of fuss-**SC flexibility strategy**

(b) **SC flexibility strategy**	1	2	3	4	5	6	7	8	9

(c). Intend to cost saving and meet customers demand/request with a limit of acceptable service delivery-**cost sensitive strategy**

(c) **cost sensitive strategy**	1	2	3	4	5	6	7	8	9

(d). Depend on conservative asset management system to attain maximum asset management efficiency from SC assets such as trucks, machineries buildings, etc... **Asset management efficiency strategy**

(d) **Asset management efficiency strategy**	1	2	3	4	5	6	7	8	9

(e). Depend on short order cycle time, targeting aggressive market to attain more returns-**SC responsiveness strategy**

(e) **SC responsiveness strategy**	1	2	3	4	5	6	7	8	9

5.2. From the above strategies in 5.1 (A)-(E), how do you rate the **current** ethio telecom corporate commercial supplies; encircle 5 for the highest rate and 1 for the least rate.

(a) **Delivery Reliability strategy**	1	2	3	4	5
(b) **SC flexibility strategy**	1	2	3	4	5
(c) **cost sensitive strategy**	1	2	3	4	5
(d) **Asset management efficiency strategy**	1	2	3	4	5
(e) **SC responsiveness strategy**	1	2	3	4	5

5.3. The supply chain response time of commercial supplies that range from receiving POR/purchase order request/ to delivery of final customer in **days**. Encircle your answer

(A) 1-13 (superior) (C) 56-83 parity

(B)14-55 advantage (D) above 83 (please specify it) …..

5.4 Order fulfillment lead time of commercial supplies expressed in **days.** Encircle your answer

(A) < 3 (superior) (C) 6-7 (parity)

(B) 4-5 (advantage) (D) above 7 (please specify it)….

6. Pairwise Comparison Questions to Identify the most Important supply chain **performance Attributes** and **KPIs**

Please put a tick **(√)** mark on the appropriate number to indicate the scale of performance of commercial supplies in ethio telecom at HQ level.

6.1 Pair Wise Comparison of Supply Chain **Attributes /Criteria/**

Compare pairwise each **KPIs** under column '**A'** with its comparison **KPI** under '**B';** by ticking on the circle provided in front of **A** if A is preferred, Infront of **B** if B is preferred, then go to column **D** and tick from the circles 2-9 to indicate by how much it is more important. If you measure the two pairs are equal, tick **only** on column **'C'**

	A **KPI**	**B** **KPI**	**C** **Equally Important**	**D** **How Much More is Important?**
1	O Supply Chain (SC) Reliability or	O SC Responsiveness	O1	O2 O3 O4 O5 O6 O7 O8 O9
2	O Supply Chain (SC) Reliability or	O SC Flexibility	O1	O2 O3 O4 O5 O6 O7 O8 O9

3	O Supply Chain (SC) Reliability or	O SC Cost	O1	O2 O3 O4 O5 O6 O7 O8 O9
4	O Supply Chain (SC) Reliability or	O SC Asset management Efficiency	O1	O2 O3 O4 O5 O6 O7 O8 O9
5	O SC Responsiveness or	O SC Flexibility	O1	O2 O3 O4 O5 O6 O7 O8 O9
6	O Order Fulfilment Cycle Time	O SC Cost	O1	O2 O3 O4 O5 O6 O7 O8 O9
7	O Order Fulfilment Cycle Time or	O SC Asset management Efficiency	O1	O2 O3 O4 O5 O6 O7 O8 O9
8	O SC Flexibility or	O SC Cost	O1	O2 O3 O4 O5 O6 O7 O8 O9
9	O SC Flexibility or	O SC Asset management Efficiency	O1	O2 O3 O4 O5 O6 O7 O8 O9
10	O SC Cost or	O SC Asset management Efficiency	O1	O2 O3 O4 O5 O6 O7 O8 O9

6.2 Pair Wise Comparison of **Sub-Criteria**/level 2 metrics/

Compare pairwise each **KPIs** under column '**A'** with its comparison **KPI** under '**B';** by ticking on the circle provided in front of **A** if A is preferred, Infront of **B** if B is preferred, then go to column **D** and tick from the circles 2-9 to indicate by how much it is more important. If you measure the two pairs are equal, tick **only** on column **'C'**

	A	**B**	C Equally Important	**D** How Much More is Important?
1	O delivery performance to commit date or	O Fill Rate/Orders Delivered in Full/	O1	O2 O3 O4 O5 O6 O7 O8 O9
2	O delivery performance to commit date or	O Perfect Order Fulfilment	O1	O2 O3 O4 O5 O6 O7 O8 O9
3	O Fill Rate/Orders Delivered in Full/ or	O Perfect Order Fulfilment	O1	O2 O3 O4 O5 O6 O7 O8 O9
4	O Delivery order Size Flexibility or	O Delivery order Time Flexibility	O1	O2 O3 O4 O5 O6 O7 O8 O9
5	O Delivery order Size Flexibility or	O Over all Value at risk/	O1	O2 O3 O4 O5 O6 O7 O8 O9
6	O Delivery order Time Flexibility or	O Over all Value at risk/	O1	O2 O3 O4 O5 O6 O7 O8 O9
7	O SC Responsiveness / or	O Order Fulfilment Lead Time	O1	O2 O3 O4 O5 O6 O7 O8 O9

8	O Cash-To-Cash Cycle Time or	O Inventory Days of Supply	O1	O2 O3 O4 O5 O6 O7 O8 O9
9	O Cash-To-Cash Cycle Time or	O Asset Turns/ability to generate sales from its assets/ or	O1	O2 O3 O4 O5 O6 O7 O8 O9
10	O Inventory Days of Supply or	O Asset Turns/ability to generate sales from its assets/ or	O1	O2 O3 O4 O5 O6 O7 O8 O9
11	O Material Cost or	O Transportation Cost	O1	O2 O3 O4 O5 O6 O7 O8 O9
12	O Material Cost or	O Labor Cost	O1	O2 O3 O4 O5 O6 O7 O8 O9
13	O labor Cost or	O Transportation Cost	O1	O2 O3 O4 O5 O6 O7 O8 O9

6.3 Pair wise comparison to identify the intensity of importance among **Strategic Tasks, Tactical Level**, or **Operational Level**

Compare pairwise each **KPIs** under column '**A'** with its comparison **KPI** under '**B';** by ticking on the circle provided in front of **A** if A is preferred, Infront of **B** if B is preferred, then go to column **D** and tick from the circles 2-9 to indicate by how much it is more important.

If you measure the two pairs are equal, tick **only** on column **'C'**

	A	**B**	**C** Equally important	**D** How Much More is Important?
	Strategic Tasks	**Tactical Level**	O1	O2 O3 O4 O5 O6 O7 O8 O9
	Strategic Tasks	**Operational Level**	O1	O2 O3 O4 O5 O6 O7 O8 O9
	Tactical Tasks	**Operational level**	O1	O2 O3 O4 O5 O6 O7 O8 O9

7.To achieve excellence in the given criteria/KPIs of commercial supplies, strategies to be followed are listed as alternatives: **A1**=customer focused strategy, **A2**=cost focused strategy, **A3**= optimal balance of cost and customer strategy.

Based on this information please rate the importance of **each alternatives** A1, A2 and A3 with the given weight beneath it for each corresponding criteria/KPI.

N.B. please note that all alternatives: A1, A2, A3 must be rated.

NO	Alternatives	A1					A2					A3				
	Criteria/ KPIs	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
1	Delivery performance to commit date															
2	Fill Rate/Orders Delivered in Full/															
3	Perfect Order Fulfilment															
4	Delivery order Size Flexibility															
5	Delivery order Time Flexibility															
6	Overall Value at risk/ being exposed to risk in SCM/															
7	SC Responsiveness															
8	Order Fulfilment Lead Time															
9	Cash-To-Cash Cycle Time															
10	Inventory Days of Supply /The amount of inventory in stock expressed in days/															
11	Asset Turns/ability to generate sales from its assets/															
12	Material Cost / purchasing cost of goods/															
13	Transportation Cost incurred to fulfill order															
14	Labor Cost incurred for loading unloading															