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The interrelationship between suppliers and the Hub organisation within supply networks

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The interrelationship between suppliers and the Hub organisation within supply networks

A thesis submitted to Coventry University in partial fulfilment of the requirements for the degree of Doctor of Philosophy

May 2016

MARIA OLUWATOYIN AINA

An Extension of Supplier Configuration in Dai and Zhang's Novel Supply Network

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Abstract

This thesis presents a further study on Dai and Zhang's (2008) supply networks, which are Cost Saver, Adapter, and Multiple Driven. This concept is centred on hub or focal firm which is the core of the supply networks, built on Miles and Snow's (2003) strategic typology. In Cost Saver supply network, the hub firm is *'Defender'*; for Adapter supply network it is *'Prospector'*, while in Multiple Driven supply network it is '*Analyser'*. This study explores the interrelationship between the hub and supplier's configuration and its effect on organisational performance.

A comprehensive literature review is carried out with reference to supply chain (SC), supply network (SN) and supply network management (SNM). It stretches to describing Dai and Zhang's (2008) novel supply networks, its association with Miles and Snow's theory, the supply network configuration concept, and further expatiates on the need for appropriate supplier configuration for improved performances within the supply networks. The key performance indicators (KPI) adopted for this work, the variables considered in the simulation modelling were evaluated.

Usable data were collected from a sample of 630 suppliers, and 15 hub firms. This is accompanied by Hypotheses testing, Case study and Simulation experiments to fulfil the aims and objectives of this research.

From the findings of this study, it is confirmed that organisations can be grouped as either the Defender, Prospector, Analyser or Reactor type according to the Miles and Snow typology. The investigation identified that for Multiple Driven, Adapter and Cost Saver supply networks, performances are most improved with an increase in the existence of suppliers of the same typology with the hub organisation within the supply network.

Preface

The focus of this research as described in this thesis is to investigate the configuration of suppliers within the three types – Cost Saver, Adapter, and Multiple Driven – and the supply networks, and the impact of these suppliers' configurations (in terms of ratio) on the performance of the hub organisation. This research developed and tested different configurations to present the interrelationship in supplier configurations and the core organisation's performance.

Quantitative and qualitative data analysis methods were adopted using Questionnaires, Interviews and Case Studies. A series of propositions and hypotheses were generated based on the Literature Review covering Supply Network Management, Strategic Management and Miles and Snow (2003) typology. These were analysed using statistical tools such as Statistical Package for the Social Science (SPSS) and Minitab, which were adopted to analyse the data, hypotheses and proposition. A Case Study was conducted to buttress the findings that could not be covered qualitatively. Conclusively, Simul8 (discrete event simulation software) helps to suggest the configuration that is most suitable for each of these supply networks.

These combined methods generated a number of successful outcomes to achieving the aim of this research which are; to examine the strategic configuration of suppliers within Dai and Zhang's supply networks; to investigate the impact of suppliers' configurations (in terms of ratio) on hub organisations performances, and to suggest the suppliers' configuration that offers improved performances – *satisfies customers and hub organisation needs within the supply networks.*

Current Outputs

Aina M., Dai Y., and Petrovic D., 2011 Analysis of interrelationships between Suppliers' configuration and performance within the supply network: A simulation approach Coventry University, UK

Aina M., Dai Y., and Petrovic D., 2010 A sustainable supply network model and its configurations: A novel supply network model for the hub and spokes companies, Coventry University

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List of Abbreviations and Symbols

Terminology	Abbreviations/Symbols
Adapter Supply Network	ASN
Analysis of Variance	ANOVA
Agent Based Simulation	ABS
Activity Cycle	ACD
All Analysers	All A
All Defenders	All D
All Prospector	All P
Base Object Model	BOM
Balance	(1:1:1)
Cost Saver Supply Network	CSSN
Confidence Interval	C.I.
Discrete Event Simulation	DES
Degrees of Freedom	DF
Defence Conceptual Modelling Framework	DCMF
Date and Time Agreed for delivery	D_tAD
Date and Time of delivery	D_tOD
Defender: Prospector: Analyser: Reactor	D: P: A: R
Difference in Time	DIT
Intercontinental Distiller's Limited	IDL
Inputs to simulation model	I_S
Inputs to real system	I_R
Key Performance Indicators	KPIs
Local Purchase Order	LPO
Multiple Driven Supply Network	MDSN
Miles and Snow	M&S
Multivariate analysis of variance	MANOVA
Occurrences of *Defenders* in CSSN	$CSSN_d$
Occurrences of *Prospectors* in CSSN	$CSSN_p$
Occurrences of *Analysers* in CSSN	$CSSN_a$
Occurrences of *Defenders* in ASN	ASN_d
Occurrences of *Prospectors* in ASN	ASN_p

Occurrences of *Analysers* in ASN	ASN_a
Occurrences of *Defenders* in MDSN	$MSDN_d$
Occurrences of *Prospectors* in MDSN	$MSDN_p$
Occurrences of *Analysers* in MDSN	$MSDN_a$
Occurrences of Defenders	M_d
Occurrences of Prospectors	M_p
Occurrences of Analysers	M_a
Outputs from real system	O_R
Outputs from simulation model	O_S
Prospectors	P
Supply Network Configuration	SNC
Supply Chain	SC
Supply Chain Management	SCM
Statistical Package for the Social Sciences (Software)	SPSS
Supply Network	SN
Supply network management	SNM
Supply chain network	SCN
Supply network management	SNM
Small and Medium Enterprises	SME
Virtual Logic	VL
Less than	>
Greater than	<
Not equal to	=/=

Terminology

Dai and Zhang's Model

Dai and Zhang (2008) generated three supply network models which are; Cost Saver, Adapter and Multiple Driven. The concept is based on *'Hub and spokes'* where the core, or focal organisation, is referred to as the *'Hub'*, while the suppliers are the *'Spokes'*. The typology of hub companies is built on Miles and Snow's strategic types. In this model, the first tier suppliers and customers orbit around the hub or focal company.

Cost Saver Supply Network

The Cost Saver supply network mainly emphasises on achieving maximum cost efficiency in the production and distribution within supply network. This type of supply chain tends to use a hierarchical structure, which is led by a Defender firm of Miles and Snow typology as the hub company of the Cost Saver supply network.

Adapter Supply Network

The Adapter supply network builds the network around the hub of a Prospector, which emphasises the innovation, advanced technologies, flexibility and fast response in the supply chain, and shares some common features with the Responsive supply chain in Fisher's model and the Innovation driven of Miles and Snow's model.

Multiple Driven Supply Network

The Multiple driven supply network is a combination of cost efficiency, efficiency and effectiveness and centred on an Analyser. This type of supply network tries to take advantage of both efficiency and effectiveness, and can achieve the maximum benefits from the supply network compared with the above two supply networks.

Defenders

Organisations in this category defend and dominate an existing niche market; they provide a narrow range of products and services; and the emphasis is on reducing cost and focusing on efficiency *(doing things right)* whilst avoiding unnecessary risk. Sample Companies: Dell, Walmart.

Prospectors

Prospectors invest in high-tech products which are highly priced, dependent on flexibility in the design; they maximise new opportunities for competitive advantages and centre on effectiveness *(doing the right things)*. Sample Companies: Sun, Sony, Apple and Nokia.

Analysers

Analysers are a hybrid of Prospector and Defender typology, which focus on imitation; moderate prices, and balance effectiveness and efficiency. Sample Companies: Microsoft and IBM.

Reactors

This type of firm will not adjust to change for some organisational reasons; they embrace short term planning; while environmental change inevitably presents some difficulties.

Chapter 1: Background to Research

1.1 Introduction

Currently, as economic globalisation develops, customers' demands are diversifying and competition among firms is becoming fiercer. This has caused the market place to become increasingly dynamic and volatile, and has resulted in many organisations experiencing market pressures. Trade-offs between transportation costs, labour costs, response time and inventory costs to the customers are becoming ever more complex (Ecklund, 2010). As competition coupled with unexpected market changes grew, these challenges enforced a fundamental rethink of the way businesses should be managed. It is no longer possible to focus solely on a singular organisation as a source of competitive advantage. Rather, the focus is on groups of organisations that work hand-in-hand to achieve a common goal. This has led to a shift in competition from 'organisation versus organisation' towards 'supply chain or network versus supply chain or network' (Antai, 2011; Antai and Olson, 2013). As foretold by Christopher in (1992), the competitive nature of firms will cause a shift from individual organisations competing against each other, to supply chains competing against other chains.

Therefore, supply network management is prevalent in today's research and study. It is a main element to forging core competence for firms, thus making it a powerful weapon to tackle competitive challenges, and a tool that guarantees service quality (Davis and Vollmann 1990; Chow, et al, 2013). It has undergone substantial changes such as increasing globalisation; improving the trend of outsourcing business; and decreasing the number of suppliers (Christopher, et al., 2011), to add considerably huge values to firms and their customers (Johnston, 1999).

However, to maintain and improve performance within the supply network, has posed a major challenge in supply network management (SNM). SNM aims at efficiently integrating suppliers, manufacturers, warehouses, and distribution centres so that the product is produced and distributed in the right quantities, to the right locations, and at the right time. The approaches to achieving these include; integrating the supply network into the system; designing the supply network; inventory control; management of information flow; customer service; integrating planning and control systems; financial and physical flows; and supply

network configuration (Lee, 2004). The choice of suppliers within a supply network eventually leads to the overall system performance, while the most important task in the supply network configuration is to allocate resources and select suppliers (Willems, Minner, and Klosterhalfen, 2014). Literature affirms that the success of an organisation is dependent on the performance and reliability of suppliers within its system. This brought about the introduction of the concept of inventory management focus and cost control in the 1960's, which later formed an aspect of supply chain management and supply network management in recent years. Subsequently, to enhance supply network management, there is a need to examine the strategic suppliers' configuration that makes up a supply network, and the configuration that gives preferred performances. However, very little has been done in this aspect.

Therefore, the focus of this research is on Dai and Zhang's (2008) supply network models, which are: Multiple Driven, Adapter or Cost Saver. A supply network is a more complex form of supply chain that consists of various organisations. In Dai and Zhang's (2008) model, a supply network should be centred around a hub company, which is based on Miles and Snow's (2003) typology. A Cost Saver supply network is led by a Defender firm of Miles and Snow typology. An Adapter supply network builds its network around the hub of a Prospector, while a Multiple Driven supply network is centred on an Analyser firm.

1.2 Research Purpose

This aim of this research is to examine the strategic configuration of suppliers within the Multiple Driven, Cost Saver and Adapter supply networks, and to investigate the impact of suppliers' configurations (in terms of ratio) on hub organisations performances.

1.3 Research Questions

To achieve the aim of this work, the research questions listed below were addressed:

(1) What are the strategic typologies that exist in Multiple Driven, Cost Saver and Adapter supply networks?

(2) What are the impacts of suppliers' configurations (in terms of ratio) on the performances of the supply networks hub firms?

1.4 Research Objectives

The outlined objectives to satisfying the aim of this research are to:

(1) Validate the Multiple Driven, Cost Saver and Adapter supply networks.

(2) Extend Dai and Zhang's supply networks – Multiple Driven, Cost Saver and Adapter supply networks.

(3) Investigate the hub and suppliers as either of Miles and Snow's (M&S) four typologies – Defenders, Prospectors, Analysers or Reactors.

(4) Examine if the majority of the suppliers have the same strategic typology as their hub organisation, and also, the strategic typology that is dominant within the supply networks.

(5) Evaluate the performances of the following suppliers configurations for Multiple Driven, Cost Saver and Adapter supply networks:

(5a) Equal ratio of suppliers' strategic types.

(5b) Supplier's strategic types that are different from that of the hub organisation.

(5c) Varied supplier's strategic types.

(6) Suggest the suppliers' configuration that offers improved performances - *satisfies customers and hub organisation needs within the supply networks.*

To realise these objectives, the detailed related literature on supply network management (SNM), theoretical framework describing Dai and Zhang's (2008) supply network and its connection with Miles and Snow's (2003) typology were reviewed in Chapter 2, the adopted analysis methods were explained in Chapter 3. Chapter 4 entails the case study discussions on the interrelationship between suppliers, hub organisations and their supply network. Statistical results were detailed, presented and discussed in Chapter 5. Furthermore, the simulation methods, simulation results and analysis were illustrated and presented in Chapter 6.

Clearly, the purpose of these research objectives will make several contributions to knowledge. Firstly, Dai and Zhang's (2008), supply network model will be extended into an area that was underrepresented in the original exposition. Secondly, it validates the supplier's configuration that gives improved performance in the supply networks based on the strategic typology of the suppliers. These two contributions are of immense value to both academics and practitioners in this field. The knowledge brought forth by this research presents to organisations that embrace supply network, an enlightenment to 'working smarter', at selecting the suppliers that will best meet their performance targets and satisfy their immediate customers.

1.5 Research Methodology

The research used objective scientific methods to collect facts and then study the relationship of one set of facts to the other. Data was analysed using valid statistical techniques. The validity and reliability of data were tested to formulate quantifiable and generalisable conclusions. Hypotheses were generated from existing theory as discussed in the subsequent chapters. The hypotheses were tested and confirmed, to give suggestions for further study in the concluding chapter. This research adopts both quantitative and qualitative techniques where the quantitative research captures the *structure* while qualitative research the *process* (Bryman, 2012). Using the quantitative approach, which originates in philosophical positivism, the research conducted empirical investigations of the configuration of suppliers, and performance of supply network using statistical techniques and experiments. Qualitative research aligns with interpretivist (naturalistic inquiry) – observation, interview, case study and document analysis techniques (Gill and Johnson, 2010; Saunders et al., 2015). These were used to explore the interrelationship between the hub firm and their suppliers within the supply networks.

This research extends Dai and Zhang's novel supply model (2008). The basis of this work is to suggest the supplier's configuration that best suits Multiple Driven, Cost Saver and Adapter supply networks. This is an aspect of supply network management meant to enhance suppliers' selection for improved performances. The supply networks' suppliers and hub is either of the three Miles and Snow's (2003) typology – Defenders, Prospectors and Analysers.

Hence, propositions are made around the supplier's configuration of each of the three supply networks.

For the quantitative research, the questionnaire has been designed to investigate the issues concerning the proposition and hypotheses. The useful questionnaires that were returned and used for this study are for 15 production lines across 4 industries (9 printing, 4 distilleries, 1 bottle making and 1 bottled water production) and 630 of theirs suppliers. To analyse the generated samples of Defenders, Prospectors and Analysers, a range of statistical hypothesis analysis methods have been adopted. To ensure the reliability and confidence of the quantitative analysis in this research, the exact tests using Statistical Package for the Social Sciences (SPSS) and Minitab have been implemented for analysis. While the quantitative analysis serves as a means to verify the proposed hypotheses, it cannot explain the reasons behind the statistical results. Therefore, qualitative analysis has been adopted to explore the reasons behind the configuration of each of the supply networks. A case study was conducted on the 15 operation lines, also referred to as the hub or core firms. The use of interviews has been adopted to validate the findings. The research seeks to unveil the unknown idea of the interaction that exists between the hub company and the spokes companies of the supply network.

Although, the qualitative analysis provides reasons for the configuration, nevertheless this study extends to discovering the effect of diverse suppliers' configuration on performance, using an experimental test. The Simul8 *(Business Simulation Software)* has been found to be more convenient and appropriate. This Simulation experimental test helped to suggest the ideal configuration for each of the three supply networks studied.

1.6 Thesis structure

This thesis is broken down into seven chapters, which are: *Introduction, Literature Review, Methodology, Case Study, Hypotheses Testing, Simulation Methodology and Analysis, and*

Conclusions. Figure 1.2 shows a brief description of the different chapters outlined.

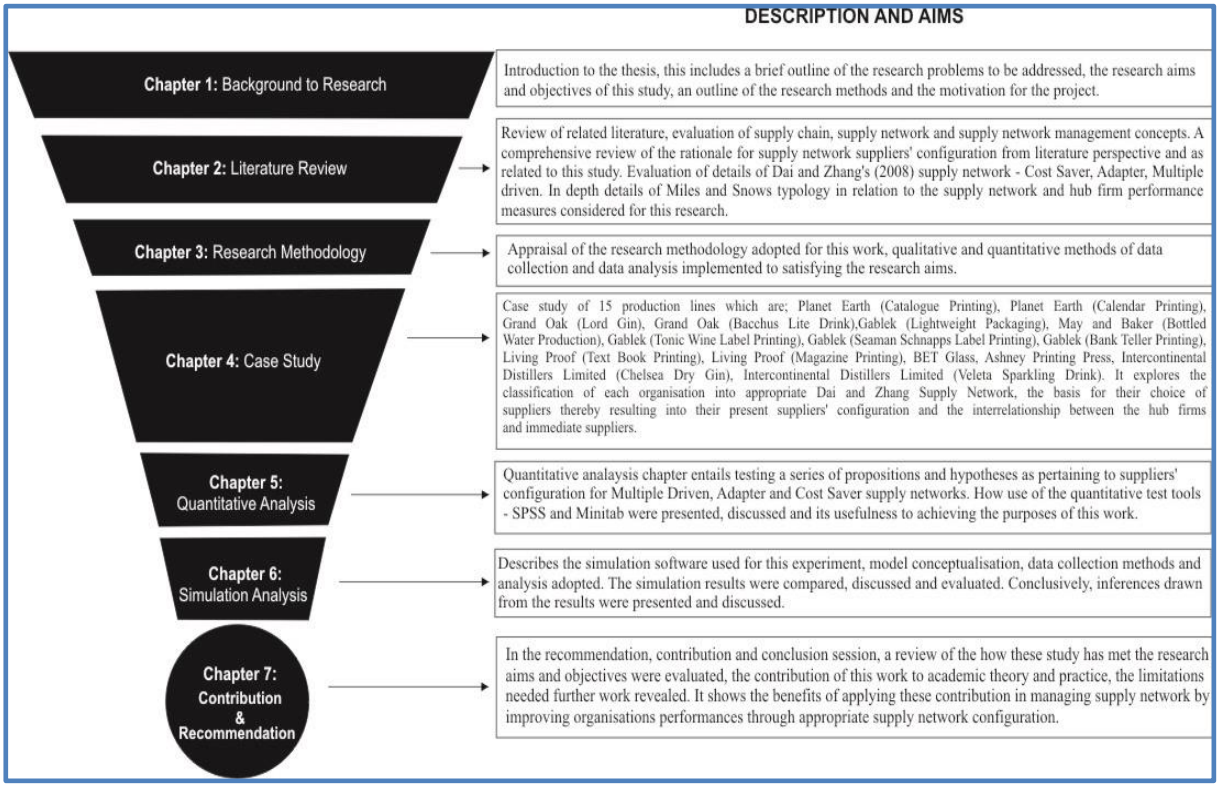

Figure 1.2: Chapter structure and aims in relation to each of the chapters.

References and Appendices – following these chapters are lists of references and appendices including questionnaire, interview scripts and published papers that are related to this study.

1.7 Research Findings

This work presents that in;

Multiple Driven Supply Network

The occurrence of Analyser suppliers is greater than the occurrence of Defender suppliers, while the occurrence of Defender suppliers is greater than the occurrence of Prospector suppliers.

The performances of As Is suppliers' configuration is greater than All Defenders, All Prospectors, Balance (equal occurrence of Defenders, Prospectors and Analysers), Cost Saver supply network, Adapter supply network and, As Is suppliers' configuration is less than All Analysers' suppliers configuration. This shows that a Multiple Driven supply network accommodates more Analysers' suppliers which share the same typology with its hub organisation for improved performance.

This exploration discloses that suppliers' configurations are not equal, i.e. the occurrence of Defender suppliers is not equal to the occurrence of Prospector suppliers, and not equal to the occurrence of Analyser suppliers in Multiple Driven supply network.

Adapter Supply Network

The occurrence of Prospector suppliers is greater than the occurrence of Analyser suppliers, which is greater than the occurrence of Defender suppliers.

The performance of As Is suppliers' configuration is greater than All Analysers, All Prospectors, Balance (equal occurrence of Defenders, Prospectors and Analysers), Cost Saver supply network, Multiple Driven supply network suppliers' configuration; and As Is suppliers' configuration is less than All Prospectors suppliers' configuration. This suggests that when an Adapter supply network accommodates more Prospector suppliers which share the same typology with its hub organisation, its performance is improved.

Cost Saver Supply Network

The occurrence of Defender suppliers is greater than the occurrence of the number of Analyser suppliers, and is greater than the occurrence number of Prospector suppliers.

The performance of As Is scenario is greater than All Prospectors, All Analysers, Balance (equal occurrence of Defenders, Prospectors and Analysers), Adapter supply network, Multiple Driven supply network suppliers configuration; As Is suppliers' configuration is less than All Defenders suppliers' configuration. This suggests that the Cost Saver supply network could accommodate more Defenders that share the same typology with its hub organisation, for improved performance.

This work equally presents that there is a relationship between the hub organisations, suppliers and performance. The choices of suppliers are driven by hub organisation performance preferences, and the Hub organisation's choice of suppliers affects the overall performance of the supply network.

1.8 Conclusion

This work establishes the relationship between the hub organisation, suppliers and performance.

It reveals that each of the three supply network suppliers' configurations is different to one another. This work equally presents that the choices of suppliers are driven by hub organisation performance preferences.

It suggests the appropriate supplier configuration for improved performances in each of the supply networks studied. It presents that in each supply network, performances are improved with an increase in suppliers sharing same typology with the hub organisation.

It also puts forward that hub organisation performance preference and priorities should be followed in their choice of suppliers, which will eventually affect their performance.

1.9 Summary

In this chapter, the main research question is clearly stated, which is to examine supplier's configuration (choice of suppliers) on performance in supply networks. It also enumerates the research objectives, the research methods and outline of the thesis structure. The next chapter provides a comprehensive review of existing literature relating to supply chain, supply network, supply network management, organisation performance measures, suppliers' selection and configuration. It includes details of the comprehensive review of literature relating to this study.

Chapter 2: Literature Review

2.1 Introduction

As briefly described in the first chapter, Chapter 2 presents a review of relevant studies and concepts related to this research. This covers areas such as supply chain (SC), supply network (SN), and supply network management (SNM) within the scope of this research. Primarily, the section provides a thorough understanding of these subject areas, evaluation areas and gaps from literature that this work intends to fill, and areas that need further research development and investigation.

In recent times, firms no longer perform all vital functions in-house to build and maintain competitive advantages; rather, businesses form alliances with other firms to execute their activities (Zhang and Frazier, 2011). This begets the concept of supply chain and supply network, however, due to the complexities of supply network (Lusch, 2011), there has been a quest among scholars about the essentialities of improving supply network management based on supplier selections (Braziotis et. al, 2013). Therefore, this study adopts a conceptual way to enhance supplier selection based on suppliers' adopted strategy using Dai and Zhang's novel supply network (2008). The network gives a clearer presentation for the hub firm and suppliers strategy types. The supply network concept was explored providing insight into strategic compositions; the need for appropriate supplier's configuration within supply networks and improved organisation performances (Lawrence, 2015; Moser, et al., 2011; Srai, 2011). In conclusion, this chapter examines the interrelationship between the supply network and Miles and Snow's theory, the variables considered in modelling the supply networks; suppliers - Defenders, Prospectors or Analysers; and the key performance Indicators (KPI) adopted in evaluating the performances of the hub firm.

2.2 Supply Chains

2.2.1 Origin of Supply Chains

Since time immemorial, there has been the movement and trading of goods and services along what is described as supply trade routes or lines. Historical evidence shows that the great exploits of engineering in ancient times were accomplished mainly by the support of these supply lines. An example of this is the construction of *The Great Pyramid* in Giza during the fourth dynasty reign of King Khufu (c.2589 – c.2566 BC); a project which took between 20 to 25 years to accomplish. It involved the carriage of millions of blocks of stone, some of which were transported hundreds of miles by a workforce of nearly 30,000 men (Lehner, 2010; Lee, 2012). This required many supply lines, which were are long and complex to manage, as are most of the supply lines in use in large modern construction projects today. Herodotus, the Greek historian, writing on his travels to Egypt in the fifth-century BC, describes the movement of limestone along a supply line as:

"*Blocks of stone were brought from the quarries in the Arabian hills to the Nile, and then ferried across by others who hauled them to the Libyan hills. The work went on in three-monthly shifts, with a hundred thousand men on each shift. It took ten years of this oppressive slave-labour to build the track along which the blocks were hauled*" (Herodotus, Book two of the histories, 440 BC: 124).

Other examples are the silk routes for exporting goods from East to West over thousands of miles across many countries; and the management of World War II supply lines to reach 2 million troops with arms and food, which has played a significant role in many wars. These supply routes or supply lines are traditionally referred to as "supply chains" (Christopher, 2011; Harrison and Van Hoek, 2011; Christopher and Holweg, 2011).

According to Kent and Flint (1997), the first literature to use the term supply chain (SC) was documented by Bowersox and Closs (1996) in a paper titled "*The integrated supply chain process*". However, other accounts revealed that SC existed in an earlier article in the Financial Times, on the 4th June 1982 by Arnold Kransdorff, on Booz Allen's new supply chain management concept, and reported by Christopher and Holweg (2011). There has been an increase in publication and the use of the term supply chain in literature in recent times (Braziotis et.al, 2013). Publication data revealed the increased interest in *supply-related* fields of inquiry took off in the early 1990s, with approximately 2,000 publications annually, and reached the peak of interest during the 1990s, with both business process reengineering and total quality management evaluations reporting annual publication rates of around 1,100 respectively (Noppakorn, Klintong 2012; Thawesaengskulthai, 2010).

Supply chain is an integrated process that comprises of a number of business entities such as retailers, distributors, manufacturers and suppliers working together with the common focus of acquiring raw materials and transforming these raw materials into finished products, delivering these products to retailers, who in turn convey them to the end users or consumers (Wisner, 2011; Slack et al, 2013). On the other hand, Kilibi, Martel and Guitouni (2010) explain that supply chain focuses more on organisation to organisation interaction within the chains; as it involves groups of organisations that are established for the main purpose of performing value-creating activities, through the flows of products or services along the line of production. Clemons, Kauffman and Weber's (2011), definition includes finance and information. It explains that a supply chain is congregated of at least a set of three entities of individuals or organisations that are involved directly in the downstream and upstream flows of information, finances, products and services. Consequently, it is deduced that these definitions are holistic in their meaning, emphasising that various activities within the chain contribute to the makeup of a supply chain, and that the main characteristic of the supply

chain is to satisfy the needs of customers and involves the incorporation of various organisations.

More importantly, supply chain structure is perceived as linear (from raw material to the final product), hence it is less complex. An example is the flower supply chain which practices a global supply chain, exporting flowers from growers thousands of miles around the world. The flowers are transported using different modes from the growers through to the customer. The majority of the world's flowers are grown in Ethiopia, Israel, Kenya and South America (Flora Holland, 2015), and are then exported by air to buyers around the world. These flowers are sold to wholesalers and exporters who distributes 85 percent on the same day, either by truck or ship, to other wholesalers and retailers (Bloemenveiling Aalsmeer, 2015). These flowers are then distributed to florists to be purchased by customers, a typical example of this linear flow is shown in Figure 2.1 below;

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Figure 2.1: A typical design of a flower supply chain (Flora Holland, 2015)

2.2.2 Evolution of the SCM concept

In response to the stormy business environment in these present times, supply chain management (SCM) has been elevated from a traditional operation tool for logistics management, to a strategic tool for creating and sustaining competitive advantage and achieving better performance for businesses (Cohen and Roussel, 2013; Kumar and Banerjee, 2012; Wowak, et al., 2013). Effective SCM projects have shown how companies have been able to gain a significant competitive advantage over their rivals through improved performance. There have been diverse success experienced by fashion industries like H&M and Zara through implementing SCM.

H&M improved responsiveness in its supply chain through reduced time to market, unique transportation system, use of the lowest cost transportation, and adopting flexible procurement in the supply chain. Local sourcing reduces the lead time, which benefits in matching supply and demand by adopting a quick response strategy. As the importers and retailers, H&M have to monitor every step of the supply chain by updating information technology constantly for supporting the logistics system. H&M always make the best route plan according to the truck routing. Usually, the producer will directly send to the central warehouse, then deliver to the stores. But if the production is designed for a regional market, the product will be delivered directly to the segment in the country, and even directly to the stores, to ensure the supply just in time. Generally, the apparel industry purchases seasonally, but H&M have broken this mode since 1968. H&M use the strategy that they purchase twelve times a year in order to change according to the change of trend. Thereby, H&M expanded. As of August 31 2011, H&M had 2,325 stores, and by February 24, 2012, H&M had 2,500 stores in 43 countries, with revenues of around $19 billion (Lou and Xu, 2014; Shen, 2014).

Zara also developed a highly responsive supply chain that enables delivery of new fashions as soon as a trend emerges. It created a partner network of more than 300 small shops in Portugal and Galicia to handle the finishing work, where the gray goods are transformed into dresses and suits. Zara delivers new products twice each week to its 1,763 stores around the world. Rather than subcontracting manufacturing to Asia, Zara built 14 highly automated Spanish factories, where robots work around the clock cutting and dyeing fabrics and creating unfinished material. Zara's revenue increased by 10% to $19.15 billion for its financial year ending January 31, 2012 (Jhamb, 2013).

These organisations have effectively used supply chain management as a tool to improve outcomes and performances, and to gain competitive advantages over their peers (Chopra and Meindl, 2004; Blanchard, 2010; Holzner, 2006). These three firms in the fashion industry

have devised processes which they have absorbed for agility (Lee, 2004; Chopra, Meindl, and Kalra, 2012; Christopher, 2016). Before, it took months for retailers to interpret designs by luxury labels for the general public. As soon as designers spot possible trends, and sketches and order of fabrics are made, this gives them a head start over competitors because fabric suppliers require the longest lead times. H&M, Mango, and Zara have become Europe's most profitable apparel brands, and have grown at more than 20% annually since 1990, with double-digit net profit margins (Xun li Qun, Wu Clyde Holsapple, 2015; Jhamb, et al., 2013). This has enabled fast-fashion retailers like Top Shop and H&M to cut the time span between catwalk and store. Designs of luxury brands can be interpreted to the general public quicker than before.

Another organisation that embraced SCM is Dell Incorporated. In 2008, Dell found that its configure-to-order supply chain model no longer fitted the need of some of its fastest-growing businesses: its new physical retail channel, its enterprise sales or even its high-volume consumer products. Realising that different supply chain models are needed to address different dimensions of demand, uncertainty and customer relationship, Dell created four supply chains, Build-to-Order, Build-to-Plan, Build-to-Stock, and Build-to Spec, each dedicated to a different customer segment (Sim Chi-Levi et al., 2013). In 2004 Keith Rollins, the CEO of Dell Incorporated said "our strategy is the direct business model, bringing great value to customers through a unique and world-class supply chain, customer intimacy, and great support" (Kirkpatrick, April 19th, 2004). As a result, Dell has experienced a substantial business transformation. Through increasing supply chain adaptability, Dell's product availability has improved 37%, and order-to delivery times are 33% shorter (Sim Chi-Levi *et al.,* 2013). Dell's pioneering direct-sales and made-to-order business model placed the PC maker in the reaches of the Supply Chain Top 25 for several years. Dell's strength in forecasting demand and keeping costs low has become a pillar of the supply-chain. However,

with the changing pace of today's consumer market, towards tablets and smart phones, buyers are no longer interested in waiting too long for a customised Dell desktop to be assembled and delivered, leading to a global decline in the personal computer market. This led to a fall in shipments, leading to Dell Inc's acquisition of a data-storage company, which reinforces the computer giant's shift from its roots as an icon of supply-chain management in manufacturing, toward providing technology services to businesses. The shift has been Dell's main focus since Chief Executive Michael Dell took the company private in a $25 billion buyout in 2013. Since then, the company has aimed to be "an end-to-end solution provider," which the acquisition of EMC will further foster. Erica (2015), reported that Dell needs to see a need for a lot more technology inside the factory floor that could return Dell to the forefront of supply-chain innovation.

However SCM scope and definition has evolved over the years and has been ever changing. The meaning of the word supply chain management in industry parlance is not the same as it was 20 years ago. It is continuously evolving and broadening its scope. Publications referring to SCM first appeared in 1985 (Houlihan, 1985; Jones and Riley, 1987), while its usage increased strongly from the mid-1990s and reached a peak of just over 1,000 annually (Braziotis, 2013). SCM covers all aspects of supply chain such as purchasing, marketing, commerce, and production. These are treated as separate operational entities in logistics-functions, but are merged under the same umbrella of SCM. Supply chain management is the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company, and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies.It is also to obtain sustainable competitive advantage and superior firm performance within the supply chain as a whole (Lee, 2004; Wowak, Craighead, Ketchen, and Hult, (2013); Li *et al.*, 2008; Gligor and Holcomb, 2012). "Supply Chain Management

includes managing supply and demand from sourcing raw materials and parts, warehousing and inventory tracking, order entry and order management, manufacturing and assembly, distribution across all channels, and delivery to the customer" (Supply Chain Council, 2012). It promotes an holistic approach to strategy formation and management to improve the entire supply chain as a result. Therefore, inappropriate activity changes made within a company can result in overall weakening and unfavourably affect other activities of the entire supply chain.

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Figure 2.2: Development Stages of SCM (Nasr, 2015)

Over the years, there has been a transformation in the approach to SCM from the inception of the concept. Early SCM explanations focused on the physical movement of goods, which is the total flow of materials from suppliers to end customers (Jones and Riley, 1985; Monczka and Morgan, 1997). This is also described "an integrative philosophy to manage the total flow of a distribution channel from supplier to the ultimate user" (Ellram and Cooper, 1990). These

explanations suggest the existence of supporting infrastructure and information linkages amongst businesses within the SC. On the other hand it fails to provide complete guidance on SC management.

Imperatively, competition and value is created through collaboration and relationships creation. Companies enjoy competitive advantages by holding or controlling unique SC resources or capabilities and integrative SCM approaches (Barney, 1991; Newbert, 2008). Also, Handfield and Nichols (1999), pointed out that for enhanced competitive advantage, it is essential to develop effective SC relationships as this is crucial for managing the flow of information and materials across the SC. This awareness agreed with the advent of the relational approach, which suggests that firms exist within large networks of purchasing and supply, as well as within competitive and collaborative relationships. In addition, capabilities, values and key resources are seldom created within a solitary company, rather co-created among SC actors based on these relationships (Dyer and Singh, 1998; Dyer, 2000).

As SCM awareness grew amongst companies, competition increased based on entire SCs while less competition took place between businesses (Dyer, 2000). This prompted the need for companies to manage and organise their SCs activities as integrated systems (Hill, 2000; Xu et al., 2001). Therefore bringing about the advent of SC collaboration, Barratt (2004) refers to this as encompassing several elements. Min (2001), emphasised that all members must assist each other to improve SC competitiveness, and achieve goals and objectives via mutually beneficial relationships. Christopher (2011), analysed the perspective of 'mutually-beneficial' and pointed out that SCM helps enhance SC relationships in such a way as to achieve a more profitable outcome for every member involved. On the other hand, Kannan and Tan (2010) argued that there is the need for functional integration outside firm boundaries to heighten sustainable value creation. To date, the concept of SCM has been described as cutting across various scopes with the common focus of linking together partners; as a

concept that manages the flow of materials, information and funds end to end i.e. from upstream to downstream members (Dubey et al. 2012; Randall and Mello, 2012; Machowiak, 2012; Dubey and Ali, 2013; Chang et al., 2013; Parkhi, 2015).

Figure 2.2 illustrates the development stages of SCM definition, suggesting the constantly evolving actual business practice, developing further the earlier process-centric SCs approach of managing the flows of materials and activities, to current approaches that manages members and their mutually beneficial relationships, i.e. as one system.

2.3 Supply Network Perspective

There is a significant rise in the number of publications that discuss supply chain (SC) alongside the term supply network (SN), leaving the conceptual differences between SC and SN unclear, while other authors use these terms interchangeably (Braziotis, 2013). The first appearance of the term supply chain network (SCN) has increased gradually in such a way that it is approaching the same level as that of SN before 1985, but gradually increased to 142 in 2010. These concepts have been used interchangeably alongside SC, a term that gained the highest publicity compared to SN, and SCN, the usage of both adding up to nearly 10% of that of SC. However, the scholars' concept of SCN is an alternative to SN, while others refer to it as a midway terminology between SC and SN (Braziotis, 2013). The interchangeable usage of these terms makes it ambiguous and poses a need for clarity.

On the contrary, other management scholars differentiate SC from SN where the interplay between interconnectedness and complexity of SC is regarded as a shift towards SN (Allesina et al., 2010; Jarillo, 1988; Anderson et al., 1994; Bardach, 1994; Lazzarini et al., 2001; Tomkins, 2001; Ford *et al.*, 2003; Ritter et al., 2004; Mikkola, 2008;). Braziotis et al., (2013) and Cousins *et al.*, (2008), explained that the evolution of the SCM approach was developed in three stages: dyadic linkages, a chain of suppliers (the SC) and Supply Network (SN).

Similarly, Harland (1996) prior grouping also incorporates the SN concept and views SCM as covering four distinct classes: internal SC, the dyadic, the chain and the network. Ellis (2011) used the word "net" to represent links of various SC. Spekman et al. (1994, 1998) stressed that competition is not actually based on chains, rather on networks of companies that work in cooperation to create value through the change of raw materials into final products (Handfield and Nichols, 2002). In the same vein (Ford et al., 2006) pointed out that interactions, interdependence and connections amongst SN are mostly complex, which continuously evolve to adhere to the constantly changing environment. This results in a web or network of relationships where firms are connected directly and indirectly with a number of other companies, mostly through non-linear but complex relationships (Ford et al., 2003; Ford et al., 2006). Hakansson and Johanson (1993) and Cousins et al., (2008) added that it is unusual for a SC actor (supplier, distributor, retailer etc.), to interact within only one dyad. These scholars presented and explained that there is a distinct variance of these associated terms.

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Figure 2.3: The Supply network (Harrison, and Hoek, 2011)

However, for this research, SN is regarded as a centralised network with the existence of the focal firm that monitors and administers transactions in the upstream for the production of the downstream - finished goods and services. On the other hand, for downstream distribution the manufacturer is directly connected to the distributor that buys its products, while retailers source these products from the distributor (Hakansson and Johanson, 1993; Cousins et al., 2008). This focal firm operates in the centre, a profit-driven entity with the most investment in the supply network, the most powerful firm in the supply base, that controls and monitors the actions of the network members (Choi, Krause, 2006). Upstream of supply networks are complex due to the constant interactions and interrelations that transpire among the suppliers' firms, as well as other associated firms (Harrison, and Hoek, 2011).

The SN as shown in Figure 2.2 is best suited for this research because it considers 1st tier suppliers, where firms which supply materials and services to the focal firms are connected directly, and are involved with each other through the supply of materials to the focal firms. As illustrated in the diagram above, in order to satisfy the downstream distribution, the manufacturer purchases raw materials or semi-finished goods directly from suppliers, and in turn gets materials from various other suppliers for upstream distribution.

2.4 Supply Network Management

Due to the complexity of SN structure, it has been managed based on the perspective of either a decentralised or centralised network structure. A decentralised network is more complex as a result of the integration that exists among the suppliers, which are either directly or indirectly connected or involved with each other, as well as a number of other firms outside the network. However, most organisations are actually centralised in their structure based on the existence of the focal or hub firm (Osman., 2015). The focal firm monitors, administers and serves as a centralised coordinator as the centre of a transformation process, which ultimately has a huge influence on the capital outcomes of SN (Choi Kraise, 2006). Therefore,

a centralised network is easier to manage and oversee because of the concise connection between suppliers and focal firm.

According to Osman (2015), the reductionist strategy attracts effective results in the short term, but may impact the supply network negatively in the long term. This approach suggests that focal firms remove partners that do not meet the required performance of the supply network as a means of managing the extensive inter-firm relationship in a supply network (Kim, 2008). However, Putnam (1993; 2000) added that merely removing these underpinning supplier organisations is not appropriate for a complex inter-firm network, because focal firms might remove resourceful and influential partners. Therefore, the concept of embeddedness overcomes the shortcomings of reductionist strategies (Polanyi, 1944; Granovetter, 1985; Zukin and Di Maggio, 1990; Portes and Sensenbrenner, 1993).

According to (Granovetter, 1985), embeddedness emphasises the necessity of interactions within firms, and that the outcomes of a network are affected by the relationships that exist by each actor with other firms in the network, and the relationships that exist within the SN as a whole. SN performance is dependent on the level of a firm's actions and the behaviour of members. Gibbons, Holden, Powell, (2009) and Choi, Kim (2008) added that no firm is an island, rather, they are embedded in a larger network structure of interconnected firms. Also, a hub firm would benefit immensely from understanding the embeddedness of its suppliers. This allows for more realistic assessments about a supplier's ability to innovate or contain cost, or simply better establish suppliers for partnerships.

However, (Putnam, 1992; Cousin *et al.*, 2001; Osman, 2015) argued that the embeddedness approach has not described the level of involvement or metrics measures for partners, to give improved SN performance. Neither has it sufficed for the gap in the reductionist approach. Additionally, it is pointed out that it is necessary to have a clear definition of embeddedness,

since it constitutes an important element that enhances performance. Conclusively, Choi and Kim (2008) propositioned that focal firms with a good understanding of their suppliers' embeddedness are likely to have better performance, both in operations and finance.

Choi and Kim (2008), suggested that an appropriate way to know the level of involvement or measures of partners' commitment, is the hub company considering strategic choices of their suppliers. The knowledge of suppliers' strategy gives an insight to the level of commitment of each partner; gives a clear representation of each organisation's characteristics, and gives an awareness into their level of involvement in the network. According to Reeves, Haanaes, and Sinha, (2015**)** and Watkins, (2007; 2013), strategy is the sum of the activities a company anticipates taking to achieve long-term goals. Therefore, categorising suppliers based on strategy will give a clear characteristic of suppliers, thereby enabling the hub organisation to manage suppliers appropriately.

In 2008, Dai and Zhang's supply network model was introduced, where the hub company and suppliers are categorised based on the Miles and Snow (2003) strategy - a processual strategy approach. There are four strategy approaches described by Whittington (2001) which are Classical, Evolutionary, Processual and Systemic approaches. The Classical approach relies on the ability of the market to secure a unitary goal of profit maximisation; the Evolutionary approach uses the law of the jungle of biological evolutions, where markets are based on survival of the fittest (Whittington 2001:16). In the Systemic approach perspective both the process and the outcome of strategy must line up with the cultural rules of the local society. Profit maximising is not based on the company's interests alone, but on different social backgrounds. In this approach, both the process and the outcome of strategy must align with the cultural rules of the local society. However, in contrast with the Classical and Evolutionary approaches, the Processual approach to strategy pursues pluralist goals as it seeks more than profit maximisation as the expected outcome of strategy. This strategy

emerges from individuals in the organisation seeking to include their personal objectives as part of the organisational goals (Batamuriza et al, 2006). According to Wright, (2000) in the Classical approach, uncertainty of events may occur in the macro environment that may render the approach obsolete. The Classical and Evolutionary approaches share a similarity as they both agree on the unitary goal of profit maximisation as the outcome of strategy. However, the Evolutionary takes a different position as it relies on the ability of the market to secure profit maximisation. While the Evolutionary and the Processual approaches share the same view on the unsuitability of the Classical approach to cope with an unpredictable environment, the Evolutionary believes in allowing the market to determine the choice of strategy, while the Processual requires the organisation to maintain the status quo and work with it (Whittington, 2001). Consequently, Dai and Zhang's supply network model was based on the Processual school of strategy – where Miles and Snow's typology was to be utilised. This strategy acknowledges management weaknesses and organisational rigidities as given, and builds models and solutions around what is administratively possible in such a context. The Miles and Snow strategic types can easily be classified, and there are no limitations to the industries in which they exist.

2.5 Dai and Zhang Models Relationship with Lean, Agile and Leagile

Dai and Zhang (2008) satisfied Choi and Kim's (2008), suggestion on categorising suppliers based on strategy. On the other hand, Dai and Zhang use strategic thinking to construct lean, agile, and leagile strategies under the strategic supply network model. The model, consists of three successful supply networks: Cost saver, Adapter, and Multiple Driven. The previously mentioned characteristics of hub companies of the supply network is based on Miles and Snow's strategic typology (2006). As shown in Figure 2.3 below, the model is made up of a hub organisation, and considers its immediate suppliers (first tier suppliers).

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Figure 2.4: Direct Supply Network (Dai and Zhang, 2008)

The model extends the concept of Lean, Agile, and Leagile which belong to the operational level strategies. Fisher, (1997) argued that these cannot solve the deprived performance problems in businesses. The lean paradigm's main focus remained on the reduction of waste (Muda - operations which add no value) to enhance cost, flexibility, and improvement of processes, and fulfil customers' needs whilst retaining profits. This envelops the entire lifecycle of the product, starting from the order by the customer (upstream-distribution), to design of the product, down to the delivery of the product or selling of the product, and ensuring the availability of right product to end customer at the right time, as well as location (Downstream-distribution) (Reichhart and Holweg, 2007; Vonderembse et al., 2006). The Lean approach of management, as developed by Taiichi Ohno (1998), forms the main foundation for "Toyota Production System (TPS)" in Japan at the Toyota Motor Corporation. The internal efficiency of manufacturing, and reduction in setup time are the enablers for the manufacturing flexibility, cost reduction, profitability and economic production of small quantities (Vonderembse et al., 2006).

There is a need for agility as presented by Fisher (1997) because, although lean management reduced the throughput in the supply chain dramatically, significant delay of delivery still happened (Fisher, 1997; Bruce, Daly, and Towers, 2004). Lean strategy is unsuitable for a speedy and unpredictable market environment. However, to overcome the weakness of lean management, the agile operation concept was developed, to proffer high level accessibility, reasonable service quality, and explosive and variable market demand, under the least needed lead time (Hiebelar, Kelly, and Katteman, 1998; Bruce, Daly, and Towers, 2004). Therefore, the main focus of agile SCs is the capability of responding quickly to the comprehensive changes that occur in the market.

Christopher & Towill, (2000) argued that agility conserves the ability to survive adequately through unpredictable demands, and adjusts for uncertain market changes, while lean principles are suitable for steady demand. Christopher, (2000); Agarwal et al., (2007), Baramichai et al., (2007) added that the agile paradigm not only has a quick response but is also budget efficient in responding to instability, random variations in market situation and reduction of lead time, compared to other processes (Vinodh et al. 2010). Summarily, agility is accompanied by cost reduction, introduction of fresh products, improved quality, speedy-delivery, improvements in service level, customers satisfaction, and reduction in lead-time. The incorporation of business associates facilitates fresh proficiencies for reacting swiftly to the persistently irregular marketplaces (Rai and Azfar et al., 2014), attaining flexibility in business solving to stay afloat amidst market instability and challenges (Winkler 2009, Merschmann and Thonemann, 2011). This shifts towards the combination of agility and leanness into using leagility principles (Vinodh and Prasanna, 2011).

Nonetheless, lean, agile, and leagile belong to operational level strategies that focus on product and market, in finding the best way to achieve business objectives, since these strategies ignore the consideration of organisational structures, human resources, the fitness

within the market environment, and the relationships between these factors. It is risky and it will not suffice to concentrate an organisation's strategies on only the operational facet in a dynamic business environment coupled with intense competition. Therefore, it cannot solve the poor performance problems of a supply chain (Fisher, 1997). To overcome the limitations of these operational strategies, choices should be made from the corporate and business strategy levels that enable an organisation to identify a specific market to compete in, and also to design the supply chain structure a firm exists in (Hines, 2004). Thus, Dai and Zhang (2008) extends the concept by lean, agile, and leagile by introducing the three supply networks that cut across the corporate and business strategy levels. These are Cost Saver Supply Network (CSSN); Adapter's Supply Network (ASN); Multiple Driven Supply Network (MDSN).

The Cost Saver Supply Network (CSSN) makes use of a hierarchical structure, led by the Defenders hub company whose business environment is characterised by *stability*. The Cost Saver's Supply network is similar with Fisher's (1997) Efficient Supply Chain and Cost driven of Miles and Snow's supply types (2006), which mainly emphasises achieving maximum cost efficiency, and efficiency of production and distribution within the supply network. The business environment of this type of supply network is stable, therefore the supply network can target to achieve cost saving and efficiency. Lean manufacturing and supply chain strategy are appropriate and favourite supply network strategy. Thus, efficient features, such as lead-time efficiency, Cost efficiency, Inventory efficiency, Machine efficiency, Planning efficiency, Distribution efficiency, and Quality accuracy, are vital for this type of supply network.

The Adapter's Supply Network (ASN) builds the network around a Prospectors hub, which emphasises the innovation, advanced technologies, flexibility and fast response in the supply chain, and shares some common features with responsive supply chain in Fisher's (1997)

model, and Innovation driven of Miles and Snow's (2006:459) model. The business environment of this type of supply network is uncertainty and fast change; hence the agile strategy is more suitable for this type of supply network. Flat and flexibility are the features of the structure of this supply network. To ensure the flexibility, the technological feature of the hub company should prefer prototypical, manufacturing flexibility, process flexibility, and fast response features for a chosen technology.

The Multiple Driven Supply Network (MDSN) is a combination of cost efficiency, efficiency and effectiveness and centred on an Analysers hub company, much like *Op-Win driven* type of Miles and Snow's (2003) model. This type of supply network tries to take advantage of both efficiency and effectiveness, and can achieve the maximum benefits from the supply network compared with the above two supply networks. Ideally, leagile strategy is proper for the multiple driven type of supply network. Due to the dual core characteristics of the Analyser, both above mentioned efficient and effective technological features are required by this multiple driven supply network. In addition, features such as Resource efficiency, Integration efficiency, and Reliability are also emphasised in this type of supply network. Table 2.5 below presents a detailed description of the three types of supply networks.

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Table 2.1: Characteristics of Dai's Supply Network Model Dai and Zhang (2008)

2.6 Suppliers Configuration and Management

It is advantageous to group suppliers based on strategy. It presents the holistic features, the behaviour, and the quality of the suppliers. This helps the hub to know how to manage such suppliers. In developing the structure of the model, Dai and Zhang (2008), unveil the mixed levels of different company types as members of Multiple Driven supply network. It states that the supply networks partners can be selected from a wide range of choices of either Defenders, Prospectors, Analysers or Reactors, with the tendency to change partners frequently. Thereby, this concludes that Multiple Driven supply networks have the widest range of Miles and Snow typologies as their network firm members.

For the Cost Saver supply network, the supply network members are not limited Defenders, but the dominant ones might be Defenders. Knowledge is shared easily in this type of supply network and high investment in the whole supply network often occurs.

In the Adapter supply network each member of the supply network has a wide choice of different types of Miles and Snow typologies. However, there might be a frequent change of partners in this supply network. However, this leaves a gap in the literature because the proposition is not yet validated, neither is it precise on supply network about the dominant supplier type. Knowing the dominant supplier will enhance the structure of these supply

networks, helping manage the supply network through choosing the appropriate supplier for each of the networks. Therefore, in this supply network the choice of supplier will not be limited or based solely on price as is the traditional way of most organisations (Moody,1992) rather on various characteristics that are not limited to price.

Supplier selection has played a major role in managing supply network to achieve improved performance. The choice of suppliers within a supply chain eventually leads to the overall system performance as stated by Graves and Willems (2003). The choice of appropriate suppliers has been a great help to many organisation to improve their performance and outshine their competitors. (Turnbull et al., 1992).

This research extends Dai and Zhang's model, to investigate the dominant supplier's strategy for each supply network, to validate if hub strategic types are dominant, and to determine the dominant supplier strategic types that make up each of the supply networks. This will help to measure what makes up each supply network, offer management to the supply network, and supplier selection that suit each supply network. To achieve these, this research work will introduce the concept of *suppliers' configuration*. *Suppliers Configuration* in this study, is the occurrence or ratios of the Miles and Snow's strategic type – Defender, Prospector, Analyser and Reactor as suppliers within each of the supply networks. Although, supply network configuration has been mentioned numerous times in literature, very few have evaluated supplier proportion based on strategic typology.

Thus, the research is designed to test in three steps: the first phase, is to test the composition of suppliers strategy that makes up the supply networks ratio (Defender: Prospector: Analyser: Reactor). To this end, hypotheses are proposed on the typologies that are dominant and the existence of the four typologies in each of the supply networks. The proposed hypotheses and validations are detailed in Chapter 5.

The second step, to examine the reasons why hubs choose their preferred suppliers, the interrelationship that exist in the whole supply network - (if suppliers configuration are dependent on hub company or vice versa); and how the choice of suppliers impacts the hub organisation - see details in Chapter 4 Case Study.

Finally, the third phase, is to evaluate the performances of the various supplier configurations for Multiple Driven, Cost Saver and Adapter supply networks. This will be carried out by varying the suppliers' configuration using simulation. Conclusively, from the simulation result, suggestions will be made on the supplier's configuration that gives improved performances.

2.7 Miles and Snow's typology

2.7.1 Literature review of Miles and Snow's typology

Hambrick and Crozier (1985), pointed out that the primary reason for the popularity of the Miles and Snow typology is that it offers a simple and parsimonious characterisation of the strategic stance of organisations. Since the development of these corporate-level strategies by Miles and Snow typology in 1978, it has formed the basis of many studies and it has been illustrated in different strategic management textbooks (Karen Blackmore, 2012; Johnson 2005; Lynch 2005). Over the years, researchers have tested Miles and Snow's theory extensively in various industries and verified their claims in marketing, entrepreneurial and organisational fields. Also, articles published in leading management and strategic journals confirmed the continuing relevance of these typologies (Chaganti and Sambharya 1987; Conant, Mokwa et al. 1990; Zahra and Pearce II 1990; Weisenfeld-Schenk 1994; Ghobadian, James et al.1998; Simmonds, Dawley et al. 2001; Ghoshal, 2003; Aragón-Sánchez and Sánchez Marín, 2005; Desarbo et al., 2005; Hambrick, 2003; Mitchell and Zmud, 2006; Slater et al., 2006; Boulianne, 2007; Zinn et al., 2008).

The 20th century recorded numerous related researches carried out on Miles and Snow's strategy. Shortell and Zajac (1990), conducted an investigation on 400 organisations and ascertained that the self-typing method is robust enough to validate Miles and Snow's strategy types. The 'self-typing' approach is regarded by Conant et al., (1990) as a subjective approach. Bahaee (1992) explored Miles and Snow's strategy type in small firms comprising of 82 regional airlines, and found the support for the proposition that the four Miles and Snow strategic types would be present in the small, entrepreneurial firms that make up the regional airline industry in the US. Also, Gimenez (1999)s investigation of 150 small firms in Brazil, reveals that Defenders, Prospectors, Analysers and Reactors exist in Brazil's small business settings. Similarly, Miles and Snow's strategic behaviour has also been validated in various other small businesses by (Beynon et al., 2010; Boyne and Walker, 2010; and Slater et al., 2010; Garett, Lambin and Naylor, 2013; Aragón-Sánchez and Sánchez-Marín, 2005; Gimenez, 1999, 2000; O'Regan and Ghobadian, 2006). Furthermore, numerous empirical studies have been conducted to validate the existence and characteristics of the Miles and Snow strategy types in different domains (Garrigós-Simón et al., 2005; James and Hatten, 1994; O'Regan and Ghobadian, 2006; Weisenfeld-Schenk, 1994; Zahra and Pearce, 1990).

In recent times, the related researches on Miles and Snow's typology still receives great interest from several researchers. The relationship between Miles and Snow's strategy types and organisational outcomes in an athletic department was evaluated by Cunningham (2002). The study contributes that the outcomes of organisations which follow various Miles and Snow's strategy types are different. Moore (2003) concluded that Miles and Snow's typology is suitable for the retail industry and contributes to retail strategy. On the other hand, Heijltjes and Witteloostijin (2003) proposed a framework to link environment, strategy, technology, HRM linkages, using two strategy typologies – *Miles and Snow's typology and Porter's typology* to verify the model in two diverse industries. In addition, Karen Blackmore (2012)

further established the existence of Miles and Snow typology in different firms of various sizes and industries in Australian SMEs. This study was the first to use objective measures that cover the multiple dimensions of Miles and Snow's entrepreneurial, engineering and administrative activities. Vladimir Gnjidic (2014), researched the dynamics of Miles and Snow's strategic typology and confirmed the existence of the four strategic types in medium and large companies in the Croatian food and beverage industry. Conclusively, the expositions of these scholars confirm that Defenders, Prospectors, Analysers and Reactors do not behave in the same way even within similar environments. These organisations' strategy maintain their beliefs and characteristics and are not reshaped based on changes in their external environment (Miles and Snow, 2003).

2.7.2 Adaptive model

The framework of the adaptation model proposed by Miles and Snow (1978) can be traced back to Child (1972). Child emphasised both the variety of appropriate responses to environmental change and the strong political elements that characterise strategic decisions. Figure 3.1 below illustrates the three domains of Miles and Snow's adaptive cycle – entrepreneurial, engineering and administrative. The 'problem' of these three sets are: (1) The entrepreneurial problem is the choice of product and market domain; (2) The engineering problem is the choice of technologies for production and distribution, and (3) The administrative problem involves the structure and processes in the organisation.

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Figure 2.5: The Miles and Snow's adaptive cycle (Miles and Snow's 2003)

Each typology moves in the cycle of these three problems - entrepreneurial, engineering and administrative. However, the way it is perceived by each typology is different and as such, the way each reacts to each problem differs. The entrepreneurial problem for Defenders is -*"How to seal off a portion of the total market in order to create a stable domain"*; Prospectors is "*How to locate and develop product and market opportunities"* and for Analysers is "*How to locate and exploit new product and market opportunities while simultaneously maintaining a firm base of traditional products and customers".* Table 2.2 below shows the solution methods adopted by each typology in solving the entrepreneurial problem.

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Table 2.2: Entrepreneurial characteristics (Miles and Snow's 2003)

The engineering problem for Defenders is *"How to produce and distribute goods or services as efficiently as possible"*; Prospectors is *"How to avoid long term commitment to a single type of technological process";* Analysers is *"How to be efficient in stable portions of domain and flexible in changing portions".* In the case of administrative problems, for Defenders is *"How to achieve strict control of the organisation in order to ensure efficiency"*; Prospectors is "*How to facilitate rather than control organisational operations";* Analysers is "*How to differentiate the organisations structure and processes to accommodate both stable and dynamic areas of operation".* Tables 2.3 and 2.4 below show the solution methods that each typology implements in solving the engineering and administrative problems respectively.

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Table 2.3: Engineering solutions (Miles and Snow's 2003)

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Table 2.4: Administrative Solutions (Miles and Snow's 2003)

2.7.3 Miles and Snow's Typology Properties

Miles and Snow (2003) used the effective adaptation cycle to characterise and classify individual firms into either Defenders, Prospectors or Analysers depending on the way each responds to the environment. Table 3.4 below describes the characteristics of the 4 types of typology. Miles and Snow (2003) also identify a fourth type of firm, called a *Reactors*, which cannot or will not adapt to change for some organisational reasons. Croteau and Bergeron's (2001) research found that *"a significant and negative link was observed between the Reactors strategic activities and organisational performance which suggest that Reactors*

strategic activities impede organisational performance". Therefore, Reactors will be ignored in this research and the study only focuses on the other three successful types.

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Table 2.5: Typology Properties (Miles and Snow's 2003)

Furthermore, Johnson and Scholes (1989) summarises the comparative advantages; Defenders - Cost, efficiency and low risk; Prospectors - The ability to cope and enjoy change, innovation; Analysers - successful imitation organisation.

2.8 Simulation Variables

2.8.1 Key Performance Indicators

The third phase of this work is to evaluate the effect of various suppliers' configurations on performance. This is meant to achieve some of the aims illustrated in Chapter 1 which are to; evaluate the performances of the following suppliers configurations for Multiple Driven, Cost Saver and Adapter supply networks. Using, Equal ratio of suppliers' strategic types; suppliers' strategic types that are different from that of the hub organisation; varied supplier's strategic types.

This will be achieved by varying the suppliers' ratio of Defenders: Prospectors: Analysers for the three supply network using discrete event simulation (DES). DES is a form of computer based modelling that provides an intuitive and flexible approach to representing complex systems (Karnon, *et al*., 2012) - see details in Chapter 6 Simulation. This phase of the work

will not consider Reactors' suppliers, this is because according to Miles and Snow (2003), it does not thrive in the market but fades off after a short while.

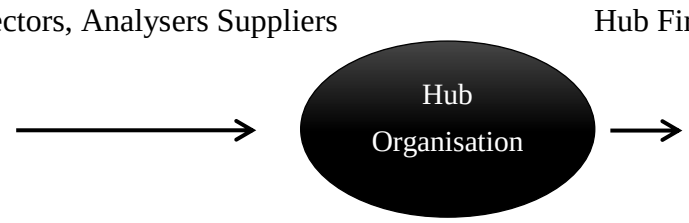

Figure 2.6: The Proposed Research Model

Performance can be defined as a metric used to quantify the efficiency and or effectiveness of an action (Neely, 1994). And a system or standard of measurement (Oxford advanced Learners Dictionary, 2015). Performance enables firms to measure success in their supply network initiatives and serves as one of the cornerstones of business excellence (P. Goebel *et al.*, Nov 2012; Reuter, Goebel, and Foerst, Dec 2012; Baskaran, Nachiappan, and Rahman, 2012; Molamohamadi, et al.,2013).

There have been arguments about how best to categorise performance, whether as qualitative or quantitative (Beamon, 1999; Chan et al., 2003); about what it measures: cost and non-cost (Gunasekaran, 2001; De Toni & Tonchia 2001); cost, quality, resource utilisation, flexibility, visibility, trust and innovativeness (Chan et al., 2003); resources, outputs and flexibility (Beamon, 1999); supply chain collaboration efficiency; coordination efficiency and configuration (Hieber, 2002). Effectiveness is the extent to which customer requirements are met and efficiency measures how economically a firm's resources are utilised when providing a pre-specified level of customer satisfaction (Shepherd and Gunter, 2006); and input output and composite measures (Chan and Qi, 2003). Gunasekaran et al (2004) claims that performance can either be Financial or Non-Financial as shown in Table 2.6 and are grouped as either of three levels - *the strategic level* deals with decisions that have a long-term planning effect on the firm; *the operational level* focuses on customer satisfaction, flexibility and

productivity which involves day-to-day decisions, such as Scheduling and Routing, and *the tactical level* includes decisions that are typically updated periodically such as inventory policies, resource allocation and measuring performance against targets to be met, in order to achieve results specified at the strategic level. A framework developed by Gunasekaran *et al* (2004) as shown in Table 2.6 below;

Level	**Performance metrics**	**Financial**	**Non-Financial**
Strategic	Range of product and service		•
	Variations against budget		•
	Lead time		•
	Flexibility (volume, delivery speed, specification)		•
	Quality of service		•
	Customer satisfaction		•
	Buyer–supplier partnership level-		•
Tactical	Effectiveness of delivery invoice methods		•
	Supplier assistance in solving technical problems		•
	Suppliers backing in procedure		•
Operational	Capacity utilization		•
	Service capacity		•
	Supplier cost saving initiatives	•	
	Supplier pricing against market	•	
	Effectiveness of scheduling techniques		•
	The service order entry method		•
	The customer service order path		•

Table 2.6: Performance Measures and Metric

On the other hand, KPI (key Performance Indicators) are widely used in measuring the business performances of different industries, logistics and manufacturing firms (Ghalayini et al., 1997; Fawcett and Cooper, 1998). According to Brignall and Ballantine (1996), the topic of performance measurement has become increasingly important in recent times, reflecting widespread dissatisfaction with traditional performance measurement systems, which are

argued to focus on short-term measures of financial performance, neglecting non-financial aspects of performance such as service quality, service delivery speed and flexibility.

Financial performance measures gauge the extent to which a business is successful from a financial context, but do not indicate operational competencies (Kaplan and Norton, 1992; Maskell, 1991). Financial performances are the most significant measures with shareholder value being the primary objective (Harrison and Van Hoek, 2005:61). Moreover, a useful channel by which to define inputs and outputs for evaluation of a company's performance efficiency has recently been its financial data (Tang and Liou, 2010; Kin et al., 2011; Mankiw, 2011). The output is assigned as the profitability of a company, and the inputs are its resources such as time and money, because the common definition of efficiency is the property of a resource allocation maximising the surplus received by a company. Therefore this study will combine both financial and non-financial measure to analyse the performance of each of the supply networks.

Uniformity in performance measures are considered for the simulation of the Dai and Zhang's supply networks in this project. The four most widely used key performance indicators chosen are; *Quantity delivered, Profit or Loss, Quality delivered, and Throughput.* This combines the financial measures (Profit or Loss), those that can be determined in monetary terms, while non-financial measures include Quantity delivered, Quality delivered, and Throughput. According, to (Tang and Liou, 2010; Kin et al., 2011; Mankiw, 2011) an approach that evaluates both financial and operational performance is the most beneficial for business performance measures.

Quality is a vital measure of performance of supply chain by the fact that the quality of final products delivered into the organisation should be of maximum quality. Lead time refers to the time which elapses between the receipt of the customer's order and the delivery of a

service to the customer (Fitzgerald *et al*., 1991). Lead time is also the crucial aspect of supply chain management and relates to the duration from which the customer initiates an order or the time when the company acknowledges the requirement, to the time at which the customer's order is fulfilled (Clemons, Kauffman and Weber, 2011; Flynn, Huo and Zhao, 2010). The reduction in service order lead time leads to a reduction in service supply network response time, and as such is an important performance measure and source of competitive advantage (Christopher, 1992). Klibi, Martel and Guitouni, (2010), added that the goal of supply network management is to a reduce the supply lead time. A short lead time can offer firms competitive advantage, particularly in situations whereby there are no stocks held in advance such as the case of build-to-order. According to Stewart (1995), an increase in delivery performance is possible through a reduction in lead time attributes. Thus, each sector of the service industry needs to have its own set of specific challenges to decrease service order lead time.

For this study the hub organisations preferred performances decides the variable that will be modelled for the suppliers. Therefore, for this research the variables considered for the Miles and Snow supplier; Defender, Prospector and Analyser are *Quantity delivered, price of materials, Quality delivered, and Time of delivery* – see details in Chapter 6 Simulation, and the Key performance measures are *Quantity produced, Profit or Loss, Quality produced, and Throughput.*

2.9 Summary

This chapter has set out the literature which is associated with the foundation of this research study. The concepts of supply chain and supply network configuration were put into context and reviewed. It reveals how this concept is part of the wider subject, supply network management (SNM). Other related aspects are covered whilst presenting the choice of supply network for this work. It stretches to explaining the concept for this research,

describes the proposed linkages and relationship between variables, and presents the theories underlying the framework and hypotheses, ranging from the choice of supply network under study, its connection to Miles and Snow typology, the variables for the suppliers, and finally the key performance indicators. Subsequent chapters reveal how this has been achieved and the impact on enhancing supply network management.

Chapter 3: Research Methodology

3.1 Introduction

In Chapter 4, various hypotheses have been proposed based on Miles and Snow's typology in relation to Dai and Zhang's (2008) supply networks. This chapter discusses the statistical method used to test these hypotheses, the questionnaire design and interviews used in gathering data for this research. The three statistical test methods analysis used for this research were examined: MANOVA, goodness of fit test and chi-square test. In the previous studies of Miles and Snow's strategic typology, questionnaires and interviews have been found reliable and acceptable ways of classifying organisations into either Defender, Prospector, Analyser or Reactor. This was used to classify hub and supplier organisations in this study (Zahra and Pearce, 1990; Miles and Snow 2003; Snow and Ketchen, 2014; Stanwick and Taylor, 2015; Cronin, et al, 2015; Barua and Barthakur, 2015).

Chapter 5 contains detailed analysis of the case study, which is a qualitative method adopted in this research. According to Saunders, et al. (2015), the qualitative method explains the reasons behind happenings rather that describing events. On the other hand, Potter (1996) mentions that quantitative research can be viewed as a movement from specific to abstract explanations, while a qualitative approach examines a wider range of meanings and deduces norms from it. This research combines quantitative and qualitative methods to gather data. This helps to certify details for clarity, to give wholesome understanding and appropriate insight for this study (Creswell, 2013; Bernard, 2012; Vogt, et al., 2014). Subsequently, this chapter explains the qualitative aspect of this research, the sample size, and sampling methods.

3.2 Questionnaire Design and Quantitative Analysis

Questionnaires were chosen as the quantitative methods in this research, because this allows collection of an appropriate amount of data within a short timescale and in an economic way (White and McBurney, 2012; Walliman, 2010). A sample of the questionnaire is attached (see Appendix B). The aim of the questionnaire is to classify each organisation into one of the Miles and Snow strategic types. The information derived from this questionnaire from hub and supplier organisations was used to verify the 12 propositions and hypotheses in Chapter 5. Also, to satisfy these objectives as listed in Chapter 1 as follows;

- To study the Multiple Driven, Cost Saver and Adapter supply networks.
- Investigate if the suppliers in the supply networks can be any of Miles and Snow's (M&S) four typologies: Defenders, Prospectors, Analysers or Reactors.
- Identify if the majority of the suppliers of the Multiple Driven, Cost Saver and Adapter supply networks have the same strategic typology as their hub organisation.
- To investigate the strategic typology that is dominant within the supply networks.

Thus, this chapter will follow this structure: Identification of Miles and Snow's typology is described in Section 3.3; the questionnaire structure and questionnaire design in Section 3.4; the Research Plan, Research Approach and steps to carrying out this research is explained in Section 3.5 and 3.6; the Data collection process, sample size and sampling methods, and the adopted and appropriate statistical test methods are evaluated in Section 3.7; Quantitative Data Analysis Methods are discussed in Section 3.8; the qualities of the data, to enhance reliability is analysed in Section 3.9; the Data qualities and data distribution analysis is described in Section 3.10, which explains the Qualitative Research and Analysis methods,

Data Collection and Interview question design, and Section 3.11 is the concluding part that provides the summary of this chapter.

3.3 The identification of Miles and Snow's Typology

There have been 2 major types of questionnaire used to reveal a company's Miles and Snow strategic type. The first is the questionnaire designed by Conant *et al.* (1990) that examines different dimensions of (11 questions) to assign the dominant type of strategic orientation to which a company belongs. This has been adopted by Vladimir Gnjidic (2014); Andrews et al. (2006); Moore (2005); Desarbo et al. (2004); Evans and Green (2000); Dyer and Song (1997), and proven to be effective.

The second type, and the most common method, is the 'self-typing paragraph' approach. This approach is a practical method to identify Miles and Snow's strategic types, initiated by Snow and Henbrick (1980). In the self-typing questionnaire, the questionnaire describes the characteristics of each of the 4 groups of the Miles and Snow types. The organisation selects what best closely resembles their own strategic orientation from one of four groups that identify the Miles and Snow strategic types (Blackmore and Nesbitt, 2013). Many researchers admitted that the self-typing method is a reliable method of recognising the specific Miles and Snow type (see Table 3.1) for some scholars that have adopted and proven the validity of this questionnaire. Therefore, the self-typing test questionnaire is adopted to identify the Miles and Snow type of the surveyed companies in this research.

Studies	Industry group	Strategic Group covered
Snow and Henbrick (1980)	Automotive Air transportation Plastics semiconductors	Defender, Prospector, Analyser, Reactor
Hambrick (1980a,b)	Hospitals, College, Insurance	Defender, Prospector,
Hambrick (1983)	Growth-non innovative	Defender, Prospector,
Hawes and Crittenden (1984)	Retailing	Defender, Prospector, Reactor
Zahra (1987)	Hospitals	Defender, Prospector, Analyser, Reactor
Mc Daniel and Kolari (1987)	Banks	Defender, Prospector, Analyser
Odom and Boxx (1988)	Churches	Defender, Prospector
Simon (1987)	Cross-sectional	Defender, Prospector, Analyser, Reactor
Conant , et al (1988)	HMOs	Defender, Prospector, Analyser, Reactor
Usidken, et al (1988)	Construction	Defender, Prospector, Analyser, Reactor
Smith, et al. (1989)	Electronics	Defender, Prospector, Analyser, Reactor
Zajac and Shortell (1989)	Hospital	Defender, Prospector, Analyser, Reactor
Dai (2007)	Manufacturing in Uk	Defender, Prospector, Analyser, Reactor
Blackmore and Nesbitt (2013)	Australian small-and medium-size enterprises	Defender, Prospector, Analyser, Reactor
Helmig, Hinz, and Ingerfurth (2014)	German hospital	Defender, Prospector, Analyser, Reactor
Barthakur (2014)	Non-governmental organisations of Assam	Defender, Prospector, Analyser, Reactor
Shoham, Lev - Lev (2015)	Manufacturing in Israel	Defender, Prospector, Analyser, Reactor

Table 3.1: Overview of the past research on typology Identification

3.4 Questionnaire Design

The aim of the questionnaire is to collect the relevant information from organisations that can be used to verify the hypotheses in Chapter 5. The use of the questionnaire for this research enhanced the collection of an appropriate amount of data in a short timescale and in an economic way (Saunders, et al., 2015). Creswell (2013), states that the importance of a well-designed questionnaire is to help establish the purpose of the research. To achieve this,

conscious steps have been taken by the researcher to make the questionnaire as clear as possible, by presenting the questions in a logical order and ensuring it does not stray away from what it is meant to satisfy.

This questionnaire has been pre-tested with Coventry University researchers, and MSc Management students of Cardiff University and London Metropolitan University. Furthermore, a pilot study was carried out on 5 production managers in the printing industry. A pilot study is a small-scale test of the methods and procedures to be used on a larger scale. This helps to identify any ambiguities or complexity, to identify problems related to the questionnaire, to avoid mistakes and complications, such as time required to complete the questionnaire, clarity of the instructions, omission of any significant topics or element, and questionnaire layout, (Polit, and Springs, 2011; Saunders, et al., 2015). These steps help to ensure that the final questionnaire is as straightforward as possible, as this would lead to a higher response rate as well as more reliable data.

The pilot testing was carried out using a Conant et al. (1990) designed questionnaire (see Appendix A). This questionnaire examines 11 different dimensions of the Miles and Snow adaptive cycle. For each question, there are four different mutually exclusive responses (each response is matched with one type of strategic orientation), that uses nominal measurement scales. The questionnaire classifies companies according to the largest number of responses that correspond to a specific type of strategic orientation.

After pre-testing the questionnaire and pilot testing, the researcher observed a need to modify the initial questionnaire which was too long and complex. To maintain a high response rate and get the desired data, the questionnaire was replaced with a shorter one, for ease of

completing within a shorter time. The questionnaire was replaced with the self-typing approach (Appendix B) which was thereby adopted for the completion of this project.

There are 5 main questions in the self- typing questionnaire as shown in ***Figure 3.1*** *below*. These questions are preceded by the description of each of the 4 Miles and Snow strategic types (see Appendix B) for these descriptions. *Where, Type A: Defenders, Type B: Prospectors, Type C: Analysers, Type D: Reactors.*

Q1. Which one of the 4 organisation types most closely fits your organisation?

Q2. Do you anticipate your organisation moving to any of the four 'type descriptions' within the next 3 years? ○Yes ○No

Q3. If the above answer is yes, which description would you anticipate moving towards? ○Type A ○ Type B ○Type C ○ Type D

Q4. Has your organisation moved from any of the other 'type descriptions' within the last 3 years? ○Yes ○ No

Q5. If you above answer is Yes, please describe which description has the organisation moved from? ○Type A ○ Type B ○ Type C ○ Type D

Where, Type A: Defender, Type B: Prospector, Type C: Analyser, Type D: Reactor

Figure 3.1: (Sample I)

By dynamic company strategic orientation, the criticism regarding the static nature of Miles and Snow strategic typology has been accepted. However, for clarity, this problem is solved

by the parallel measuring of a company's average strategic orientation in three (3) different time periods: the past (last 3 years), present (1 year), and future (next 3 years) as portrayed in the questions above. The relevance of the questions is explained below;

Q2 Do you anticipate your organisation moving to any of the four 'type descriptions' within the next 3 years?

Q3 If the above answer is yes, which description would you anticipate moving towards?

These questions further explore whether a firm has or will change Miles and Snow type in the past or future 3 years, in order to help analyse the relationship between the interview context and Miles and Snow typology in the future. Since, if a firm is in a transition period, its behaviour might be contradicted with the pure Miles and Snow type it claims, and that might arouse confusion in future analysis.

Q4 Has your organisation moved from any of the other 'type descriptions' within the last 3 years?

Q5 If the above answer is Yes, please describe which description has the organisation moved from?

The results of these questions provide the dynamics in the company strategic orientation. This reveals not only the levels and types of changes in strategic orientation for each type of strategic behaviour; but the holistic *(dominant)* strategic orientation of the company over a longer period of time.

3.4.1 Further interview opportunity

The final part of the questionnaire is to solicit the cooperation of the responders for further discussion and interview if the need arises. Also, to express appreciation for their help and cooperation in completing the questionnaire. These questionnaire results form the basis for the interviews in (see Appendix C and D), and to satisfy the case study and simulation analysis (in Chapters 4 and 6).

3.5 Research Plan

The purpose of this study is to examine the strategic configuration of suppliers within the 3 supply network types; and to investigate the impact of suppliers' configurations (ratio *of Miles and Snow types*) on the performance of the hub organisation within the supply network. The research questions this study aims to satisfy are **"What are the strategic typologies that exist in supply networks?"** This is achieved through propositions and hypotheses validations (see details in Chapter 5). The second aim is, *"***What are the impacts of suppliers' configurations (in terms of ratio) on the performance of the hub organisation within the supply networks?"** The effect of configurations (in terms of ratio) on the performance will be achieved using simulation modelling as a qualitative tool and case study approach as discussed, details and analysis are in Chapters 4 Case Study, and 6 Simulation Analysis. Propositions and hypotheses were validated to achieve the objectives of this research enumerated below;

(1) To study the Multiple Driven, Cost Saver and Adapter supply networks.

(2) To investigate if the suppliers in the supply networks can be any of Miles and Snow's (M&S) four typologies: Defenders, Prospectors, Analysers or Reactors.

(3) To identify if the majority of suppliers of the Multiple Driven, Cost Saver and Adapter supply networks have the same strategic typology as their hub organisation.

(4) To investigate the strategic typology that is dominant within the supply networks.

(5) To suggest guidelines for selecting the appropriate suppliers' configuration that satisfies customer and organisation needs within the supply network.

3.6 Research Approach

This research adopts both quantitative and qualitative techniques. The quantitative aspect covers the structure, while qualitative research covers the process of the study (Bryman, 2012). The quantitative and deductive approach originates from philosophical positivism. The deductive method is a 'top-down' approach where the study looks for logical reality and independence of man, where conceptual and theoretical structure developments are tested by empirical observation. This can be described as shifting from general to specific (Sekaran and Bougie, 2013). This study adopts a deductive approach to achieving these purposes - Chapter 5 described the proposed hypotheses and propositions; the theory behind each hypothesis; the evaluation and testing of the proposed hypotheses using statistical techniques; and concludes with evaluating the proposed hypotheses on suppliers' configuration for each of the supply networks.

On the other hand, qualitative research, and the inductive approach aligns with interpretivist (naturalistic inquiry). The inductive approach is referred to as the 'down-top' approach which involves the movement from a particular or individual observation to a broader general law. Inductive research concentrates on the researcher believing that reality could only be expressed relative to individual experience or personal understanding (Meredith, 2013). The inductive approach used in this work is detailed in Chapter 4 where a case study was

conducted, interviews, and document analysis techniques were adopted (Gill, et al., 2010; Saunders et al., 2015).

This research mixed different methods. For example, observations and interviews (qualitative data) were combined with traditional surveys (quantitative data). So the results from one method can help develop the other method. Alternatively, one method can be nested within another method to provide insight into different aspects or units of analysis. This also helps to achieve triangulating data sources - a means for seeking convergence across qualitative and quantitative methods (Frankfort-Nachmias, et al., 2014). Most importantly, mixed methods were used to overcome, neutralise or cancel the limitations and biases inherent in using a single method (Green, Caracelli, and Graham, 1989; Tashakkori and Teddlie, 1989; Campbell and Fiske 1959; Sieber, 1973).

3.7 Data collection and Sampling

3.7.1 Sample Size

Deciding the appropriate sample size depends on the kind of statistics method employed and data type, since various statistics require different assumptions of parameters. For this questionnaire, which is nominal, the proposed hypotheses in Chapter 5 are based on the frequency of occurrence of either Defenders, Prospectors, Analysers or Reactors. Therefore, the variables of the statistics tests belong to ratio types. The parametric statistical methods have been adopted for the analysis. For testing under this category, the sample size was investigated for each employed statistics method to satisfy each test as appropriate. In this case, using SPSS (statistic package for the social sciences) as a tool. It will be used to validate the hypotheses using statistical analysis: goodness-of-fit test and MANOVA at 95% Confidence Interval.

For the hypotheses based on the relationship and similarity between suppliers configurations, i.e. proportion Defenders: proportion Prospectors: proportion Analysers, for organisations that adopted the same supply network, a range of non-parametric procedures was used. A small sample size is applicable because there is no distribution estimation for the variables. These methods do not require normal distribution either, terms such as mean or standard deviation. This chi-square correlation analysis was adopted to test these hypotheses on Minitab, where the minimum sample size admitted is 3.

3.7.2 Sampling Methods

Probability sampling methods have been discussed by many researchers, these are; simple random sampling, systematic sampling, cluster sampling, stratified sampling, multistage area sampling and hybrid sampling (Fowler, 2013). Simple random sampling gives accurate samples; the systematic sampling method selects every *nth* sample in a population with a fixed sampling rate; the cluster sampling method randomly selects a sample of clusters and gets data from the selected clusters; the stratified sampling method randomly selects samples from each sub-population (stratum), which is formed according to the proportion of that stratum in the overall population and the strata should be mutually exclusive; whilst the simple random sampling works best with an accurate and easily accessible sampling frame that lists the entire population (Saunders et al., 2015).

Therefore, this research is implemented using simple random sampling; where the research population is the exact number of suppliers for each of the hub organisations. This is obtained from the hub organisation on the suppliers' directory. These suppliers include a wide ranges

of industries. There are 900 companies that currently exist as a supplier to the hub firm. At this juncture, the number of samples that should be picked up from over 900 and how to choose the samples has to be considered. Thus, the choices of the surveyed suppliers are based on their current existence as a supplier to the hub firm. Therefore, leaving the population size for 750 suppliers' for 15 production lines, this same amount of questionnaires were generated and sent through the mail. 720 were returned out of which 630 supplier questionnaires were found useful and hereby used in the analysis.

Azmi Mohd Tamil, (2012), suggests the need to calculate sample size to meet research and accepted standards. This study calculates sample size using the Sloven formula, a random sampling technique formula used to estimate sampling size, the formula is;

$n = N/ (1+Ne^2)$

Where,

n = sampling size

N = total population

e = level of confidence/error margin

To achieve 95%, e = 0.05.

From using the formula above to calculate the sample size for the population of 750 suppliers; the sample size gives 260.9. This gives 86% of the whole population 750 suppliers.

For the hub organisation sampling frame, simple random sampling was also used, to ensure that the sampling frame represents the potential population of south-western Nigeria. The Nigerian companies' online database was used to get the population to take the samples in

this research. The Nigerian online shows 90 printing industry and manufacturing companies in south-western Nigeria. This represents the potential population of the south-western Nigeria printing industry and manufacturing companies. Based on the categories of the company on the database, there are 9 manufacturing companies including printing. However, this research focuses on 4 industrial sectors which are Printing, Glass, Water bottling and Pharmaceutical companies. The choices of industry were because literature revealed that very little research has been carried out in these industries on Miles and Snow's classifications and Dai and Zhang's supply network in Nigeria.

Furthermore, in deciding how many samples should be picked out from over 90 south-western Nigeria companies, and how to choose the samples, has to be considered. First, the chosen company should be in existence, so their latest turnover should be greater than zero. Thus, the first round of the choice of the surveyed companies is based on their latest turnover. There are 50 companies whose latest turnover is more than nil. Therefore, the surveyed south-western Nigeria companies' population size of this research is 50. In order to make a random selection of samples from the whole company population, the simple random sampling method has been used in this research. According to the method of simple random sampling, 20 random numbers between 1 and 50 have been generated by Excel's mathematic function: rand ( ) the rand ( ) function can provide real random number with unified distribution between 0 and 1. The 20 samples are chosen according to the random numbers generated from Excel rand function from the database population of 50 companies. Then, questionnaires were sent to the 20 hub organisations, 16 responded, which is an 80% response rate. Out of these respondents, 4 are Reactor organisations and cannot be classified into Dai and Zhang's (2003) supply network; 4 other organisations withdrew afterwards, leaving this research to continue with 8 companies; having 15 production lines.

3.8 Quantitative Data Analysis Methods

The received responses in this research are independently and randomly generated from the underlying population, so the samples of Miles and Snow types for company exists: Defenders, Prospectors, Analysers and Reactors are independent from each other. Based on Dai and Zhang's supply network, and Miles and Snow's typology hypotheses generated in Chapter 5, various hypotheses testing methods are adopted to validate these proposed hypotheses. These tests include inferential statistics tests, multiple analysis of variance and chi-square test. These methods are used as appropriate for the analysis of each hypothesis.

To analyse a proposed hypotheses for the variance in the occurrence of Defenders, Prospectors and Analysers and Reactors suppliers, the chi-square goodness-of-fit test was used to analyse the inconsistency in the proportion of the strategic types in the south-western Nigeria industries. To analyse hypotheses for comparing inequality amongst Defenders, Prospectors and Analysers of the three supply network suppliers, a Multiple Variance Analysis was adopted. To analyse proposed hypotheses which relates to the similarity between suppliers' configuration - *Defenders: Prospectors: Analysers* for hub organisation of same supply network, a chi-square correlation analysis test was used.

To accept or reject the results of hypothesis testing, the value of alpha (α) or p-value has to be determined. The common value of alpha can either be 0.001, 0.05 and 0.10. However, for management science, the value of 0.05 and 0.10 is generally used (black 1997). However, for this research, 0.05 level is adopted. The significant level alpha (α) = 0.05.Alpha (α) with confidential Interval of 95%.

For goodness-of-fit test, when p- value > = 0.05 reject the null hypotheses; for MANOVA test when p- value > = 0.05 in variance analysis there is no significant difference in the typology

compared; for chi-square tests when p- value > = 0.05 there is association in the suppliers configuration of same supply networks.

In this research, non-parametric methods were adopted because most data types are category and nominal. The advantage of nominal is that it is suitable for small samples and exact probability (Black 1997).

3.9 Data qualities and data distribution analysis

The Kolmogorov-Smirnov test is used to decide the specific distribution of a sample from a population. To identify the data quality, the distribution and randomness of sampled data are assessed. It is adopted to evaluate if the probability distribution of Defenders, Prospectors, Analysers or Reactor suppliers belong to a specific distribution. In this research the Kolmogorov-Smirnov test was used to answer the question: Are the data from a normal distribution? (Nistsematech, 2012). This test helps to ensure that the appropriate parametric test methods are applied in the quantitative analysis. According to Pauly (1991), "without a random sample it is not possible to generalise in a scientific manner''. Since quantitative research can be generalised based on a crucial assumption that if all elements in the population are given an equal chance of being selected, then the sample is truly represented, then the research presents an accurate reflection of the population (Boslaugh, 2012). The test shows that the distribution of Defenders, Prospectors, Analysers and Reactors are normal. Therefore, MANOVA was used for the group comparison of each strategic type to the others.

3.9.1 Analysis for inequality in Defenders, Prospectors, and Analysers suppliers

Proposition 1a: the number of suppliers that are Defenders, Prospectors, and Analysers in the south-western Nigeria industry are not the same.

To verify that the four typologies exist as either Defenders, Prospectors, Analysers or Reactors typology as suppliers in each Dai and Zhang's supply networks in their underlying supplier.

These will be tested by the binomial sign test as follows:

H_0: A_d: A_p : A_a = 1:1:1

H_1: A_d : A_p: A_a =/= 1:1:1

Where,

A_d: Represents the amount of Defenders

A_p: Represents the amount of Prospectors

A_a: Represents the amount of Analysers

In this research, the exact test in SPSS, chi-square goodness-of-fit test is adopted to test the null hypotheses (Ho), where, *p- value >= 0.05 reject* the null hypotheses. The chi-square goodness-of-fit test is used to verify whether the observed frequencies for k cells are different from the expected frequencies in the population. Therefore, this method will be used to test proposition 1a. Sheskin, (2011) pointed out that to employ the chi-square goodness-of-fit test, the experiment meets three conditions: The experimental data type is categorical or nominal; the sample consists of an independent observation; and the frequency of each cell should be equal to or greater than five.

3.9.2 Analysis for the existing ratio of Dais supply network Suppliers

To verify propositions 2a, 3a, 3b, 4a, 4b, 5a, 5b and 5c.

Proposition 2a: The proportion of Reactors suppliers are less compared to Defenders, Prospectors, and Analysers suppliers companies in South western Nigeria.

Proposition 3a: In CSSN there are less proportion of Prospectors compared to Defenders and Analysers as suppliers.

Proposition 3b: In CSSN there are more proportion of Defenders compared to Prospectors and Analysers as suppliers.

Proposition 4a: In ASN there are more proportion of Prospectors compared to Defenders and Analysers organisations as suppliers.

Proposition 4b: In ASN there are more proportion of Analysers compared to Defenders as suppliers.

Proposition 5a: In MDSN there are more proportion of Analysers suppliers compared to Defenders and Prospectors suppliers.

Proposition 5b: In MDSN there are less proportion of Prospectors suppliers compared to Defenders and Analysers suppliers.

Proposition 5c: In MDSN there would be significant difference in the proportion of Defenders, Prospectors and Analysers compared to Reactors.

There is a need to verify whether there are differences in the means of the strategic typologies of suppliers compared one to another. From this comparison, it can be inferred whether there is a difference in the mean among one typology group of suppliers to the other typologies

groups of suppliers for each of the supply networks. This shows the suppliers configuration (Defenders, Prospectors, and Analysers) of each of the three supply networks.

The Multivariate analysis of variance (MANOVA), this is simply an ANOVA with several dependent variables. MANOVA tests for the difference in two or more *vectors* of means. The test compares whether the means of suppliers of the same strategic group is significantly different from the means of suppliers of other strategic groups. It has several advantages over ANOVA. First, by measuring several dependent variables in a single experiment, there is a better chance of discovering which factor is truly important. Second, it can protect against errors that might occur if multiple ANOVA's were conducted independently. Additionally, it can reveal differences not discovered by ANOVA tests.

The main Research Objectives in using MANOVA to determine is;

- To investigate if the suppliers in the supply networks can be any of Miles and Snow's (M&S) four typologies: Defenders, Prospectors, Analysers or Reactors.
- To identify if the majority of the suppliers of the Multiple Driven, Cost Saver and Adapter supply networks have the same strategic typology as their hub organisation.
- To investigate the strategic typology that is dominant within the supply networks.

3.9.3 Analysis for comparing the proportion of Suppliers typology types

Proposition 6a: In Cost Saver supply networks, the occurrence of Defenders as suppliers are higher than Analysers, and the occurrence of Analysers are greater than Prospectors, and this configuration will be the same for all CSSNs.

Proposition 6b: In Adapter supply networks, the occurrence of Prospectors as suppliers are higher than Analysers, and the occurrence of Analysers are greater than Defenders.

Proposition 6c: In Multiple Driven supply networks the occurrence of Analysers as suppliers are higher than Defenders, and the occurrence of Defenders are greater than Prospectors.

Correlation analysis is an inferential statistical technique used to show how variables are related one to another (Pallant, 2010). The chi-square test for homogeneity is to verify whether the y samples are homogeneous with the proportion of observation. The chi-square test for homogeneity is used when y independent samples (where y $\geq$2) are categorized on a single dimension, which consist of c categories (where c $\geq$ 2) (Sheskin, 2004). The test for homogeneity is evaluating the equality of several populations of categorical data. The test asked whether 3 or more populations are equal with respect to some characteristics. However, the chi-square test for y x c table needs to meet three conditions of category or normal data, the random sample consists of independent observations. The frequency in each cell in the contingency table is equal to or greater than 5. Cochran states that the chi-square test for 2x 2 contingency table should be employed when the sampled size (n) is smaller than 20 (n, 20), and the frequency in each cell should be equal to or greater than 5, when 20, n, 40 (Sheskin, 2004). The chi-square homogeneity test is binominal. The hypothesis testing methods for two or more independent samples is therefore appropriate. The chi-square test of association is used to determine whether one variable is associated with a different variable.

Therefore, The Minitab – chi-square test can be used to test Propositions 6a, 6b, and 6c, whether the Defenders, Prospectors and Analysers configuration are similar or equal or

homogeneous in some characteristics for each specific supply network suppliers. These propositions satisfy the following objectives; to study the Multiple Driven, Cost Saver and Adapter supply networks and the interrelationships between each supply network. The necessary results for analysis is the p-value when, p-value < 0.05 then there exists no relationship amongst the configurations of the supply network.

3.10 Qualitative Research Methods

One of the advantages of qualitative analysis is that it describes the trend of events in the research. It has been argued by some sections of researchers that, the significance of statistics test results only give statistical significance guide and inference. However Porter (1996), pointed out the need for researchers to find substantive significance, claiming that substantive significance is more important than statistical significance.

Therefore, the qualitative research is used to verify the significant and non-significant indications of this study. Thus, the detailed explanations as to why this research used qualitative analysis are presented in Section 3.10.1, the Research Approach 3.10.2, Data Collection 3.10.3, the interview method is selected to collect qualitative data and the potential reasons are; the design of interview questions is discussed in Section 3.10.4, and the adopted qualitative analysis methods are evaluated in Section 3.10.5.

3.10.1 Why use qualitative methods

Qualitative research is a phenomenon that is intended to give an explanation and further builds a theory that cannot be measured in numerical terms (Chrisman 1989; Strauss and Corbin 1990). *As stated by Miles and Huberman (1994) qualitative data are useful to "explain, illuminate, validate, supplement or reinterpret" quantitative data gathered from the similar setting*. Potter (1996) argued that the qualitative method is superior to the quantitative method for interpreting the meaning and giving details of something. Miles and Huberman (1994), took a middle ground between qualitative data and quantitative data by mentioning the benefits of the linkage between both. These are to provide *fresh insight*, *enable confirmation* and *provide fuller in-depth details.*

In this research, reasons why the hypotheses in Chapter 5 can be verified are explained by the qualitative fieldwork. If the statistical analysis result say that the hypothesis is right - verified, or wrong - not verified, the quantitative data cannot explain why. Therefore, the qualitative research is essential for this research to overcome the weakness of quantitative work.

3.10.2 Data collection and Interview question design

Interviews provide a comprehensive source of material if used properly, and have been accepted as one of the most popular forms of data collection (Lindon and Meyer, 1987; Jackowaski and Wester, 1991; Potter 1996; White 2000), and a reliable source of gathering valid data (Saunders et al., 2015). When compared to questionnaires, interviews best deal with complex topics whilst providing insight into the measurement situation (Kervin, 1992). Since this research aims to explore the hypotheses, which are already validated by the quantitative analysis, and to find the relevant reasons to back up the results; the use of interview is the appropriate method for the qualitative data collection of this work.

Marshall, and Rossman, (2015), describes qualitative in-depth interviews as much more like conversations compared to formal, structured interviews. This involves the researcher exploring a few general topics to uncover the participant's interpretation and perspective of the subject, whilst respecting the way participants structure and frame their responses' (Potter 1996). Interviews are used to further explore and buttress the hypotheses and findings in the quantitative analysis. Therefore, the qualitative interview questions are designed into four (4) catalogues respectively. First, the identification of a firm's general information, followed by supplier typology questions, the supply network questions and lastly the relationship between hub suppliers and performance.

The information this interview aims to get is: *the identification of a firm's general information* i.e. to confirm which Miles and Snow type a company belongs to. Also, to confirm that the self-typing method has accurately recognised to which Miles and Snow type the organisation belongs. This is *followed by supplier typology questions* to clarify the main reason why a firm prefers certain suppliers to others. Then the Supply Network *questions- more details on why* some specific preferences for suppliers types are clarified in detail; the effect which suppliers' choices have on hub performances, and to ascertain the interrelationship between hub suppliers and performance, i.e. if the hub is dependent on supplier or suppliers on the hub, and the effect on performance.

Personal interview is appropriate for this research because face to face communication clears up most misunderstanding, and also allows both parties to question immediately any issues they are unsure of during the interview. However, this is time and money consuming, whereas

telephone interviews have a lower cost than personal interviews (Cooper and Schindleer, 2001). Therefore, due to this research budget and the request of the surveyed companies, both personal interviews and telephone interviews are adopted.

3.10.3 Qualitative Analysis Methods

Qualitative analysis helps in gathering information and the verification of existing data, and adds to drawing conclusions for the investigation (Potter, 1996). It enhances content analysis, which assists in the evaluation of the results from the analysis of data and testing of the hypothesis, whilst providing emphasis that even the qualitative data does not provide (Carney, 1972). Quotations have been adopted by researchers as a means of presentation (Lewis 1991, Potter 1996), since "quotations best conveys the meaning of the situation" (Potter 1996).

Thus, quotations will be used as the evidence to support arguments in this research. According to Miles, et al., (2013), the two types of qualitative analysis methods are within - case and cross-case analysis. These analysis methods can be used either during or after collection. The concept of *case* depicts boundary of a context. The case can either be an individual in a setting, a small group, or a large unit such as a community department or organisation. (Miles, et al., 2013). Within-case analysis in case study research is the in-depth exploration of a single case as a stand-alone entity, or to find out the specific. The aim of within-case analysis is in-depth understanding and description of the phenomenon under study (Paterson, 2010). Thus, the group analysis is to explore the characteristic hub and to ascertain classification of hubs into Defenders, Prospectors or Analysers in Dai and Zhang's supply network.

Cross-case analysis is a research method that facilitates the comparison of commonalities and differences in the events, activities and processes that are the units of analyses in case studies. Engaging in this analysis extends the investigator's expertise beyond the single case. It provokes the researcher's imagination, prompts new questions, reveals new dimensions, makes sense of puzzling or unique findings, or further articulates the concepts, hypotheses or theories discovered or constructed from the original case (Stretton, 1969; Ragin, 1997; Eckstein, 2002; Khan and Wynsberghe, 2008). The cross-case analysis was adopted in deepening the understanding and enhancing generalisability of the hypotheses and findings around *Defenders, Prospectors* and *Analysers* supplier configurations for the Cost Saver, Adapter and Multiple Driven supply networks. This analysis is carried out based on the relevant quotations from interviews.

3.11 Summary

This chapter describes the questionnaire as the quantitative method and the interview as the qualitative method. The questions entailed in the questionnaire and their link to this research aims and objectives are presented. The process about how the questions for interview samples are extracted from questionnaires, where the questionnaires were sent, and about interviewees, have been explained step by step. Additionally, goodness-of-fit test, chi-square test and MANOVA test, the analysis methods for the data, have been discussed. Interview analysis methods data, which are within-group analysis and between-group analyses are chosen, and how it is adopted for this research, is explained. In Chapter 4 Case Study and Chapter 5 Hypotheses, the analysis methods mentioned in this chapter are used to analyse the quantitative and qualitative fieldwork results and to test the proposed hypotheses.

Chapter 4: Case Study

4.1 Introduction

This chapter presents a case study of 8 hub organisations and their supply network, which delves into the 15 supply lines considered in this research. In Planet Earth Printing Company the supply lines considered are; *Planet Earth Catalogue Printing and Planet Earth Calendar Printing;* In Nigeria Distilleries Limited (NDL) the supply lines considered are; *Grand Oak Lord Dry Gin and Grand Oak Bacchus Lite;* In May & Baker Nigeria Plc the supply line considered is; *May and Baker Lily Spring Water;* In Gablek Reproduction & Print Limited the supply lines considered are; *Gablek Light Weight Packaging Printing, Gablek Wine Tonic Label Printing, Gablek Seamann Label Printing and Gablek Bank Teller Printing;* In Ashney Printing press the supply line considered is; *Ashney box packaging*; In Intercontinental Distilleries Limited (IDL) the supply lines considered are; *Veleta sparkling fruit drink and Chelsea dry gin; In* Living Proof Press Limited the supply lines considered are; *Living Proof Textbook Printing and Living Proof Magazine Printing* and In BET Glass Company plc the supply line considered is *Wine bottles production.*

Case study is adopted as an empirical inquiry to investigate a contemporary phenomenon within its real life context (Yin 1994:13). This chapter is divided into three phases, the first describes each hub organisation's Miles and Snow strategic typology, which in turn validates the Dai and Zhang supply network it belongs to, as discussed in Chapter 2. If the hub is a Defenders organisation it belongs to Cost Saver supply network; if the hub is a Prospectors organisation then it is an Adapter's supply network, and if the hub is an Analysers organisation it is a Multiple Driven supply network. This case study is based on semi-structured interviews, and multiple data sources such as document examination, administrative reports and news clippings. Questionnaires were also used as a third data

gathering tool to affirm the strategic types of hub organisations, the supplier *Defenders, Prospectors or Analysers.* (See Chapter 3 Methodology for details). The second focus is on suppliers configuration for ratio *(Defenders: Prospector: Analysers)* of the suppliers, interviews and discussions on why each supply networks prefers particular types of suppliers; and also presents the reasons for different suppliers configuration for the 3 types of supply network. In conclusion, the chapter compares the suppliers' configurations of Multiple Driven, Cost Saver and Adapter supply networks, and suggests the configuration for each of these supply networks as deduced from the case study.

4.2 Nigerian South West Region Overview

The core organisations adopted for this study are situated in the South Western region of Nigeria. A map of South Western Nigeria is shown in Figure 4.1 below, and also indicates the location of the each of these organisations.

Figure 4.1: South Western Nigeria map

Five of the organisations are located in Lagos State and three in Ogun State, Nigeria. These organisations source their products directly from suppliers which are also referred to as spokes organisations in this research. Nine of these supply lines are categorised as Multiple

Driven supply networks, three as Cost Saver supply networks and three Adapter supply networks. The research is spread across 4 industries; 4 printing organisations, 2 distilleries, 1 bottle making and 1 bottled water production. This enables for comparison of characteristics and configuration of the same supply networks and between the different supply networks.

S/N	Hub Organisation	Supply Network	Industry	No of Spokes	City
1	Planet Earth Catalogue	MDSN	Printing	63	Lagos
2	Planet Earth calendar	MDSN	Printing	60	Lagos
3	Grand Oak Lord Gin	MDSN	Distillery	53	Lagos
4	Grand Oak Bacchus	MDSN	Distillery	42	Lagos
5	May and Baker	MDSN	Water Bottling	28	Lagos
6	Gablek Lightweight Packaging	MDSN	Printing	50	Lagos
7	Gablek Wine Tonic Label	MDSN	Printing	48	Lagos
8	Gablek Seamann Label	MDSN	Printing	55	Lagos
9	Gablek Bank Teller	MDSN	Printing	49	Lagos
10	Living Proof Textbook	CSSN	Printing	14	Ogun
11	Living Proof Magazine	CSSN	Printing	14	Ogun
12	BET Glass	CSSN	Bottles production	15	Ogun
13	Ashney Printing Press	ASN	Printing	49	Lagos
14	International Distilleries Limited (alcoholic)	ASN	Distillery	42	Ogun
15	International Distilleries Limited (non-alcoholic)	ASN	Distillery	48	Ogun

Table 4.1: Hub and Number of Suppliers' Organisations

4.3 Multiple Driven Supply Networks

In this section, the nine Multiple Driven supply networks describes each hub organisation's typology, goes on to describe their suppliers' configuration and then discusses the

interrelationship between hub organisations, supplier's configuration. This helped to presents reasons behind the choices of this supply networks suppliers and supplier's configuration.

4.3.1 Planet Earth Printing Company

Planet Earth Printing Company is involved in large scale printing, and combines both direct imaging and conventional printing that relies on printing plate making methods. It is a small sized company with an average of 70 workers. The company was incorporated on 9th April 2001. This organisation tries to locate new customers while ensuring that it does not lose the market it has already established and occupied. This involves merging and maintaining Direct imaging printing technology with Offset lithographic. A new technology is not absorbed until it is adequately proven to be fruitful and has yielded positively to other printing firms. This is a way of avoiding risks, incurring loss and maintaining stability. There is consistent effort put in place to harmonise this organisation's adopted structure and their chosen technologies in order to accommodate both the stable and changing market. Planet Earth produces catalogues all year round, while the production of calendars, which is seasonal, is at the beginning of the year. These two productions lines are studied in this research. Managers said 'Investment is heavy on marketing', their productions are not so rigid but combine other types of printing to the stable ones. These can either be printed in the conventional or latest technology based on preferred customer specifications. The company employs the tactics of buying materials on demand while the general materials, such as necessary chemicals and machine spare parts, are sometimes stored to meet the demands of the stable customers. Planet Earth Printing is of the Analysers typology of Miles and Snow and does not intend to change its strategy within the next three years. This reveals that the firm is thriving in its exploiting of new markets while maintaining its domain of catalogues and calendars production. According to the manager 'the company is very profitable with large turnover'.

4.3.1.1 Planet Earth Suppliers Configuration

The table below shows the configuration Planet Earth Catalogue and Planet Earth Calendar Printing.

Suppliers Typology	Planet Earth Catalogue	Planet Earth Calendar	Planet Earth Catalogue	Planet Earth Calendar
Defenders	16	14	26 **%**	23**%**
Prospectors	9	9	14 **%**	15**%**
Analysers	38	37	60 **%**	62**%**
Total	**63**	**60**	**100 %**	**100%**

Table 4.2: Planet Earth Suppliers' Configuration

Table 4.2 above shows the configuration of Planet Earth Printing company, using Defenders: Prospectors: Analysers. From the table above, the percentage of occurrences of the typologies in Planet Earth Catalogue and Planet Earth Calendar are (26%, 14%, 60%) and (23%, 15%, 62%) respectively. The highest number of Suppliers organisation in the configuration are Analysers with (60% and 62%); this is followed by Defenders (26% and 23%) the lowest proportion being Prospectors (14% and 15%). From these the ratio (1.9: 1: 4.3) and (1.5: 1: 4.1) were deduced for Planet Earth Catalogue and Planet Earth Calendar respectively.

4.3.2 Nigeria Distilleries Limited *(NDL)* - Grand Oak Limited

NDL started on the 6th of March 1961 with solely Nigerian ownership. It is the largest wine and spirits producing company in Nigeria, exclusively devoted to the manufacturing and marketing of fourteen brands of alcoholic and non-alcoholic beverages in 35 different pack sizes. The company caters for the needs of alcoholic and non-alcoholic drinks consumers ensuring that these drinks are available to customers at any needed time. These drinks include *St. Lauren alcoholic, St. Lauren non-alcoholic, Calypso Coconut Liqueur, Dark Sailor Rum, Swagga Bitters, Lord's dry Gin, Seaman's Schnapps, Crown Gin, Regal dry gin, Bacchus*

Wine (alcoholic) and Bacchus Lite. The company has more than one thousand (1000) employees and has a philosophy of nurturing local personnel through training and exposure to modern equipment. The company has achieved phenomenal growth from inception, through the quality of its workforce. The current beverage capacity of the company is ten million litres per year with distribution outlets spread across the country.

There is high demand for both Seamans Schnapps & Dry Gins drinks, which are produced all year round to meet continuous public demand. This is Nigeria's bestselling schnapps brand, used at every traditional and cultural festival and popularly called *the prayer Schnapps*. The non-alcoholic drinks are mostly seasonal in production such as Bacchus Lite and St. Lauren, a non-alcoholic drink produced to meet the Christmas, Easter and the Muslim faithful in the Holy month of Ramadan.

As demand for their products increased, the firm delved into intensive research which has expanded and improved their product range and quality level to satisfy customers and meet the high demand for products. The organisation makes heavy investments in marketing and distributes to every state of the country. It is a profitable firm that doesn't like its new products to fail even in short run**.** This has landed the company as the best brand of beverages and a foremost leader in the alcoholic and non-alcoholic beverage segment of the Food and Beverage Industry in Nigeria. The organisation also produces sales of alcoholic beverages in 20cl PET bottles and 3cl sachets, offering its beverages in the Cool Twista range of packaging. Cool Twista deploys a unique single-fill technology and comes in a stylish and trendy pack, which enables the on-the-go customer to add a twist to their day and enjoy their preferred beverages. It also produces some other drinks of various flavours. These are not constant as they are chosen depending on market demands, especially during the dry-hot season in Nigeria. The

organisation carefully chooses to delve into this because of the low risk involved and high demands around this time. This strategy certifies the huge sales turnover for the company.

NDL has a promising outlook derived from its business strategies and focus which is to focus on continued research to find new, favourable markets, while maintaining the stable alcoholic gin. Appropriating the right technology to its current market is stable and the new emerging or imitated drink. This organisation was formerly a Defenders, producing Seaman's Aromatic Schnapps and Lord's Dry Gin alone for many years, but now it is an Analysers hoping to maintain this strategy in the coming years. The company ensures that it matches the drinks introduced by its rivals and by introducing similar to attract more consumers to its products.

4.3.2.1 Grand Oak Limited Configuration

Suppliers Typology	Grand Oak Lord's Dry Gin	Grand Oak Bacchus Lite	Grand Oak Lord's Dry Gin	Grand Oak Bacchus Lite
Defenders	12	9	23%	23%
Prospectors	6	5	11%	12%
Analysers	35	28	66%	67%
Total	**53**	**42**	**100%**	**100%**

Table 4.3: Grand Oak Suppliers' Organisation Configuration

In Table 4.3, the suppliers' configuration for Grand Oak Lord's Dry Gin and Grand Oak Bacchus are (23%, 11%, 66%) and (23%, 12%, 67%). Analysers' suppliers are highest with (66% and 67%) respectively, followed by Defender with the second highest in occurrence of Grand Oak Lord's Dry Gin (23%) and Grand Oak Bacchus Lite (23%), and the least suppliers are Prospectors with (11%) and (12%). From the table above, Grand Oak Lord's Dry Gin and Grand Oak Bacchus Lite's ratio of suppliers' organisations using (Defenders: Prospectors: Analysers) are (2:1:6) and (1.9 :1:5.6).

4.3.3 May & Baker Nigeria Plc

May and Baker has been in operation since 1944. It was founded precisely on September 4, 1944 as Nigeria's first pharmaceutical company. It originated from England in 1834, and was later transformed into a mega-European conglomerate through a web of mergers and acquisitions over the years. Consequently, the name of the company has changed at different times and today, only the Nigerian offshoot is known by the original name. For many years expatriates sent by the parent company managed May & Baker Nigeria but, in 1997, the first indigenous Managing Director/Chief Executive Officer, Joseph Ikemefuna Odumodu, was appointed. May & Baker Nigeria Plc aims at becoming one of the largest conglomerates in Nigeria by the year 2020. The organisation is large and according to the one of the managers, the firm is said to be very profitable. The firm deals with *human pharmaceuticals, laboratory and photographic chemicals, horticultural* and *veterinary products*, and bottled water. Some of its early products include *Quinacrine (Anti-malarial), Gonazole (antibiotic), Soneryl (sedative) Ephedrine, Sulphonamides, Nivaquine (anti–malarial) and Rovamycine (a veterinary product).* It supplies its products to Federal Government Hospitals, State Government Hospitals, Medical Centres, and Private Hospitals nationwide. Having climbed to pre-eminence on the back of well-known *anti-malarial drugs* and *Sulphonamides,* the company has since taken leadership positions in the *Biological (Vaccines), Oncology (Cancer drugs)* and the *Anti-infective* markets and is achieving a steady growth in its share of the *Analgesics* and *Anti-hypertensive* markets. In 1992, the company re-organised its business to concentrate on *human pharmaceuticals* and *human vaccines.* Bottled water production increased, and serves as a good source of gain due to the hot weather in Africa, and the introduction of Indomie noodles was accepted into the market. The organisation delved into Nigeria’s finest brand of noodles called Mimee. In 2001, it moved into the market with the introduction of Lily Table Water, and in 2006 joined the foods business with the construction of an ultra-modern pasta food-processing factory in Ota, Ogun State. The manager said the

organisation does not do long-term planning, but seeks flexibility that can allow them to delve into another market. The round the year products are noodles, waters, and Panadol, and they invest heavily in marketing and engineering.

May and Baker has continually found itself in a position where it is researching (such as emerging solutions to various illnesses), and occasionally introducing new products into the market after its is proven to be advantageous. Proper research leads to introduction of products that capture the intended market segment, leading to growth in sales and a quest for new products. The firm continually acquire skills and technology to fit into their new areas, as presented by their research, whilst maintaining efficiency in its operations and coordination. This is achieved by avoiding situations that may result from putting emphasis on the new products being launched, and forgetting to maintain the levels of efficiency that have maintained the current market that the organisation serves, as well as maintaining a structure that ensures the new products developed are well marketed, and introduced into the market in a manner that creates awareness and demand for them. The company has adopted the Analysers typology and aims at capturing emerging markets without jeopardising its current market. This research centres on the Lily bottling water supply line of May and Baker.

4.3.3.1 May and Baker Spring Water Suppliers Configuration

Table 4.4 shows the numbers of occurrence of Defenders, Prospectors and Analysers in May and Baker.

Suppliers Typology	May and Baker	May and Baker
Defenders	7	25%
Prospectors	2	7%
Analysers	19	68%
Total	**28**	**100%**

Table 4.4: May and Baker Suppliers Configuration

As revealed in Table 4.4 above, the suppliers' configuration for May and Baker (Lily) Spring Water Suppliers is (25%, 7%, 68%). Having the highest occurrence as Analysers suppliers and the lowest as Prospectors. The ratio of May and Baker Spring water Suppliers organisations are therefore (3.6: 1: 9. 7).

4.3.4 Gablek Reproduction & Print Limited

Gablek Reproduction & Print Limited was incorporated as a private limited liability company on 22nd April 1988 under the Companies Act 1968. It was able to adapt and grow with the changing environment into one of the trusted names in the printing industry in Nigeria. It is a small company with about 50 Staff. It is committed to providing impressive service in line with the latest technological trends and conventional technologies. Through the years of constant change in the media, market demand and drastic changes in technology, it still held on to conventional printing processes.

Gablek is a commercial general printing organisation, specialised in Offset Lithographic Printing, Die cutting facilities, and other finishing equipment for special jobs, focussed mostly on production of *Wine Labels, Light Packaging, Schnapps Labels, Tonic Wine Labels,*

Brochures, Catalogues, Handbills, Posters, Magazine, and Sensitive Security Documents like Bank Tellers and Withdrawal Slips for Banks. These supply lines are considered in this research.

Gablek exploits and locates emerging market design and embellishment, which most of the time comes with associated technology. The company maintains the technology for the traditional printing market, while adopting accompanying ones for the new market technology after it has been proven to be successful by other printing firms. The technology adopted in recent times is the Light Packaging for pharmaceutical industries, and Hot Foiling for both packages and labels. According to Mr Olusanjo, the company's Production Manager, the firm is satisfied with what they have, however, marketing is enforced with integrity maintenance. Marketing plans are directed towards manufacturing industries which are continuous; packages and labels, with little time devoted to seasonal jobs, like calendars, dairies, greeting cards to supplement the stable jobs for the year.

4.3.4.1 Gablek Printing Configuration

The table below shows the suppliers occurrence of Miles and Snow typology (1978) in Gablek Printing Company.

Suppliers *Typology*	Gablek ***Light Weight Packaging***	Gablek ***Wine Tonic Label***	Gablek ***Seamann Label***	Gablek ***Bank Teller***	Gablek ***Light Weight Packaging***	Gablek ***Wine Tonic Label***	Gablek ***Seamann Label***	Gablek ***Bank Teller***
Defenders	13	*12*	13	13	26%	25%	23%	27%
Prospectors	7	*7*	8	7	14%	15%	15%	14%
Analysers	30	*29*	34	29	60%	60%	62%	59%
Total	**50**	**48**	**55**	**49**	**100%**	**100%**	**100%**	**100%**

Table 4.5: Gablek Printing Press Suppliers' Configuration

The table above shows suppliers percentage configuration for Gablek Light Weight Packaging Printing (26%, 14%, 60%), Gablek Wine Tonic Label Printing (25%, 15%, 60%), Gablek Seamann Label Printing (23%, 15%, 62%), Gablek Bank Teller Printing (27%, 14%, 59%) and the ratio of these organisations are (1.8:1:4.3), (1.7:1:4), (1.5:1:4.1) and (1.9:1:4.2) respectively. Gablek has the highest number of Analysers suppliers; followed by Defenders suppliers and the lowest occurrence are Prospectors suppliers.

4. 4 Multiple Driven Supply Network, Analysers Hub and Suppliers

From the above description, these Analyser firms focus on locating and exploiting new products and market opportunities while simultaneously maintaining a core of traditional products and customers. The firm moves towards a market after it has been proved achievable, focuses on imitation, and adopts a second but better strategy. Hence, these hub organisations are Analysers, categorised as Multiple Driven supply networks of Dai and Zhang's model. From the questionnaire grouping of suppliers as shown above, in this supply network the highest occurrences of suppliers are Analysers followed by Defenders, with Prospectors as the lowest.

Preference for Mixed Characteristics in Suppliers

Dai and Zhang (2008) pointed out that Multiple Driven supply network partners are from a wide variety of strategic types; and that the hub organisation is characterised by effectiveness and efficiency. Also, the analysis above shows that Multiple Driven supply networks have a mix of Miles and Snow's strategic types as suppliers. Described below are the reasons for these varieties of choices of suppliers, drawn from the responses of manager interviewees of each of the hub organisations;

May and Baker Spring Water prefers suppliers that are prompt to business …"Yes, We need suppliers that can be quick to change with the market and meet the needs for any of our new products samples (prototype)".

May and Baker Spring Water pointed out the need for quick delivery …. "High priority to on time and quality delivery. We do not mind paying extra to get the quality we want and stay ahead of our competitors".

Planet Earth Catalogue Printing stated: "Yes we do our best to get suppliers that deliver good quality …..".

Grand Oak Bacchus Lite, preference for quality…"drinks production is lucrative during dry season… of course we try to beat our competitors by producing similar ones, yes we have suppliers that are loyal to us and meet our unique needs or specification.....Sometimes when we pick a new drink we have to design the presentation and sometimes order things from

abroad… this is not always cheap, however we order abroad when we don't find the quality we want around us…. Yes we have succeeded in taking over markets in the past and we will do it again".

Gablek Light Weight Packaging ... "Yes, we will say quality is a priority. We don't mind paying more on raw materials to achieve our …. But we try to maintain a good number of suppliers that can keep up to our priority."

Adoption of Suppliers of Different typologies

May and Baker Spring Water… "Yes we have our standards … we inform suppliers of our standards but not all meet up ……. Some supply some of our major materials…what then, can we do…"

According to Planet Earth Catalogue Printing it is not possible to have suppliers of the same characteristics… Planet Earth Catalogue Printing pointed out that: "some suppliers have similar traits but … still different in their characteristics (delivery time, quality and others)".

Planet Earth Catalogue Printing added that it is sometimes challenging to change suppliers and clearly states: "Yes …. we change suppliers when we have a better replacement for them. This is not very easy, especially when we had worked together for a while…".

Grand Oak Bacchus Lite states that the suppliers are different …. "As much as we try to get all suppliers to step up to our standards, there are still differences in their responses (quality, delivery times and quantity amongst other factors) working with us".

Gablek Light Weight Packaging "We have a combination of different suppliers with their unique ways….. we got rid of some…… so difficult to get all to keep up. It is a mix of what we find best for us".

The responses from these Multiple Driven Supply Network hub organisations are clear evidence that the organisations have a mix of suppliers and cannot have all suppliers having the same typology.

4.5 Adapter Supply Networks

This section discusses the Adapter supply networks, hub organisations typology, the suppliers' configuration and the interrelationship between hub organisation, suppliers' configuration and performances.

4.5.1 Intercontinental Distillers Limited (IDL)

IDL are producers and marketers of alcoholic and non-alcoholic beverages. The operations of IDL are manned by time tested professionals in the business and in the industry. Intercontinental Distillers Limited started back in 1749 when two Italians, Justerini and Brooks came together and formed a wine and spirit business which they named J&B.

The organisation went through a series of acquisitions and ownerships and was later known as International Distillers & Vintners (IDV), a spirit division of the then Grand Metropolitan Plc of the United Kingdom. Grand Metropolitan Plc refocused their business strategy with the intention of capturing the International Market. This gave rise to the incorporation of International Distillers Nigeria Limited (IDNL) in 1983. Over the years, the size of the company grew through the development of a wide ranging portfolio of successful brands. It relies on the comprehensive understanding of the spirit market and Nigerian wines of the West African sub–region. In 1997, International Distillers Nigeria limited transformed into Intercontinental Distillers Limited (IDL). Currently, *IDL produces and markets such leading products as Veleta Sparkling Fruit Drink (Peach, Red and White variants) Teezers (Exotic, Ginger and Lime), Derok Café Liqueur, Chelsea London Dry Gin, Squadron, Dark Rum, Eagle Aromatic Schnapps, Bull Dark Rum, Commodore Aromatic Schnapps, Finlay's Tonic Wine, Bull London Dry Gin, Samba Coconut Liqueur,* and *Action Bitters.*

They have a network of branches and distributors that covers the entire nation. The operations of the company are from regional offices which are complemented by forty one (41) depot locations. Maintaining a network of mobile salesmen and executives based at the organisation's various depots and a wide spread of distributors spread all over Nigeria. The organisation claims to be customer-oriented and built on innovation, by creating and maintaining an open but challenging environment that allows initiatives and ideas to flourish to thrive in the market. Their choices of workers are skilled, developed, and well-motivated.

However, this study considers Veleta Sparking Fruit Drink and Chelsea Dry Gin. This organisation fits perfectly into the Prospectors typology. The company increases its consumer base through research and development to produce a wide range of products meant to cater for the diverse needs of consumers, which, combined with aggressive merging, expansion, advertisements and collaboration achieve their purpose.

4.5.1.1 Intercontinental Distillers Limited (IDL) Configuration

Suppliers Typology	Veleta Sparking Fruit	Veleta Sparking Fruit	Chelsea Dry Gin	Chelsea Dry Gin
Defenders	2	5%	3	6%
Prospectors	26	62%	35	73%
Analysers	14	33%	10	21%
Total	42	100%	48	100%

Table 4:6: Intercontinental Distiller's Limited Suppliers' Configuration

Table 4:6, shows the ratio for Veleta Sparking Fruit Drink and Chelsea Dry Gin are (1:12.4:6.6), (1:11.7:3.5) respectively, and the highest percentages of Prospectors' suppliers are (62%, 73%), followed by Analysers (21%, 33%) and the lowest as Defenders (5%, 6%).

4.5.2 Ashney Printing Press

Ashney was founded in the year 2004 with a company size ranging from 51-200 employees. The company is noted for research and development abilities; it goes for the new products first and then organises around them; and so the organisation has many divisions. The organisation is privately held and supplies premium quality copier paper, Ashney Virgin Kopier and all types of high graphic industrial materials. Ashney produces large packaging (carton-boxes), has moved into various fields and markets to make the company outstanding. This includes dealing in stationery, printing and packaging, high graphic corrugated boxes and embracing various technologies to achieve their aim to be the first in market. The printing aspect of this firm takes a range of printing jobs including packaging, text books, calendars, diaries and commercial printing like greeting cards, and wedding invites, amongst others. This research focuses on the box packaging aspect of their production line. The latest printing technology adopted by Ashney is the printing of labels using reel technology. The firm

explores new trends in printing, the latest designs in production, and ensures that the necessary technology is in place to achieve them.

4.5.2.1 Ashney Printing Press Configuration

Suppliers Typology	Ashney Press	Ashney Press
Defenders	2	4%
Prospectors	30	61%
Analysers	17	35%
Total	49	100%

Table 4.7: Ashney Printing Press Suppliers' Configuration

The Ashney Printing's highest occurrences of suppliers are with 61% of Prospectors; followed by Analysers at 35% and the least as Defenders with 4%. The table above shows the ratio of Ashney suppliers using (Defender: Prospector: Analyser) as (1:15.3:9).

4.6 Adapter Supply Network (ASN), Prospectors Hub and Suppliers

From the above analysis of Intercontinental Distillers Limited (IDL) and Ashney Printing Press, these organisations are constantly in pursuit of new product development strategies, responding very fast to newly developing market threats. Therefore these hub organisations are categorised as Adapter supply network of Dai and Zhang's model. Also, the findings show that in this supply network, the highest occurrences are Prospectors suppliers followed by Analysers suppliers and the least occurrence are Defenders.

Preference for Effective Supplier

Dai and Zhang (2008) proposes that most Adapter supply network partners are from a wide varieties of strategic types; the hub organisation of this network emphasises flexibility and innovation and adopt prototypical technologies. From the supply network suppliers configuration analysed earlier, the highest occurrence of suppliers are Prospectors. Responses from manager interviewees unveils a mix in suppliers' strategic types and why most suppliers are Prospector in Adapter supply network;

International Distilleries Limited pointed out the need for cost efficiency but prioritise effectiveness. International Distilleries Limited states: "We want to reduce cost as much as possible ……but must meet the required specification that meet the present need…."

International Distilleries Limited further explains the need for suppliers that are effective…. International Distilleries Limited added: "We love to be the first to produce a variety of drinks … Yes, we need suppliers who can quickly satisfy our new packaging's bottles or cans to meet every new drink….also added that ….. Yes we want to get to the market as soon as possible so lateness in delivery is a No, No".

Ashney Printing Press states….. "We appreciate suppliers that can deliver materials to meet any changes in specification,…..as we do a lot of printing work that needs diverse material ranging from paper type bindings, embellishments and many others…… this saves us the time for looking for new suppliers for our varying printing job".

Prospectors seldom try to attain high levels of stability and efficiency in their production and distribution systems. However, the results above show their need for effective supplier (Prospectors). This is in accordance with Miles and Snow (2003) that Prospectors operate a

dynamic domain that seeks to create new products and as such there is a need for flexibility in all of its operations.

Preference for Cost Efficient Supplier

In the Adapter Supply Network, the Prospectors hub emphasises saving costs to compete in the market. However, cost efficiency is not their domain for competitive advantage (Dai and Zhang, 2008). Responses from interviewees of each of the hub organisations shows the reasons for having cost efficient suppliers;

International Distilleries Limited states…"Yes we want supplies with low cost …. We produce different drinks and also smaller ones in sachet, we make it affordable to all and it sells fast…. we need agile suppliers to satisfy our changing needs, this is of great priority".

Ashney Printing Press, pointed out the need for reduced cost on materials,

Ashney Printing Press clearly states: "we print different things most times we don't get low priced materials because of scarcity of some of the materials in the market, it is high priced."

The findings of this research also validates that Prospectors hub organisation adopts cost efficiency in their choices of suppliers.

Supplier's mix in Adapter Supply Network

As pointed out earlier, Adapter supply network partners are from a wide variety of strategic types. These interview responses reveal how Adapter supply networks ended up having a mix of Miles and Snow's strategic types as suppliers; and why the hub organisations have more preference for Prospector suppliers that best satisfies their effectiveness;

International Distilleries Limited "Yes, we have suppliers that move with our trend but not all …some are just where they have been for years …."

Ashney Printing Press, "We do not intend to have all of our suppliers having the same characteristics ….. I think that all suppliers have their pros and cons".

Ashney Printing Press, "We print various things and make sure we have the machine and resources to satisfy most of our customers. We do not want to turn down a customer simply because we do not have the facility".

4.7 Cost Saver Supply Network

4.7.1 Living Proof Press Limited

Living Proof is a printing press which has been in existence for over ten years with the sole aim of affecting creativity in the printing industry by providing professional and quality printing services. It was incorporated under the Companies and Allied Matters Act of 1990 on 18th September 1992 as a printing press with its major in commercial printing. Their vision is to be an industry leader in the provision of solely commercial printing services. Their speciality is full colour printing, ranging from single/multicolour specials to full colour to full colour plus specials, and hope to provide their customers with high quality service, delivered on time, at a fair price, in an ethical manner. The organisation's strength lies in a team made up of professionals who believe in adding value to lives through design and print. Over time, they have been able to improve in the quality of output by undergoing different training, carrying out research, and updating equipment in order to serve clients better. The core values of living proof revolve around professionalism, timelines, competitiveness, safety, excellence and quality. This is the main source of stability for the organisation. It maintains its standards for printing and its type of binding over the years, quality maintained with affordable prices.

This printing organisation takes up very limited ranges which is mainly booklet production - Magazines and Textbooks. The main thing is time, quality and lowered price and, most of the productions editing and publishing is done within the organisation. This research focuses on the textbook and magazine printing supply lines.

4.7.1.1 Living Proof Organisation Suppliers Configuration

Suppliers Typology	Living Proof Textbook	Living Proof Magazine	Living Proof Textbook	Living Proof Magazine
Defenders	8	8	57%	57%
Prospectors	1	2	7%	14%
Analysers	5	4	36%	29%
Total	**14**	**14**	**100**	**100**

Table 4.8: Living Proof Printing Textbook Suppliers' Configuration

Table 4.8, above shows the percentage configuration for Living Proof Printing Textbook as (57%, 7%, 36%) and Living Proof Printing Magazine configuration as (57%, 14%, 29%) where the configuration ratios as (1:13:7) and (1:11.7:3.3) respectively. The highest occurrences of suppliers for both are of Prospectors, followed by Analysers, and the least as Defenders.

4.7.2 BET Glass Production

The Company is engaged in the manufacture, distribution and sale of glass bottles and containers for the leading breweries, soft drinks, wine and spirit, pharmaceutical and cosmetics companies. There are 3 Glass Production companies in Nigeria with only BET in the south western region of the country. BET source overseas when demands can't be met. The Company has manufacturing plants in Agbara Ogun state and in Ughelli Delta state with three furnaces with a capacity of approximately 600 tons of produced glass containers per

day. The Company exports to 13 countries in Africa which are; Angola, Benin, Burkina Faso, Cameroon, Gabon, Gambia, Ghana, Guinea, Liberia, Mauritius, Rwanda, Sierra Leone and Togo. The Company is a subsidiary of Frigo Glass Industries Nigeria Limited. The company provides packaging solutions to a range of customers in the manufacturing of glass containers for beverages, mineral water bottles, beer, wine, and spirit bottles, and tableware. BET Glass Production company produces conical shaped bottles for organisations producing wines and other alcoholic drinks. This niche has been maintained for many years without deviating into any other. The company processed sold bottles by crushing and making them into new bottles. BET is very efficient with high turnover. However, the only threat is the adoption of plastic bottles by some of their customers, considering that there is a monopoly in Nigeria making plastic bottles cheaper. The firm strives to maintain low cost in making bottles, and the technology for production has been in place for a long time.

4.7.2.1 BET Glass Configuration

Suppliers	BET Glass	BET Glass
Defenders	10	67%
Prospectors	1	7%
Analysers	4	26%
Total	**15**	**100**

Table 4.9: BET Glass Suppliers Configuration

A*s* shown in the Table 4.9 above, the highest percentage of suppliers are Defenders (67%) followed by Analysers (26%) and lastly the Prospectors (7%) suppliers. Where the ratio for BET Glass organisations (9.6:1:3.7).

4.8 Cost Saver Supply Network (CSSN), Defenders Hub and Suppliers

Living Proof Organisation and BET Glass chooses a narrow range of products and services, and avoids unnecessary risk. Hence, these organisations are Defenders, categorised as Cost Saver supply network of Dai and Zhang's model. From the grouping of suppliers as shown above, in this supply network the highest occurrences of suppliers are Defenders followed by Analysers, with Prospectors as the lowest.

Cost Saver Supply Network Preferred Suppliers

Dai and Zhang (2008) suggests that Cost Saver supply network partners are mostly Defenders. Also, the hub of this supply network relies on Cost-efficiency which is; efficiently reducing cost of materials and labour; reducing purchase costs; and saving labour costs. Furthermore, the analysis above reveals that Defenders are dominant as suppliers in Cost Saver supply networks. The interview responses below give insights into the reasons why Cost Saver supply networks prefer Defenders suppliers;

Preference for cost efficient supplier

Living Proof Printing confirms the preference of the cost efficient suppliers. Living Proof Printing clearly states: "We avoid high priced raw materials as much as possible however, the few times we accept high priced suppliers are when unavoidable…..when there is no other substitute".

Living Proof further emphasizes the need for low priced raw materials….."as much as possible we prefer the low price…."

BET Glass states: …"most of our suppliers are low priced and we have worked together for many years. We got rid of some suppliers in the past because of high prices on materials".

The responses above give a clear indication that Cost Saver supply network prefers suppliers that deliver at low price, and enhance their cost efficiency within the supply network. This shows Cost Saver supply network preference mostly for Defenders suppliers. Miles and Snow have summarised that Defenders would centre on cost efficiency to improve the performance and increase the profits of Defenders in such an environment. Enhancing the efficiency of production and distribution would be an efficient solution. (Miles and Snow, 2003).

Preference for Quality and efficiency

Living Proof Printing gave priority to quality ….."Yes, we have been producing textbooks for a long time we want to maintain… we want suppliers that gives quality….not necessarily the most expensive ones".

Living Proof Printing added the need to keep low cost suppliers ……"we have most of our right hand suppliers with low cost. We do not have many machines however, we satisfy our customers by giving the best quality at all times". We prefer suppliers that deliver at the right time".

BET Glass states: "Since our years of production we produce one of the best bottles, we need a good supplier that delivers the right quality at the right time……Yes, it is always of good quality… customers testify".

This interview presents the preference for quality and right time for delivery by suppliers. These attributes are common to Defenders and Analysers suppliers. As stated by Miles and Snow (2003), efficiency of Defenders is emphasised in the following processes: quality, inventory control, materials handling, production scheduling and methods of distribution.

Supplier's Differences in Characteristics

As analysed above, that Cost Saver supply network has a mix of Miles and Snow's strategic types as suppliers. This interview's responses explains why there will be an existence of the various strategic types in the Cost Saver supply network;

Living Proof Printing stated that it is very difficult to have suppliers who all satisfy them perfectly… "No, our suppliers are all different in their response to delivery and quality. Some suppliers are not efficient but unavoidable……For example, the MF paper used for textbook content are easy to get, however we have suppliers that move with the market trend on binding materials which varies from textbook to textbook….although they sometimes do not keep up with standards…. we do not have many suppliers in this category".

BET Glass pointed out that: "We try to get the best suppliers that suit our work but obviously some are not reliable... ".

From this interview it is not possible to have all suppliers having the same characteristics or strategic types. However, each hub organisation works with suppliers that best satisfies their objectives and priority.

4.9 Summary

This chapter has successfully carried out a case study, to explore and affirm each hub organisation in Dai and Zhang's supply network type; evaluated the reasons for the hub organisations choice of suppliers; affirms that Multiple Driven, Cost Saver and Adapter supply networks suppliers configuration are different, and that these differences are based on the hub organisation's choices, which is based on their preferences**.** The configuration for suppliers in the Multiple Driven supply network category using *Defenders, Prospectors, Analysers* are Planet Earth Catalogue (26%, 14%, 60%), Planet Earth Calendar (23%, 15%, 62%), Grand Oak Lord's Dry Gin (23%, 11%, 66%), Grand Oak Bacchus (23%, 12%, 67%) , Grand Oak Lord's Dry Gin (23%, 11%, 66%), Grand Oak Bacchus (23%, 12%, 67%), Gablek Light Weight Packaging Printing (26**%**, 14**%**, 60**%**), Gablek Wine Tonic Label Printing (25**%**, 15**%**, 60**%**), Gablek Seamann Label Printing (23**%**, 15**%**, 62**%**), Gablek Bank Teller Printing **(**27**%**, 14**%**, 59**%**). There is a similarity in the configuration of the nine supply lines that are Multiple Driven supply networks, where, the occurrence of Analyser suppliers is greater than the occurrence of Defender suppliers; the occurrence of Defender suppliers is greater than the occurrence of Prospector suppliers.

International Distilleries Limited (non-alcoholic- Veleta Sparking Fruit Drink); International Distilleries Limited (alcoholic - Chelsea Dry Gin) and Ashney printing adopt Adapter supply networks. The suppliers' configurations for each of the organisations are using Defenders, Prospectors, Analysers (5%, 62%, 21%) (6%, 73%, 33%) and (4%, 61%, 35%) respectively. There is similarity in the configuration of these organisations that implements Adapter supply networks. This result shows that the occurrence of Prospector suppliers is greater than the occurrence of Analyser suppliers; the occurrence of Analyser suppliers is greater than the occurrence of Defender suppliers.

Living Proof Printing Textbook, Living Proof Printing Magazine and BET Bottle manufacturing are Defenders organisations and are categorised as Cost Saver supply networks. The suppliers configurations for each of the organisations are using Defenders, Prospectors, Analysers, for Living Proof Printing Textbook as (57%, 7%, 36%) and Living Proof Printing Magazine configuration as (57%, 14%, 29%) and (67%, 7%, 26%). There is a similarity in the configuration of the three organisations that are Cost Saver supply networks – the occurrence of Defender suppliers is greater than the occurrence of Analyser suppliers; the occurrence of Analyser suppliers is greater than the occurrence of Prospector suppliers.

This case study reveals that each of the three supply networks configurations are different one to another. It shows that the hub organisations type, vision, objectives and ambitions affect their choices of supplier and their configuration. The knowledge of appropriate supply network suppliers configurations serves as a tool to help organisations manage their chosen supply networks. The next chapter validates the various hypotheses based on suppliers' configuration of the three supply networks.

Chapter 5: Quantitative Analysis (Hypotheses)

5.1 Introduction

In Chapter 4 Case Study, the preferred suppliers for Cost Saver supply network (CSSN), Adapter supply network (ASN), and Multiple Driven supply network (MDSN) were introduced and reviewed. Also, in Chapter 2 Literature Review, the relationship between Miles and Snow's (2003) strategic types, and Dai and Zhang's (2008) supply networks were evaluated. Based on existing theory, for *Cost Saver supply network and its* Defenders *hub company*, the business environment is stable, therefore the supply network is targeted towards achieving cost saving and efficiency. In *Adapter supply network and its* Prospectors *hub company*, the business environment is uncertainty and fast change. Hence, this supply network derives its stability from effectiveness. Furthermore, in *Multiple Driven supply network and its* Analysers *hub company*, the business environment is a mixture of stable as well as changing and dynamic situations. Due to the dual characteristics of the Analysers, both efficient and effective features are essential in this supply network.

As discussed in Chapter 2 Literature Review, there is little research carried out on choosing the appropriate supplier partners for each of the three supply network models. To overcome this weakness, to fill the gap and enhance knowledge on the management of these supply networks, a range of relevant hypotheses and propositions were developed and tested in this chapter. The first set of hypotheses are based on the assumptions of Miles and Snow's theory; the next set of hypotheses focuses on the suppliers' configuration or suppliers' strategic occurrence for each of the supply networks. The last set of hypotheses are to validate that hub organisations that share the same supply network also have similar strategic supplier configurations (D: P: A: R). These tests were carried out using statistical packages - SPSS and Minitab. In conclusion, this chapter suggests the supplier configurations for each of the Dai and Zhang (2008) supply networks.

5.2 The Proposition of Dai and Zhang Supply Network Suppliers Configuration

5.2.1 Proposition for Ratio of the three Miles and Snow Types

Proposition 1a: The number of suppliers that are Defenders, Prospectors, and Analysers in the South western Nigeria Industry are not the same. The equations for the hypothesis are:

H_0: M_d:$M_{p:}$$M_{a:}$= 1:1:1

H_1: M_d:M_p:M_a =/=1:1:1

Where:

M_d represents the proportion of Defenders

M_p represents the proportion of Prospectors

M_a represents the proportion of Analysers

According to Miles and Snow (2003), an organisation can adopt any of the 4 proposed typologies - Defenders, Prospectors, Analysers or Reactors in any given industry. Gnjidic, 2014; Murray et al., 2002; Namiki, 1989 and Peng et al., 2004 pointed out that Miles and Snow's strategy is one of the most frequently empirically proven strategic classifications. Its usefulness has been demonstrated by numerous studies, confirming the basic assumptions of these models in areas such as strategic management and strategic marketing (Andrews et al., 2006; Conant et al., 1990; Gnjidic., 2014; Hambrick,1984; Kazazl et al., 2015; McDaniel and Kolari, 1987; McKee et al., 1989; Ozdemir, 2012; Pleshko and Nickerson, 2008; Shannan et al., 2010; Snow and Hrebiniak, 1980; Shortell and Zajac, 1990; Slater et al., 2006; Zahra and Pearce, 1990). Also, the Research Paper titled 'Organisational strategy and firm performance: a test of Miles and Snow's model' confirms the existence of Miles and Snow's strategic types in 34 paint manufacturing SMES in South-western Nigeria (Oyedijo and Akewusola, 2012). However, this is limited to a singular industry. Therefore, **Proposition 1** aims to explore the

existence of the Miles and Snow's strategic types in various industries in the South-western region of Nigeria.

5.2.2 Proposition for the Occurrence of Reactors as Suppliers

In Chapter 2 Literature Review, the three successful Miles and Snow's strategic types are Defenders, Prospectors and Analysers. According to Miles and Snow (2003), an organisation that follows a Reactors strategy has no consistent strategic approach; drifts with environmental events and mostly fails to anticipate or influence those events. This usually makes these organisations short lived, and they do not exist for too long or sustain focus like Prospectors, Defenders, or Analysers strategies. Therefore, most organisations would not adopt Reactors strategies (Ginter, 2013; Barney and Griffin, 1992; Dai 2008). From these, it is deduced that there would be a smaller proportion of Reactors compared with the other 3 strategic typologies.

Proposition 2a: The proportion of Reactors suppliers is less compared to Defenders, Prospectors and Analysers suppliers companies in South-western Nigeria. The formulas for the hypotheses are as follows:

H_{2a1}: $M_{r\,(}$proportion of Reactors) $<$ $M_{d\,(}$proportion of Defenders)

H_{2a2}: $M_{r\,(}$proportion of Reactors) $<$ Mp(proportion of Prospectors)

H_{2a3}: $M_{r\,(}$proportion of Reactors) $<$ Ma(proportion of Analysers)

Where:

H_{2a1} represents hypothesis 2a1, H_{2a2} represents hypothesis 2a2, H_{2a3} represents hypothesis 2a3,

$M_{d\,(}$proportion of Defenders) represents the expected proportion of Defenders as suppliers

M_p (proportion of Prospectors) represents the expected proportion of Prospectors as suppliers

M_a (proportion of Analysers) represents the expected proportion of Analysers as suppliers

M_r (proportion of Reactors) represents the expected proportion of Reactors as suppliers

The equations to validate for these hypotheses are:

H_0: $M_r = M_{d;}$ H_{2a1}: $M_r < M_d$

H_0: $M_r = Mp$; H_{2a2}: $M_r < Mp$

H_0: $M_r = Ma$; H_{2a3}: $M_r < Ma$

5.2.3 Propositions of Configuration of Cost Saver Supply Network Suppliers

The Cost Saver supply network with the Defenders hub prefers both cost efficiency and technology efficiency, such as lead-time efficiency, cost efficiency, inventory efficiency, productivity efficiency, machine efficiency, planning efficiency, distribution efficiency, quality efficiency, resource efficiency, and integration efficiency features (Dai, 2008). Additionally, Dai and Zhang (2008) pointed out that in a Cost Saver supply network, most partners are Defenders; and cooperate easily with Defenders. However, the strategic types that constitutes this supply network are not limited to Defenders, but might predominantly have elements of Defenders.

For a Cost Saver supply network to choose suppliers, these choices would be based on the hub organisation's aims and purposes. To satisfy these aims, the features of suppliers would be considered, and choices made based on those suppliers that could assist in achieving the hub organisation's aims and preferences.

Defender hub organisations function best in stable environments, strive to maintain cost efficiency, ensure efficiency, focus on long-term planning and doing things right. Therefore, a Cost Saver supply network, would prefer Defender suppliers that share the same focus as the hub, as this would enhance achieving its aims. On the other hand, Prospectors suppliers are characterised by a first to market and effectiveness strategy, which opposes the cost efficiency, niche market characteristics and aims of the Defender hub. Whereas, Analysers suppliers combines the dual characteristics of the efficiency of Defenders and the effectiveness of Prospectors (Miles and Snow, 2003).

Therefore, for this reason, there is a possibility that in a Cost Saver supply network with the Defender hub organisation, there will be more Defenders and Analysers types as suppliers with significantly less Prospectors as suppliers.

As a result, these Propositions **3a** and **3b** were proposed:

Proposition 3a: In CSSN there is a smaller proportion of Prospectors compared to Defenders and Analysers as suppliers. The quantitative formulas of hypothesis 3a are:

H_{3a1}: M_p (proportion of Prospectors) $<$ M_d (proportion of Defenders)

H_{3a2}: M_p (proportion of Prospectors) $<$ M_a (proportion of Analysers)

Where:

H_{3a1} represents hypothesis 3a1, H_{3a2} represents hypothesis 3a2

Proposition 3b: In CSSN there is a greater proportion of Defenders compared to Prospectors and Analysers as suppliers. The formulas for hypothesis 3b are:

H_{3b1}: M_d (proportion of Defenders $<$ M_p (proportion of Prospectors)

H_{3b2}: M_d (proportion of Defenders) $<$ M_a (proportion of Analysers)

Where:

H_{3b1} represents hypothesis 3b1, H_{3b2} represents hypothesis 3b2

H_0: $M_d < M_p$; H_{3b1}: $M_d < M_p$

H_0: $M_d < M_a$; H_{3b2}: $M_d < M_a$

5.2.4 Propositions of suppliers configuration in ASN

As stated by Dai and Zhang (2008), the Adapter supply network builds its network around a Prospector hub organisation. Prospectors are highly innovative, constantly seeking out new markets, new opportunities, are first to market, are efficient, and oriented toward growth and risk taking (Miles and Snow, 2003). However, Adapter supply network has a wide mixed level of different strategic types as its partners in its network (Dai and Zhang, 2008).Therefore, more Prospectors suppliers that share the same characteristics as the hub can suffice as partners in an Adapter supply network. This is because these suppliers could respond quickly to the first entrant and efficiency characteristics of the Prospector hub organisation. Also, Analysers suppliers can also fit into the Adapter supply network, because it has dual characteristics, and as such takes up some characteristics of the Prospector. Therefore, Analysers suppliers can also play the fast and innovative role of satisfying the dynamic features of the Prospectors hub. On the other hand, Defender suppliers do not share characteristics with the Prospectors hub. These suppliers are stable and occupy their niche in the market.

Based on this, the proposition is that there is a huge likelihood that in an Adapter supply network, there will be more Prospectors as suppliers compared to Analysers. And, there is a

possibility that Defender suppliers are not much needed compared to Analyser suppliers because of their dual characteristics.

Proposition 4a: In ASN there is a greater proportion of Prospectors compared to Defenders and Analysers organisations as suppliers. The quantitative formulas of hypothesis 4a are:

H_{4a1}: M_p (proportion of Prospectors) $>$ M_d (proportion of Defenders)

H_{4a2}: M_p (proportion of Prospectors) $>$ M_a (proportion of Analysers)

H_0: $M_p = M_d$; H_{4a1}: $M_p > M_d$

H_0: $M_p = M_a$; H_{4a2}: $M_p > M_a$

Where:

H_{4a1} represents hypothesis 4a1, H_{4a2} represents hypothesis 4a1

Proposition 4b: In ASN there is a greater proportion Analysers compared to Defenders as suppliers. The quantitative hypothesis for validating of hypothesis 4b are:

H_0 : M_a (proportion of Analysers) = M_d (proportion of Defenders)

H_{4b1}: M_a (proportion of Analysers) > M_d (proportion of Defenders)

Where:

H_{4b1} represents hypothesis 4b1.

5.2.5 Propositions of Suppliers Configuration in MDSN

For a Multiple Driven supply network, with an Analysers hub, as explained earlier, Analysers combine the features of Defenders and Prospectors by minimising risks, maximising the

opportunity for profits, maintaining market share and seeking to be innovative. Although, usually not as innovative as an organisation that uses a Prospectors strategy. But, they largely pursue a "second-in" strategy and improve upon the service offered by their competitors.

Therefore, for a Multiple Driven supply network with the Analyser hub, there is a high possibility of having more Analysers suppliers that combine efficiency and effectiveness; and are careful to enter into new businesses. Also, the Defenders suppliers focus on efficiency and reduced price. These traits increase the possibility of having more Defenders suppliers in a Multiple Driven supply network as compared to Prospectors suppliers that are innovation driven. On the other hand, (Dai and Zhang, 2008) stated that there would be a wide mix of different strategic types as partners in this supply network.

From this discussion, Propositions 5a, 5b, and 5c were proposed;

Proposition 5a: In MDSN there is a greater proportion of Analysers suppliers compared to Defenders and Prospectors suppliers. The formulas of hypothesis 5a are:

H_{5a1}: M_a (proportion of Analysers) > M_d (proportion of Defenders)

H_{5a2}: M_a (proportion of Analysers) > M_p (proportion of Prospectors)

Where:

H_{5a1}represents hypothesis 5a1, H_{5a2} represents hypothesis 5a2

Proposition 5b: In MDSN there are less proportion of Prospectors suppliers compared to Defenders and Analysers suppliers. The quantitative formulas of hypothesis 5b are:

H_{5b1}: M_p (proportion of Prospectors) < M_d (proportion of Defenders)

H_{5b2}: M_p (proportion of Prospectors) < M_a (proportion of Analysers)

Where:

H_{5b1} represents hypothesis 5b1, H_{5b2} represents hypothesis 5b2

Proposition 5c: In MDSN there would be a significant difference in the proportion of Defenders, Prospectors and Analysers compared to Reactors. The formulas of hypothesis 5c are:

H_{5c1}: $M_{r\,(}$proportion of Reactors) $<$ $M_{d\,(}$proportion of Defenders)

H_{5c2}: $M_{r\,(}$proportion of Reactors) $<$ M_p (proportion of Prospectors)

H_{5c3}: $M_{r\,(}$proportion of Reactors) $<$ Ma (proportion of Analysers)

Where:

H_{5c1} represents hypothesis 5c1, H_{5c2} represents hypothesis 5c2, H_{5c3} represents hypothesis 5c3.

5.2.6 Proposition Consistency in Dai and Zhang's Supply Networks Configurations

According to Chapter 4 Case Study, the supplier choices for (Defenders: Prospectors: Analysers) for Cost Saver, Adapter and Multiple Driven supply networks are different. However, to validate and ascertain that there is similarity in the suppliers configurations for hub organisations that fall into the same category of supply network, and to ascertain uniformity in the configuration for each of the supply networks of the same type, these propositions below were brought forth;

Proposition 6a: In Cost Saver supply networks, there is consistency in the suppliers' configurations - *Defenders, Prospectors and Analysers* for all CSSNs. The quantitative hypothesis for validating of hypothesis 6a is:

P_a: $CSSN_1 = CSSN_2 = CSSN_3$

Where:

$CSSN_1$ represents the first CSSN suppliers' configuration

$CSSN_2$ represents the second CSSN suppliers' configuration

$CSSN_3$ represents the third CSSN suppliers' configuration

Proposition 6b: In the *Adapter supply network*, there is a relationship between the suppliers' configurations - *Defenders, Prospectors and Analysers* for all ASNs. In *Adapter* Saver supply networks, the quantitative hypothesis for validating of proposition 6b is:

P_b: $ASN_1 = ASN_2 = ASN_3$

Where:

ASN_1 represents the first ASN suppliers' configuration

ASN_2 represents the second ASN suppliers' configuration

ASN_3 represents the third ASN suppliers' configuration

Proposition 6c: In a *Multiple Driven supply network*, there is similarity between the suppliers' configurations - *Defenders, Prospectors and Analysers* for all MDSNs. The quantitative hypothesis for validating of proposition 6c is:

P_C: $MSDN_1 = MSDN_2 = MSDN_3$

Where:

$MSDN_1$ represents the first MDSN suppliers' configuration

$MSDN_2$ represents the second MDSN suppliers' configuration

$MSDN_3$ represents the third MDSN suppliers' configuration

5.3 Results and Quantitative Analysis

In Chapter 4 details of the sampling method used for this study is discussed. 750 questionnaires were sent to the total supplier population, and 630 usable questionnaires were received, which gives an 84% response rate. There are 9 received questionnaires indicating that the companies would not be involved in this research because of their confidential policy; another 11 questionnaires failed to identify their Miles and Snow types appropriately. In addition, there are 15 questionnaires belonging to Reactors, which are analysed in this chapter. However, Reactors are ignored in Chapter 4 Case Study and Chapter 6 Simulation Analysis of this research, leaving a total of 615 suppliers to be analysed in these chapters.

Therefore, the valid sampled percentage for Defenders is 51.679%, Prospectors is 27.626%, Analysers is 20.579% and Reactors is 0.116% (see Table, 5.1). Based on these samples, the quantitative analysis is carried out to validate the hypotheses in this chapter.

Typology	Frequency	% of Variance	Cumulative (%)
Defender	132	51.679	51.679
Prospector	154	27.626	79.306
Analyser	329	20.579	99.884
Reactor	15	0.116	100
Total	630	100	

Table 5.1: Suppliers Miles and Snow Frequency

5.4 Analysis for General Propositions

5.4.1 Analysis for the Occurrence of Three Miles and Snow types

Proposition 1a: the number of suppliers that are Defenders, Prospectors, and Analysers in the South western Nigeria industries are not the same.

H_0: M_d:$M_{p:}$$M_{a:}$ = 1:1:1

H_1: M_d :M_p:M_a =/=1:1:1

To validate the hypotheses that the ratio of Defenders: Prospectors: Analysers is not 1:1:1 in the South western Nigeria industries. The chi-square good fitness test is used. Out of the 630 questionnaire responses, 132 suppliers are Defenders, 154 Prospectors, 329 Analysers and 15 Reactors. According, to the results of chi square good fitness test, the p-value is 0.03, and 0.03 less than 0.05. This means that the hypothesis (H_1) is accepted, therefore, this result suggests that the population of the three Miles and Snow typologies are not equally distributed in the South western Nigeria industry.

5.4.2 Analysis for the Occurrence of Reactors as Suppliers

Proposition 2a: There would be a smaller amount of Reactors compared with Defenders, Prospectors and Analysers as supplier companies in South western Nigeria. The quantitative hypotheses for validating the proposition 2 are as follows:

H_0: $M_r = M_d$; H_{2a1}: $M_r < M_d$

H_0: $M_r = M_p$; H_{2a2}: $M_r < M_p$

H_0: $M_r = M_a$; H_{2a3}: $M_r < M_a$

Where:

M_d: proportion of Defenders

$M_{p:}$ proportion of Prospectors

M_a: proportion of Analysers

$M_{r:}$ proportion of Reactors

H_0 = Null hypothesis

$H_{2a1,}$ H_{2a2}, H_{2a3} = Alternative hypothesis

According to the results of chi square good fitness test, the p-value is 0.01; this is less than 0.05. Therefore, the hypothesis is accepted, that, there would be a smaller amount of Reactors compared with Defenders, Prospectors, and Analysers as supplier companies in South western Nigeria.

5.5 Hypotheses Test for Proportions of Miles and Snow Configuration as Suppliers

Table 5.2 shows the 15 different hub organisations supply networks, and the amount of suppliers that falls into either Defenders, Prospectors, Analysers or Reactors strategy. This shows the occurrence of each supplier strategy types as; Defenders (132), Prospectors (154), Analysers (329) and Reactors (15).

Supply Network	Defenders D	Prospectors P	Analysers A	Reactors R	Total
MDSN (1)	16	9	38	2	65
MDSN (2)	14	9	37	1	61
MDSN (3)	12	6	35	0	53
MDSN (4)	9	5	28	1	43
MDSN (5)	7	2	19	0	28
MDSN (6)	13	7	30	2	52
MDSN (7)	12	7	29	1	49
MDSN (8)	13	8	34	1	56
MDSN (9)	13	7	29	1	50
ASN (1)	2	26	14	1	43
ASN (2)	3	35	10	1	49
ASN (3)	2	30	17	3	52
CSSN (1)	8	1	5	1	16
CSSN (2)	8	2	4	0	14
CSSN (3)	8	2	5	0	15
Total	**132**	**154**	**329**	**15**	**630**

Table 5.2: Miles and Snows types occurrence in different supply network

Table 5.3 below shows the percentage occurrence of Defenders, Prospectors and Analysers. It is observed that in the Cost Saver supply network the proportion of the Defenders is greater than the observed proportions of the Prospectors and the Analysers **(D>A>P)**. With a large proportion of the suppliers as Defenders followed by Analysers and minimal number of

Prospectors suppliers. In an Adapter supply network, it is observed that occurrence of Defenders suppliers is lower than the proportions of the Prospectors and Analysers **(P>A>D)**. In **a** Multiple Driven supply network, it is observed that there is a smaller proportion of the Prospectors and Analysers suppliers when compared to Defenders suppliers **(D>A>P**).

Supply Network	***Defenders***	***Prospectors***	***Analysers***	***Proportion Ranks***
MDSN (1)	25 %,	14%	60 %	**A>D>P**
MDSN (2)	23%	15%	62 %	**A>D>P**
MDSN (3)	23%	11%	66%	**A>D>P**
MDSN (4)	23%	12%	67%	**A>D>P**
MDSN (5)	25%	7%,	68%	**A>D>P**
MDSN (6)	25%	15%	60%	**A>D>P**
MDSN (7)	26%	14%	60%	**A>D>P**
MDSN (8)	23 %	15 %	62 %	**A>D>P**
MDSN (9)	27%	14%	59%	**A>D>P**
ASN (1)	4%	61%	35%	**P>A>D**
ASN (2)	6%	73%	21%	**P>A>D**
ASN (3)	5%	62%	33%	**P>A>D**
CSSN (1)	57%	7%	36%	**D>A>P**
CSSN (2)	57%	14%	29%	**D>A>P**
CSSN (3)	53 %	13 %	33%	**D>A>P**

Table 5.3: The observed proportions in different supply network

5.6 Hypotheses Test for Configurations of Supply Networks

Multivariate analysis of variance (MANOVA) is simply an ANOVA with several dependent variables. It is an ANOVA test for the difference in means between two or more groups. MANOVA is used for the comparison study of the mean value of each Miles and Snow strategic type to the other 3 strategic types within each supply network. Tables (5.4, 5.5, and

5.6), show the MANOVA test results of a Cost Saver supply network, Adapter supply network and Multiple Driven supply network respectively.

5.6.1 Hypotheses Test for Suppliers Configurations of Cost Saver Supply Networks

Typology (I)		Typology (J)	Mean Difference (I-J)	Sig. Difference (α)	Comparison	Comparison Range
Defenders (D)	**vs.**	Prospectors	6.3333*	***.000***	D > P	**D > P, A, R**
		Analysers	3.3333*	***.001***	D > A	
		Reactors	7.6667*	.000	D > R	
Prospectors (P)	**vs.**	Defenders	-6.3333*	***.000***	P < D	**D, A > P> R**
		Analysers	-3.0000*	***.002***	P < A	
		Reactors	1.3333	.091	P > R	
Analysers (A)	**vs.**	Defenders	-3.3333*	.001	P < D	**A > P, R D > P**
		Prospectors	3.0000*	.002	A > P	
		Reactors	4.3333*	.000	A > R	
Reactors (R)	**vs.**	Defenders	-7.6667*	.000	R < D	**D, P, A > R**
		Prospectors	-1.3333	.091	R < P	
		Analysers	-4.3333*	.000	R < A	

Note * represents: 0.05 level

Table 5.4: Hypotheses test result for the proportions Cost Saver Supply Network

Table 5.4 shows the statistical results for the proportion of suppliers' strategic type in a Cost Saver Supply Network. Each row compares the mean value of one of Miles and Snow's types to the other 3 types, where the mean difference (I-J) is the difference between the means of each strategy. For example, the mean difference between Defenders (D) and Prospectors (P) is 6.3333. Also, when the Sig. difference (α) is greater than 0.05 then, there is no difference between the two variables compared; but if the Sig. difference (α) is less than 0.05 then, there is a significant difference between the variables compared. The results and discussions are explored below for each of the three supply networks.

Suppliers' Proportion in Cost Saver Supply Network

H_{3a1}: M_p (proportion of Prospectors) $<$ M_d (proportion of Defenders)

H_{3a2}: M_p (proportion of Prospectors) $<$ M_a (proportion of Analysers)

The results of the hypothesis 3 (a1) test shows a significant difference ($\alpha = 0.000$) for the proportion of Prospectors compared to Defenders; and for hypothesis 3 (a2) the proportion of Prospectors compared to Analysers suppliers shows a significant difference ($\alpha = 0.002$). The significant difference of hypothesis 3 (a1) and hypothesis 3 (a2) are less than 0.05 level. Thus, it can be concluded that the proportion of Prospectors suppliers is lower compared to Defenders and Analysers suppliers in CSSN of the Southern west Nigeria industries. Therefore, Hypotheses $H_{3a1\ and}$ H_{3a2} are true.

Dominant Suppliers Proportion in CSSN

H_{3b1}: M_d (proportion of Defenders) $>$ M_p (proportion of Prospectors)

H_{3b2}: M_d (proportion of Defenders) $>$ M_a (proportion of Analysers)

The field work results show that the proposition of Defenders suppliers are greater than Prospectors suppliers; and the proposition of Defenders suppliers are greater than Analysers

suppliers (See Table 5.2 and 5.3). It shows that more than half of the suppliers within the CSSN are Defenders. The results of the hypothesis 3 (b1) test show there is a significant difference (α = 0. 000) for the proportion of Defenders suppliers compared to Prospectors; and for hypothesis 3 (b2) for the proportion of Defenders compared to Analysers suppliers, the significant difference (α = 0.001) at 0.05 level (see Table 5.4). The significant difference for Hypotheses 3(b1) and 3(b2) are less than 0.05 level. Therefore it is deduced that Defenders suppliers are dominant in CSSN. The proportion 3b is true.

5.6.2 Hypotheses test for configurations of propositions in ASN as suppliers

(I) strategy	(J) strategy	Mean Difference (I-J)	Sig. Difference (α)	Comparison	Comparison Range
Defenders (D) vs.	Prospectors	-28.0000*	.000	D < P	**D > P, A, R**
	Analysers	-11.3333*	.017	D < A	
	Reactors	0.6667	.993	D > R	
Prospectors (P) vs.	Defenders	28.0000*	***.000***	P > D	**D, A > P> R**
	Analysers	16.6667*	***.002***	P > A	
	Reactors	28.6667*	.000	P > R	
Analysers (A) vs.	Defenders	11.3333*	***.017***	A > D	**A > P, R D > P**
	Prospectors	-16.6667*	.002	A < P	
	Reactors	12.0000*	.013	A > R	
Reactors (R) vs.	Defenders	-.6667	.993	D < R	**D, P, A > R**
	Prospectors	-28.6667*	.000	P < R	
	Analysers	-12.0000	.013	A < R	

Note * represents: 0.05 level

Table 5.5: Hypotheses test result for the proportions Adapter supply network

Suppliers' Proportion in Adapter Supply Network

H_{4a1}: M_p (proportion of Prospectors) > M_d (proportion of Defenders)

H_{4a2}: M_p (proportion of Prospectors) > M_a (proportion of Analysers)

H_{4a3}: M_a (proportion of Analysers) > M_d (proportion of Defenders)

An Adapter's supply network builds the network around the hub of a Prospectors organisation. The questionnaire results show that the proportion of the Prospectors supplier is greater than that of the Defenders $\mathbf{P_s} > \mathbf{D_s}$; and proportion of the Prospectors suppliers is greater than that of the Analysers $\mathbf{P_s} > \mathbf{A_s}$. where, the Analysers amount is higher compared to Defenders as suppliers $\mathbf{A_s} > \mathbf{D_s}$ (see Table 5.2 and 5.3). The result of MANOVA test shows that, for hypotheses test 4a (1) that compares the proportion of Prospectors to Defenders, the significant difference (α = 0. 000); for hypotheses test 4a (2) for the comparison between Prospectors and Analysers suppliers, gives a significant difference (α = 0. 002); and in hypotheses test 4a (3) that compares the occurrence of Analysers suppliers to Defenders suppliers, gives significant difference (α = 0. 017). For hypotheses, 4a (1), 4a (2), 4a (3) the significant differences is less than 0.05 (See Table 5.5). Therefore, the test results suggests that the proportion 4a is true.

(I) strategy		(J) strategy	Mean Difference (I-J)	Sig. Difference (α)	Comparison	Comparison Range
Defenders(D)	**vs.**	Prospectors	5.4444*	.000	D>P	**A >*D*> P**
		Analysers	-18.8889*	.000	D<A	
		Reactors	11.1111*	.000	D>R	
Prospectors(P)	**vs.**	Defenders	-5.4444*	***.000***	P<D	**A ,D >P**
		Analysers	-24.3333*	***.000***	P<A	
		Reactors	5.6667*	.000	P>R	
Analysers (A)	**vs.**	Defenders	18.8889*	***.000***	A>D	**A >D,P, R**
		Prospectors	24.3333*	***.000***	A>P	
		Reactors	30.0000*	.000	A>R	
Reactors (R)	**vs.**	Defenders	-11.1111*	.000	R<D	**P,D, A >*R***
		Prospectors	-5.6667*	.000	R<P	
		Analysers	-30.0000*	.000	R<A	

Note * represents: 0.05 level

Table 5.6: Hypotheses test result for the proportions Multiple Driven supply network

5.6.3 Hypotheses test for configurations of propositions in MDSN as suppliers.

As discussed in Chapter 2, a Multiple Driven supply network is a combination of cost efficiency, efficiency, effectiveness and centred on an Analysers hub. The field work results show that the proportion of Analysers suppliers is greater than Defenders, with more than half of suppliers as Analysers in the Multiple Driven supply networks **A>D>P**.

Adoption of more Analysers as suppliers in MDSN

H_{5a1}: M_a (proportion of Analysers) $>$ M_d (proportion of Defenders)

H_{5a2}: M_a (proportion of Analysers) $>$ M_p (proportion of Prospectors)

The results of the hypothesis test 5a (1) shows there is a significant difference (α =0.000) and for 5a (2) the significant difference (α =0.000) at 0.05 level (see Table 5.6). Thus, the results suggest that Analysers suppliers have a higher proportion compared to Defenders and Prospectors suppliers in a MDSN. The Propositions 5a is true.

Minimal amount of Prospectors suppliers in MDSN

H_{5b1}: M_p (proportion of Prospectors) $<$ M_d (proportion of Defenders)

H_{5b2}: M_p (proportion of Prospectors) $<$ M_a (proportion of Analysers)

From the MANOVA test results of the hypothesis test 5b (1), the amount of Prospectors is less than the amount of Defenders, shows a significant difference (α = 0.000); hypothesis 5b (2) that the amount of Prospectors is less than the amount of Analysers, the significant difference (α = 0.000) at 0.05 level (see Table 5.6). Thus, it presents that that Prospectors occurrence is the least compared to Analysers and Defenders suppliers a MDSN.

Minimal amount of Prospectors suppliers in MDSN

H_{5c1}: M_r (proportion of Reactors) $<$ M_d (proportion of Defenders)

H_{5c2}: M_r(proportion of Reactors) $<$ M_p(proportion of Prospectors)

H_{5c3}: M_r (proportion of Reactors) $<$ M_a (proportion of Analysers)

The results of hypothesis test 5 (c1) gives a significant difference of (α = 0.000); for hypothesis 5 (c2) the significant difference is (α = 0.000); and for hypothesis 5 (c2) significant difference (α = 0.000). The significant difference 5 (c1), 5 (c2) and 5 (c3) are less than 0.05 level. Therefore, Propositions 5c, there would be a significant difference in the proportion of Defenders, Prospectors and Analysers suppliers compared to Reactors suppliers, is true.

5.7.1 Test for interrelationship in configurations of Dai and Zhang's Supply Networks

Supply Network	**P-Value**
Cost Saver	0.973
Adapter	0.603
Multiple Driven	1

Table 5.7: Suppliers Chi-square P-values

The table shows the chi-square p-values. However, when the p-value is less than 0.05, there is no relationship amongst the configurations of that particular supply network; but, when the p-value is greater than 0.05, there is consistency amongst the configurations of that particular supply network; (see Chapter 3 Methodology for details).

5.7.1.1 Test for interrelationship in configurations of CSSN

P_a: $CSSN_1 = CSSN_2 = CSSN_3$

Where:

$CSSN_1$ represents the first CSSN suppliers' configuration

$CSSN_2$ represents the second CSSN suppliers' configuration

$CSSN_3$ represents the third CSSN suppliers' configuration

Cost Saver supply network: CSSN 1, CSSN 2, and CSSN 3. The relationship between suppliers' typology and Analysers hub organisation was investigated using a chi-square test. The analysis revealed that p-value is 0.973, and p-value > 0.05, it *accepts* Propositions 6a, that there is an association in the suppliers' configuration - Defenders: Prospectors: Analysers in for Cost Saver supply networks.

5.7.1.2 Test for interrelationship in configurations of ASN

P_b: $ASN_1 = ASN_2 = ASN3$

Where:

ASN_1 represents the first ASN suppliers' configuration

ASN_2 represents the second ASN suppliers' configuration

ASN_3 represents the third ASN suppliers' configuration

The result for ASN reveals p-value is 0.603, since p-value > 0.05 it accepts Propositions 6b, that similarity exists between Multiple Driven supply networks suppliers' configuration - Defenders: Prospectors: Analysers, for Adapter supply networks: ASN 1, ASN 2, and ASN 3.

5.7.1.3 Test for interrelationship in configurations of MDSN

P_C: $MSDN_1 = MSDN_2 \quad \ldots\ldots \quad MSDN_9$

Where:

$MSDN_1$ represents the first MDSN suppliers' configuration

$MSDN_2$ represents the second MDSN suppliers' configuration

$MSDN_9$ represents the ninth MDSN suppliers' configuration

The p-value for MDSN is 1, p-value > 0.05 .It validates Propositions 6c and suggests that there is similarity in the suppliers' configurations - *Defenders, Prospectors and Analysers* for the nine MDSNs.

5.8 Summary

In this chapter the SPSS and Minitab packages are used to test the proposed hypotheses and propositions. Chi-square tests have been used to validate that there is similarity amongst the configurations of the hub organisations that share the same supply network. The Multiple comparisons test has helped to validate the various strategic occurrences of Defender, Prospector and Analysers in each of the three supply network configurations. In a Cost Saver Supply Network there are more occurrence of Defenders, followed by Analysers suppliers and significantly few Prospector suppliers; the Adapter Supply Network, has more Prospectors and Analysers suppliers with significantly reduced existence of Defenders suppliers; in the Multiple Driven Supply Network there is a greater amount of Analysers; followed by Defenders and suppliers and significantly few Prospectors suppliers.

The next chapter is Chapter 6 Simulation, of the 15 supply lines - where 3 supply lines are Cost Saver supply networks, 3 supply lines Adapter supply networks, and 9 supply lines are Multiple Driven supply networks. It presents the analyses of the various suppliers configuration for each of the supply networks on performance, and recommends the configuration that gives enhanced performance.

Chapter 6: Simulation Methodology Analysis

6.1 Introduction

This chapter continues on from the hypotheses and case study chapters that explore the supplier configuration of each of the supply networks, to discuss how the configurations impact on the hub performances. This section starts off by outlining the structure of the simulation process, and proceeds to discussing the rationale for using Simul8 software, a Discrete Event Simulation package. It then identifies the problem that is intended to be resolved using simulation and the objectives that are meant to be satisfied. Subsequently, it describes the level of abstraction to deriving the conceptual model, and gives a pictorial depiction of the concept for the modelling details of the three types of supply networks for this study, alongside details of the simulation Model Development concepts adopted for this experiment. The third part analyses the performance results from the modelled supply networks - Multiple Driven, Cost Saver and Adapter. The first experimental work is the *'As Is'* scenario *which is the conceptual replica of the real situation of the hub organisation and its suppliers*, after which the models are verified and validated (see Appendix H1 and H2 for details). Then, followed by various '*what if*' scenarios with suppliers configurations - All Defenders, All Analysers, All Prospectors, Balance (where, the occurrence of Defenders, Prospectors and Analysers suppliers are equal), Multiple Driven, Cost Saver and Adapter. The section concludes by presenting the overall comparison, discussion and analysis of results gathered from the simulation, and the effect of various configurations (in terms of ratio) on the organisation's performances – *Quantity Profit/Loss, Throughput produced and Quality.* Finally, this chapter concludes by presenting the interpretation of the simulation model performance results and recommends the configuration that suggests improvement in the performances for the three types of supply networks.

6.2 Simulation Process

The traditional simulation framework by Naylor (1968), sets out a nine-step approach. These key steps are; formulation of the problem, collection and processing of the real world data, formulation of mathematical model, estimation of parameters of operating characteristics from real world data, evaluation of the model and parameter estimates, formulation of a computer program, validation, design of simulation experiments, and analysis of simulation data. On the other hand, Banks' (2009) approach combined the traditional approaches from a business perspective, an approach that simplifies the processes and incorporates the additional activities of documentation and implementation. This is more applicable for this work because of the details involved.

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Figure 6.1: Simulation Process (Banks *et al*, 2009)

Figure 6.1 above shows the steps from the start to the completion of the simulation experimentation process. Problem formulation - *defining the gap of the study*, Setting of objectives and overall plan - *a clear cut list of what the study targets to achieving,* Model conceptualisation - *defining the boundaries of the model*, Data collection - *method of gathering data,* Model translation - *interpretation of details of variables,* Verification - *ascertaining the appropriateness of the model*, Validation - *weighing the closeness of the model to reality,* Experimental design - *prototypical model,* Production runs - *ascertaining and running the model to debug and analyse,* More runs - *running the model over and over to ensure consistency in the model results and model,* Documentation and reporting - *documenting and writing the results and findings of the experiment,* Implementation of the model - *implementing the finding of the research.*

6.3 DES - Simulation Software

Within supply chain management and supply network management, simulation is used in various ways, as a tool to optimise performance (Sudhir and Sekharan, 2005), the choice of suppliers (Ding et al, 2009), to improve collaboration between organisations and suppliers (Cigolini and Rossi, 2006), and for the effective design of operations in supply chain

(Agarwal et al. 2011; Banks, et al., 2011; Chen et al., 2011; Duran, 2013; Campuzano and Bru, 2011). This research adopts this concept by using simulation as a decision support tool to help suggest the suppliers' configuration that gives preferred performances. The input parameters (typology) that represent each supplier are varied (suppliers' configuration) to decide the suppliers' configuration that offers an enhanced performance response for each of the 3 supply networks.

The major types of simulation systems are Discrete Event Simulation (DES), System Dynamic (SD) and Agent Based Simulation (ABS). SD uses Continuous approach and DES and ABS (Agent Based Simulation) uses Discrete Event simulation techniques (Robert Maidstone, 2012; Law, and Kelton, 2000; North, and Macal, 2013). However ABS allows for modelling agents and more behaviours, and the full range of diversity required of large-scale, real-world applications (Siebers, Macal, Garnett, Buxton and Pidd, 2010) and is not appropriate for this study. Discrete Event Simulation (DES) has been the mainstay of the Operational Research (OR) simulation community for over 40 years. It has been proven useful in solving problems within the areas of industrial engineering, computer science and operations research. DES enables the ability to trace and track back on events within the model (Barbati, Bruno, and Genovese, 2011; Bernhardt, 2013; Chan *et al.,* 2010; Collier, Murphy, and North, 2013; Kuhn, Courtney, Morris, and Tatara, 2010; Robinson, 2014; Railsback, and Grimm , 2013; Rust, 2011; Ozik, Peer-Olaf Siebers, 2010; Parker, and Epstein, 2011).

This study is aimed at demonstrating the impact of suppliers on the supply network performance. The model represent the three successful types of Miles and Snow's typology (*Defenders, Prospectors* and *Analysers*) as hub and suppliers. These variables go through in

discrete changes as the Raw material moves from *Entry point* into *Process* until it gets to the exit where performances are measured. Hence, it is important to be able to trace the model forward and backward, the effect of various events on the performances. Thus, making it clear when significant events occur in the system and the cause as it pertains to the supply networks. Based on these considerations, DES is most suitable for this study. It fits, and is appropriate to satisfying the objectives of this research. Simul8 a DES software is used because it is convenient as it allows users to create visual models of the real world systems. It is user-friendly, with an easy and well organised user interface. Additionally, it has an in-built visual logic that is very convenient and easy to use for the researchers and to accomplish the purpose of this work (Mazzi, 2011).

6.4 Problem Identification

The Case Study chapter presents the supplier configuration for Multiple Driven, Adapter and Cost Saver supply networks as shown in Table 6.1 below. Also, the Chapter 6 hypotheses, validates that the consistency and similarity in the suppliers' configuration in organisations that share same supply network where, for a Cost Saver supply network that has an Analyser hub organisation, the occurrence of Defenders suppliers is greater than the occurrence of Analysers suppliers; the occurrence of Analysers suppliers is greater than the occurrence of Prospectors suppliers; an Adapter supply network that has a Prospector hub organisation, the occurrence of Prospectors suppliers is greater than the occurrence of Analysers suppliers; the occurrence of Analysers suppliers is greater than the occurrence of Defenders suppliers; a Multiple Driven supply network that has an Analyser hub organisation, the occurrence of Analysers suppliers is greater than the occurrence of Defenders suppliers; and the occurrence of Defenders suppliers is greater than the occurrence of Prospectors suppliers.

S/N	Hub Organisation	Defenders (%) D	Prospectors (%) P	Analysers (%) A	Proportion Ranks
1	**Planet Earth Catalogue**	25	14	60	**A>D>P**
2	**Planet Earth calendar**	23	15	62	**A>D>P**
3	**Grand Oak Lord Gin**	23	11	66	**A>D>P**
4	**Grand Oak Bacchus**	23	12	67	**A>D>P**
5	**May and Baker water**	25	7	68	**A>D>P**
6	**Gablek Lightweight Packaging**	25	15	60	**A>D>P**
7	**Gablek Wine Tonic Label**	26	14	60	**A>D>P**
8	**Gablek Seamann Label**	23	15	62	**A>D>P**
9	**Gablek Bank Teller**	27	14	59	**A>D>P**
10	**Ashney Printing Press**	4	61	35	**P>A>D**
11	**IDL (alcoholic)**	6	73	21	**P>A>D**
12	**IDL (non-alcoholic)**	5	62	33	**P>A>D**
13	**Living Proof Printing Textbook**	57	7	36	**D>A>P**
14	**Living Proof Printing Magazine**	57	14	29	**D>A>P**
15	**BET Glass**	53	13	33	**D>A>P**

Table: 6.1: Suppliers configuration

The case study and hypotheses chapters' considerations are limited to suppliers' configuration. However, the session extends this discovery by considering the effect of these configurations, on the hub organisation's performances. This is meant to achieve some of the objectives of this study as stated in Chapter 1 which are;

- To analyse whether an equal ratio of the typologies of suppliers of the supply network will enhance the overall performance of the hub organisation.
- To identify the impact on performance if the suppliers' configuration consists of strategic types that are different from that of the hub organisation.
- To study the performances of the supply network when the ratio of suppliers' typology are varied.
- Finally, to suggest the configuration that proffers enhanced performance.

6.5 Model Conceptualisation

According to Robinson (2013), there should be a level of abstraction in modelling. Not attempting any form of model abstraction leads to overly complex models. Following the objectives described above, Robinson (2008a), pointed out that the key requirements to having a good conceptual model are that the model should be valid and feasible. This can be satisfied and achieved by clarifying and fulfilling the process; objectives, inputs, outputs, content, assumptions and simplifications of the model. This section will mention and give insight to the variables evaluated in the experiment for each of the processes. However, further details on data collection and simulation of these phases are detailed in subsequent chapters.

The *inputs* are the typology of suppliers which are either Defenders, Prospectors or Analysers that are varied in various s*cenarios.* For each of these typologies, the variables considered to define each of the three typologies are *Cost of materials, Arrival times, Quantity delivered, Quality delivered (Raw materials).*

The *outputs* are the performances of the supply network. The key performance measures considered are *Profit/loss, Throughput, Quantity produced and Quality.*

Having clear and detailed *objectives, inputs* and *outputs* for the model helps to get data and information needed for the *Process or Content* to be modelled. Table 6.3, gives details of the methods adopted for these data.

Assumptions made for this study are:

- None of the workers is on any kind of leave (sick, maternity, etc.).
- All workers start at 9.00am and end by 5.00pm.
- The workers are always available at their duty posts, and workers swap for break time as work process is continuous.
- Number of working days is 28 per month.

Simplifications was incorporated in the model to enable rapid simple model development, and to improve transparency within the organisation. The production process was simplified to *suppliers, process* and the effect on *outputs/performance* as shown in Figure 6.2 .The systems for this study are nine Multiple Driven supply networks, three Adapter supply networks and three Cost Saver supply networks. The supply network is made up of entities which are*:* Suppliers, Processes, and Output.

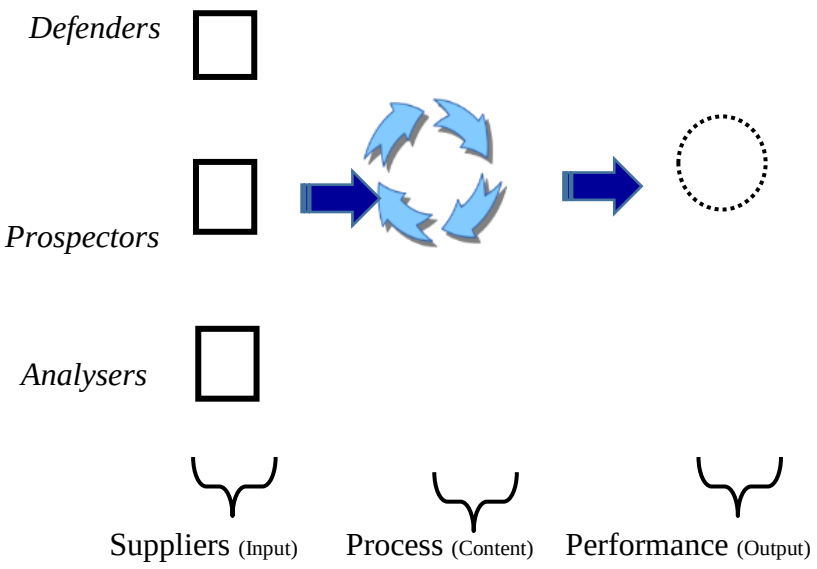


Figure 6.2: Conceptual model

Models consider the properties of each entity and as such data were collected for each attribute. The corresponding attributes for the entities are; *Suppliers - Adapter, Defender and Prospector*; Process - *The interaction within each hub organisation of each supply network,* Performance - *(Quality, Quantity, Throughput, Profit/Loss).* There are various events (a change in the state of the system) that occur when the model is run, the first occurrence is in the course of the entrance of materials into the system; secondly, is the progression where the raw materials are processed and lastly, is when the materials are finished and are moved out of the system as finished products.

6.6 Data collection

Many data collected were available but not necessarily in the right form to be used to construct the model. Tables 6.2, 6.3 and 6.4 provide a summary of the data required in the model and how they were collected. Data were manually collected by both the researcher and also staff from the hub organisation operations department. *Semi-structured Interview, Historic data, Questionnaire and Observation are* chosen processes for preparing and collecting data which is based on suitability, lower administrative costs, most straightforward analysis of data and non-threatening attributes.

Questionnaires rely on obtaining information directly from individuals by raising a number of questions. This technique is widely used for collecting data as a survey method. These questionnaires are designed to enable the researchers to know how they perceive things in their organisation that group the firm into one of Miles and Snow's strategy (see questionnaire in Appendix B). Historic data and observation were adopted, historic data assists in gathering past information about a company, to help forecast the company's future, while observation relies on the researcher's ability to collect data through senses; and allows researchers to document actual behaviour rather than responses related to behaviour. This is gathered by

watching people and events, using recording sheet, field notes, and a stopwatch as tools (see Appendix E for recording sheets). Additional, information was gathered by conducting in-depth interviews with respondents to add a qualitative dimension to the research and thereby enhance the validity of the historic data and observation (see Appendix C: Semi Structured Interviews for Hub Organisation and Appendix D: Semi Structured Interviews for Suppliers' Organisation). Structured, semi-structured and unstructured interviews provide the researcher with the opportunity to 'probe' answers, where interviewees need to explain, or build on, their responses (Singleton and Straits, 2010; Saunders *et al*., 2012; Bryman, and Bell, 2015; Clough, and Nutbrown, 2012; Creswell, 2014; Easterby-Smith, et al., 2015). Figure 6.4 below gives an overview of the model structure, data required and how data was collected at each stage. For the **variables** (Quality, Quantity, Throughput, Profit/Loss) considered for each supplier typology (Historic data was adopted); to decide the **suppliers typology** which can be either **(**Defender, Prospetor or Analyser) a questionnaire was used; for data regarding the **focal firm (**Questionnaire & Interviews) were conducted; and for **performances** of the organisation Historic data & Interviews were conducted.

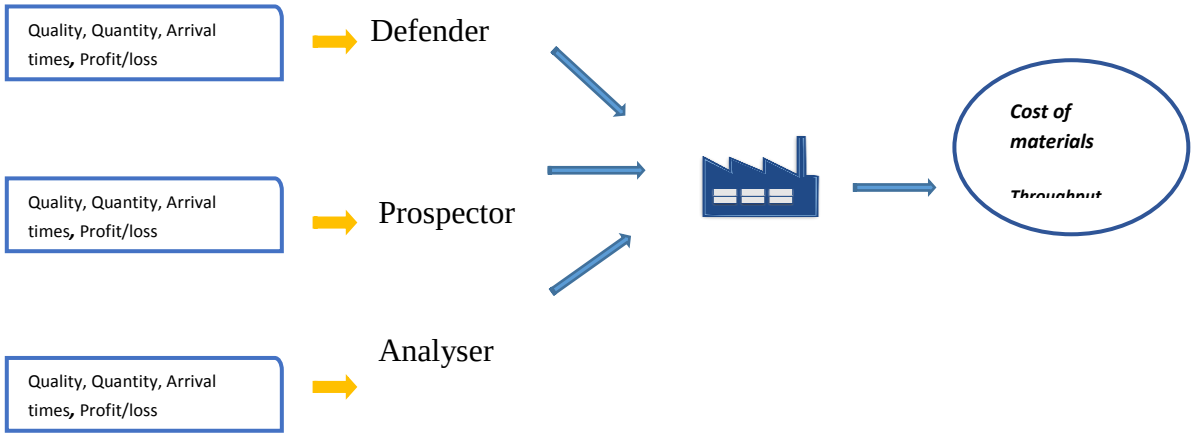


Figure 6.3: Data collection Model

6.6.1 Inputs Variables (supplied by suppliers)

In building the model the *inputs* and *outputs* where considered prior to thinking about the *content* of the model. The *inputs* are represented by the three successful Miles and Snow's typology of suppliers - Defenders, Prospectors and Analysers that are altered to achieve the modelling objectives. The Miles and Snow self-typing questionnaire test was conducted on suppliers of each supply network. This helped to identify which Miles and Snow company-type the company belongs to, either Defenders, Prospectors, Analysers and Reactors (see Appendix B for Miles and Snow Questionnaire). Also, interviews were conducted on the Reactors suppliers to ascertain their claimed typology. This is the first step of data collection for suppliers to satisfy Level 1 in Table 6.2 below

Level 1	Level 2	Level 3
Defender Prospector Analyser	*Cost of materials*	Price per unit *Very expensive (5), expensive (4), normal (3), low price (2),very low(1)),*
	Cost of materials *Arrival times*	(*Late, On time, Early*)
	Quantity delivered	Quantity ordered Quantity delivered
	Quality delivered	Quality delivered *(Excellent (5), most satisfactory (4), fair (3), poor (2), most dissatisfied*

Table: 6.2: Hierarchical structure for supplier modelling

The needed variables for simulation of each of the suppliers are input *Cost of materials, Arrival times, Quantity delivered, Quality delivered (Raw materials).* Historic Data and Observations were adopted to gather data over a period of six consecutive months and recorded in a table (see table in Appendix E). *These questions are* Date of order*;* What was ordered*;* Quantity ordered*;* Quality ordered, Date ordered, Date delivered, What was

delivered, Quantity delivered, Quality delivered *(Excellent (5), most satisfactory (4), fair (3), poor (2), most dissatisfied (1),* Price per unit price (Naira- Nigerian currency); (*Very expensive (5), expensive (4), normal (3), low price (2),very low (1);* Time of delivery*;* Methods of delivery (Courier, directly from the organisation, others), Where are the materials used? Jobs for which they are used?

From these, needed information deduced for this data are: arrival time, date and time agreed, date and time delivered, differences between arrival times, (*Late, On time, Early*). *Quality delivered:* using range (1-5), *Accuracy of Quantity*: was deduced from quantity ordered and quantity delivered, *Price:* the actual price of each material and price unit per options (1-5). This explained data gathering process was embraced to derive Level 2 and Level 3 to model each supplier.

6.6.2 Process (Hub Organisation Operations)

Process are the activities and operations within the hub organisation. This is determined by the relationship between ***input*** and ***output*** (Stewart Robinson, 2011). The table below illustrates the steps taken to derive the needed data for ***process*** (hub organisations operations).

- **The Input Variables** are divided into Level 1 (variable) and Level 2 (subdivision of each variable) as shown in Table 6.3 below.

- **The output** are the **performance** measures considered for this study.

- **Data for Process** the process is the operations within the hub organisation. This is determined by the relationship between input and output. To determine this relationship, questions were generated as shown in the 2nd column - Questions Relating **input** variables to

output - *Cost of materials, Throughput, Quantity delivered, Quality delivered*. The reply to this questions

generated the data and information that is regarded as (Data for Process) in the 3rd column. This is the data and information that shows the operations within the hub organisation.

Data sources to achieve the steps above, which is, to generate (Data for Process). Various data sources were used for each question to be satisfied.

- For questions relating *Time of delivery* to *output*, this answers were acquired using *interviews, observation and historic data.*

- Questions relating *quality* to *output* were satisfied using *interviews, observation and historic data.*

- For questions relating *Cost of Materials* to *output* the source of data was from *interviews, observation* and *historic data.*

- *Historic data* and *interviews* were conducted to satisfy questions relating *quantity* to *output*.

- For questions relating *Cost of Materials* to *output* the source of data was from *interviews, observation and historic data.* See Appendix C for semi structure interviews for hub organisation and Appendix E for tables for historic characteristics of suppliers.

The table below is the data generated for Planet catalogue hub process. The same steps were carried out on the 15 hubs firms to generated data and information for the operations within the hub firm (Data for Process).

Input Variable				
Level 2	Level 3	Questions Relating Input Variables to output (performance)	(Data for Process)	Output (performance)
Time of delivery	Late	If organisation receives your delivery (late). How will it affect your organisation performances?	Minus 2% on daily quantity output Decrease Throughput by 2%	Cost of materials Throughput Quantity delivered Quality delivered
	Early	If organisation receives your delivery (earlier). How will it affect your organisation performances?	Plus 2% on daily output	Cost of materials Throughput Quantity delivered Quality delivered
	On time	If organisation receives your delivery (on time). How will it affect your organisation performances?	Plus 4 % on daily output Increase Throughput by 2%	Cost of materials Throughput Quantity delivered Quality delivered
Quality	Excellent	If the raw materials delivered to your organisation are (Excellent) quality. How does it affect your organisation performances?	Plus 5% on Output Quality	Cost of materials Throughput Quantity delivered Quality delivered
	Most satisfactory	If the raw materials delivered to your organisation (Most satisfactory) quality. How does it affect your organisation performances?	plus 2% on Output Quality	Cost of materials Throughput Quantity delivered Quality delivered
	Fair	If the raw materials delivered to your organisation are (Fair) quality. How does it affect your organisation performances?	No effect	Cost of materials Throughput Quantity delivered Quality delivered
	Poor	If the raw materials delivered to your organisation are (Poor) quality. How does it affect your organisation performances?	Minus 2% on Output Quality Minus 2% on Unit Profit	Cost of materials Throughput Quantity delivered Quality delivered
	Most dissatisfied	If the raw materials delivered to your organisation are (Most dissatisfied) quality. How does it affect your organisation performances?	Minus 5% on Output Quality Minus 5% on Unit Profit	Cost of materials Throughput Quantity delivered Quality delivered
Cost of Materials	Very expensive	If you purchased materials at a (very expensive) price. How does it affect your organisation performances?	Plus 2% to unit cost	Cost of materials Throughput Quantity delivered Quality delivered
	expensive	If you purchased materials at a (very expensive) price. How	Plus 1% to unit cost	Cost of materials Throughput Quantity delivered

		does it affect your organisation performances?		Quality delivered
	Normal	If you purchased materials at a (Normal) price. How does it affect your organisation performances?	No effect	Cost of materials Throughput Quantity delivered Quality delivered
	Low price	If you purchased materials at a (Low) price. How does it affect your organisation performances?	Minus 1% to unit cost	Cost of materials Throughput Quantity delivered Quality delivered
	Very low	If you purchased materials at a (Very low) price. How does it affect your organisation performances?	Minus 2% to unit cost	Cost of materials Throughput Quantity delivered Quality delivered
Quantity	Exact demand	If the quantity delivered was (exact).How does it affect your organisation's performances (Quantity, Quality, Profit/Loss, and Throughput)?	No effect on quantity produced	Cost of materials Throughput Quantity delivered Quality delivered

Table: 6.3: Organisation's Process

6.6.3 Outputs (Hub Firm Performances)

Performance Category	Data Required	Data Source
Throughput	The time it takes from start to finishing production	Interviews, historic data
Quality	The quality of their production	Interviews, historic data
Profit/loss	What gain or loss the hub makes	Interviews, historic data
Quantity	The quantity produced daily	Interviews, historic data

Table 6.4: Organisation's Output (performance)

The output performances were obtained and analysed. The outputs are the performances of the supply network that informs whether the modelling objectives are being achieved for *'As Is'* scenario. The key performance indicators for this study are; Quantity Produced - the amount of finished products; Throughput - the time spent in the system, from raw materials into finished products; Profit/Loss - the gain or loss on production; Quality - standard of finished products. The model receives the inputs about suppliers Defender, Prospector or

Analyser which are modelled based on Cost of materials, Arrival times, Quantity delivered, Quality delivered, to give the outputs result or performances. The instruments used to collect the historic data can be found in Appendix E. Information derived from historic data is detailed in the next subheading, which reviews details of how the data gathered is modelled for simulation.

6.7 Model Development and Key Features

In this section, the explanation will be made using Planet Catalogue's supply line (a Multiple Driven supply network). This entails explaining how inputs variables data for Cost of materials, Arrival times, Quantity delivered, Quality delivered; are interpreted and modelled using Simul8. Secondly, it gives details of how (Data for Process) derived in Table 6.3, was used in modelling of the hub organisation. Likewise, Tables 6.5, 6.6 and 6.7 below, show the data from Planet Press catalogue. This same process, explained below was adopted in modelling the remaining 14 supply lines studied for this project.

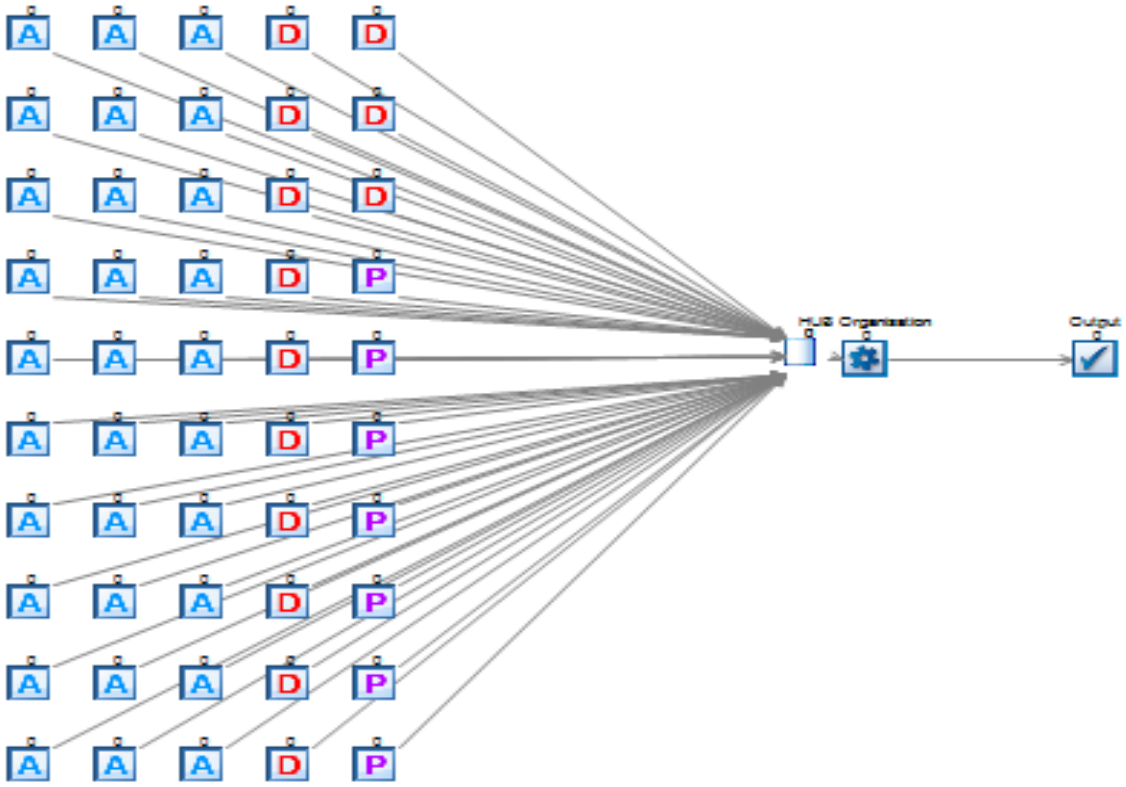


Figure 6.4: The Supply Network Model

Figure 6.5 above, is the screenshot of Planet Catalogue, the supply network was modelled for the purpose of this research using Simul8 software. The 3 major sections in this model are; firstly, **the suppliers** *(A - Analysers, D - Defenders and P – Prospectors*), secondly the **huborganisation** *(operation/Process)* and lastly the **output** *(where performance are measured).* These are explained below in Sections 6.7.1; 6.7.2 and 6.7.3 respectively.

6.7.1 The suppliers

Figure 6.5: Entrance of material

This is the first phase of the model, Raw materials are supplied by either *A - Analysers, D-Defenders or P - Prospectors* suppliers. At the entrance of materials, the data for variables; Cost of each materials, Suppliers Time of Deliveries, Quality delivered by supplier and Quantity delivered by supplier were incorporated into the model. Headings 6.7.1.1, 6.7.1.2, 6.7.1.3, 6.7.1.4 and 6.7.1.5, illustrate how the data for each variable was used to model the supply network.

6.7.1.1 Cost of each material

This unit explains how useful simulation data were deduced from the raw data, the calculations involved and presents the data that is used to model the three supply networks. The input variables considered are: Cost of Materials, Time of Delivery, Quality and

Quantity. The costs of materials for suppliers are categorised into Very expensive, Expensive, Low price, Normal Price, Very Low price. This is grouped in percentages to get the range for each typology in percentages (%). As reflected in the table below is a sample - Planet Catalogue suppliers range.

Typology / Cost Of Materials	Analysers (%)	Defenders (%)	Prospectors (%)
Very expensive Price	0	10	18
Expensive Price	63	36	64
Normal Price	31	54	18
Low Price	6	0	0
Very Low Price	0	0	0

Table 6.5: Costs of Materials for Suppliers

6.7.1.2 Suppliers Time of Delivery

The raw data gathered for delivery times of each supplier are Date and Time agreed for delivery, Date and Time delivered, (the time the suppliers brought the materials, this can either arrive on time, late or earlier) for each type of supplier.

$D_tAD–D_tOD=DIT$

DIT=O On time (Equation 5.1.1)

$D_tAD – D_tOD=DIT$

DIT > O Earlier (Equation 5.1.2)

$D_tAD - D_tOD=DIT$

DIT < O Late (Equation 5.1.3)

Notation(s)

D_tAD = Date and Time Agreed for delivery

D_tOD = Date and Time of delivery

DIT = Difference in Time

Typology / **Arrivals**	**Defenders (%)**	**Prospectors (%)**	**Adapter (%)**
Late	4	8	31
Early	35	9	35
On time	61	83	34

Table 6.6: Sample Example - Time of Arrivals for Suppliers

6.7.1.3 Quality delivered by supplier

The quality of materials supplied by each supplier are categorised as either of these options: Excellent, Most satisfactory, Fair, Poor, Most dissatisfied. This is then grouped into percentages for Analysers, Defenders and Prospectors. As reflected in the table below, a sample of how quality produced by suppliers for each of the supply networks are calculated to derive their ranges. For this Planet Catalogue, all suppliers fall into either; Excellent (5) and Most satisfactory (4), however, the percentages vary for each typology as shown in Table 6.7.

Typology / Quality	Adapter (%)	Defenders (%)	Prospectors (%)
Excellent(5)	63	73	46
Most satisfactory(4)	37	27	54
Fair (3)	0	0	0
Poor (2)	0	0	0
Most dissatisfied(1)	0	0	0

Table 6.7: Sample Example - Quality for Suppliers

Sample tables for the Cost of Materials, Time of Delivery, Quality and Quantity. For suppliers of the hub organisations are attached in Appendix (E).

6.7.1.4 Quantity delivered by supplier

For quantity delivered by supplier, two factors are considered to represent this variable in the model:

- The inter-arrival time, this is the time between each arrival into the system and the next arrival. This is calculated in hours for each of the suppliers' delivery.

- The quantity of materials that was delivered by each suppliers at every inter-arrival time. (See detail of how it is applied in the model in 6.7.1.5.1).

6.7.1.5 Modelling Distinction Fitting

To simulate the variables above, Law (2013) suggestion was followed. To implement and model the simulation correctly, there is a need to understand the concepts of probability and statistics; an inappropriate choice of distribution in simulation can lead to the risk of misinterpreting the results of the simulation model. Statistical distribution provides a method

for simulating the variations that occur in timing (and other numbers) in any process involving people, machines or anything in nature. This allows the ability to compactly represent a great deal of information about a given random variable. This in turn is what makes a distribution so important in simulation; if a simulation is going to accurately mimic the randomness seen in real world outcomes, it must have some idea of how likely each outcome is to get this information from a distribution (Devore, 2011). There are two main categories of Distribution: Discrete and Continuous (Devore, 2011). If a coin is flipped or a dice rolled, there are a finite set of possible outcomes. These finite outcomes define a discrete distribution. A continuous distribution represents an uncountable innumerable number of possible outcomes. An example is the duration of a journey - each incidence of a journey will take a marginally different time or the time taken to perform a manual operation will be continuous.

6.7.1.5.1 Quantity delivered by supplier

A Fixed distribution (not a distribution as such, but a static number that cannot vary) (Averill, 2013; Kleijnen, 2000; Devore, 2011), was used for the quantity of material delivered by a supplier at inter-arrival time. An example for ***supplier 1*** in Figure 6.7, ***the inter-arrival times was 10 minutes*** with ***fixed distribution***. This same step was carried out for each supplier in the supply network.

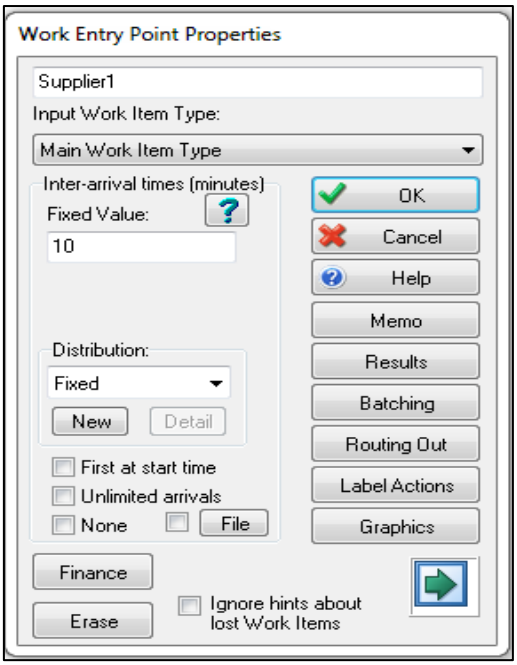


Figure 6.6: Sample Example for Quantity delivered by supplier

6.7.1.5.2 Probability Profile Distribution

Simul8 has an in-built provision that allows users to define the distribution curve. This is called *Probability Profile Distribution.* This distribution gives the exact. and effectively configures the distribution for either Discrete or Continuous. However, discrete distribution is used for the Tables 6.5, 6.6, and 6.7 which were modelled using the profile distributions. The sample below is for the Time of Arrivals for Suppliers. It replicates data (percentages) in Table 6.6 into Figure 6.7 below for modelling.

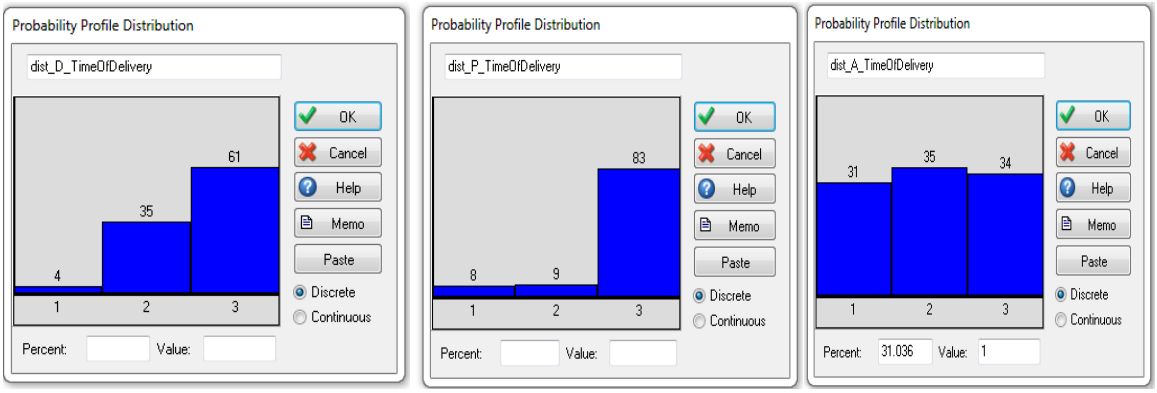


Figure 6.7: Sample Example - Probability Profile Distribution

- For Arrival times: 1 represents Late, 2 represents Early, 3 represents On time

- For typology;

Defenders is represented as (dist_D_Time Of Delivery)

Prospectors as (dist_P_Time Of Delivery);

Analysers as (dist_A_Time Of Delivery).

For example, the first box above - dist_D_Time Of Delivery represents Defender suppliers of Planet catalogue supply line; where 4% defender suppliers delivers late, 35% delivers earlier, and 61% deliveries were late. The same technique is adopted to interpret and model the data in Tables 6.5: Costs of Materials for Suppliers and Table 6.7: Sample Quality for Suppliers.

6.7.2 Hub Organisation

The 2nd major sections of the model **in (**figure 6.5), is the **hub organisation** *(operation/Process).*

Figure 6.8: The hub

The data generated in Table 6.3 (Data for Process) in the 3rd column was used to model the hub process using Simul8 visual logic (see Visual Logic sample in Appendix G: Simulation Control Logic).

6.7.3 Exit

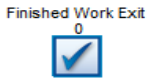


Figure 6.9: The complete model

The last sections of model in (Figure 6.5), is the output. This is where the results (performances) are collated and analysed for the supply network.

6.8 Simul8 Key Concept

Simul8 is made up of various objects for making models or structures. These structures are represented on the screen by a number of objects and lines; Routing Arrows, for joining objects; items that flow through the model are called Work Items – these are raw materials that are processed during simulating; The main objects contained within Simul8 are shown in the figure below:

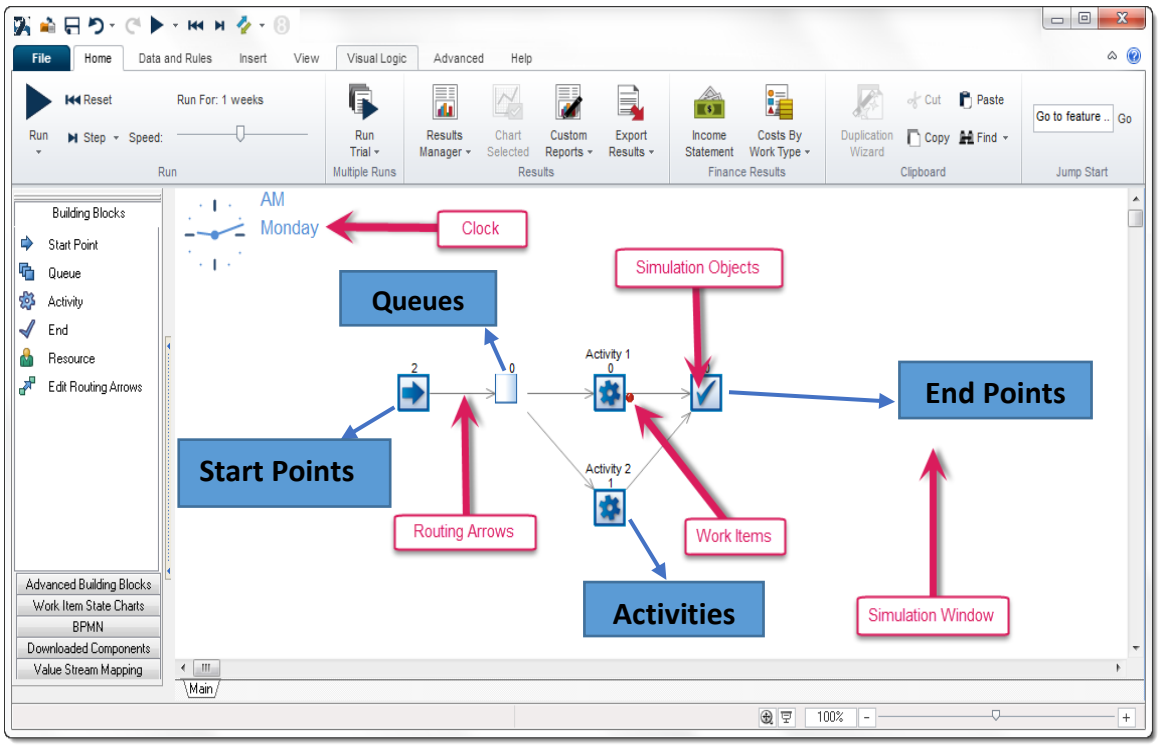


Figure 6.10: Simul8 Modelling Tools

Start Points where work enters the simulation; *Queues* where work waits to be processed; *Activities* where work has something done to it; *End Points* where work leaves the process; *Routing arrows* are used to connect simulation objects, it shows the route that the work items take through the simulation; *Simulation Window* is where the model is drawn. Each icon represents an object in the simulation, when the simulation is run, the work items flow around the model. *The Clock* in the corner of the screen helps to set the duration of model run; *Run button* ► executes the model simulation and collate the run results.

6.9 Visual Logic

Visual Logic was adopted at different stages of the model, especially for the Hub settings variables. Visual logic is Simul8's programming language introduced in 1998's version 4, and developed by Simul8 corporation. It is both proprietary and unique. Yet in many ways it resembles many other application-level languages based on the statement builder concept. Earlier versions of Simul8 relied on Microsoft Visual Basic (VB) and Visual Basic for Application (VBA) for complex control of routing logic. The picture is now much different as Visual Logic has increased in functionality, become powerful, flexible, and much faster (Hauge and Paige, 2004). In this study for the modelling of the supply networks, Visual Logic was used to incorporate (Data for Process) from Table 6.3, for the hub organisation process. Also it was used to quantify and assign ranges to the Quality produced by each of the supply network model (see 6.11.1) - the quality performance was assigned ranges because it is a qualitative performance measure and cannot be measured numerically. Additionally, Visual Logic helped to create an Excel interface, where - *output or performances (the results of the simulation*) is automatically reflected in Excel after each run.

6.10 Simulation Timings

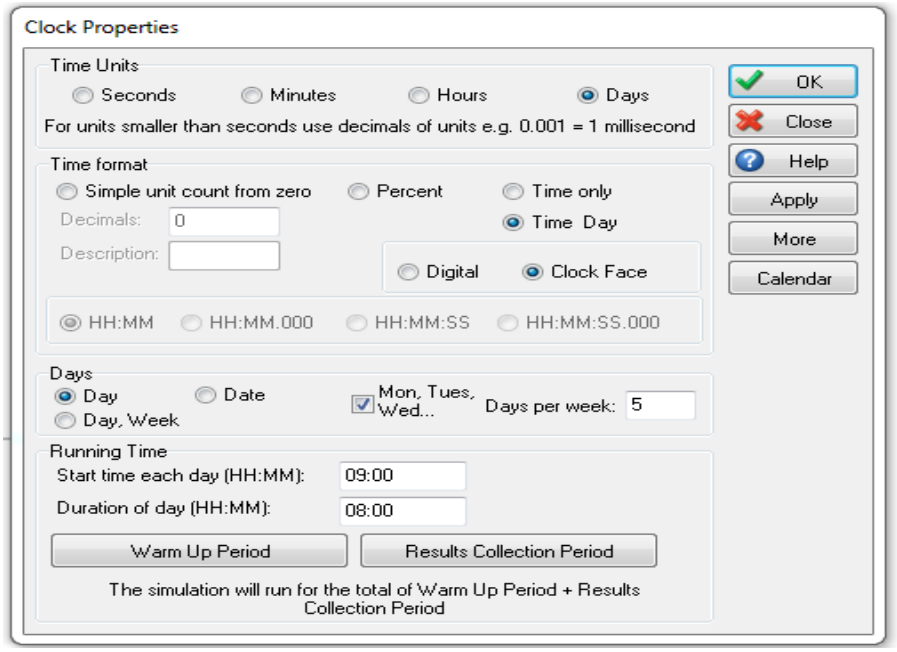
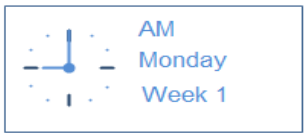


Figure 6.11: Timings

The simulation timings for this study as carried out is described below,

Clock Properties 

the simulator is set up by choosing 'Digital' on the Clock Properties screen, choosing the option of the number of weeks and date to start collating results. For the reason of the long result collection period, displaying weeks on the clock is very relevant. This is a quick way of seeing how far through the months and weeks the simulation has run.

*Duration of a Day***;** each model is set to work from 9am to 5 pm and 5 days a week, which is the actual duration each organisation operates. Under the 'Running Time' section of clock properties, the duration is set. The start time, the duration of the day (not the end time) and the number of days was set as 5 days.

Time Units used is set as days. All timing values in the simulation follows this time unit and the results reflect per day on each row.

6.10.1 Results Collection Period and Warm-Up-Period

Before considering the results collection period, it is appropriate to consider the 'warm-up' time. The *results collection period* is the length of time the model should be run collecting results. Also, simul8 will not start to collect results until the warm-up-period is finished. Therefore, it is necessary to find a suitable warm-up-time for the 15 supply lines modelled. Simulation of factories usually need a warm-up time, this is because the simulation is likely to start empty, and also real factories do start each week with work-in-progress. The only situation where there is no need for warm up time is when the factory is new with no work in progress. However, for this study, the factories are in existence so, there is a need to set a warm-up time. Simul8 package contains facilities to set a warm-up time. To decide the duration for the warm-up time of the simulations, the following 4 steps were followed as suggested by (Hague and Paige, 2000; SIMUL8 Corporation, 2015).

Step 1: Decide the measures of performance

The performance measures for this simulation are *Cost of Materials, Time of Delivery, Quality and Quantity produced*. Because there is more than one performance to be measured, this step was carried out on each of these performance measures, and the longest warm-up time indicated by either of these measures was adopted. The example used in describing these steps is the quantity produced.

Step 2: Run the simulation for a short period of time

The simulation was run for short period of time 60 minutes. However, the number of products that emerged from the factory was zero for the first 60 minutes. This means no products have reached the end of the factory yet.

Step 3: Run the simulation again

The run was increased for another 60 minutes, the run time was gradually increased until result increased above zero. As shown below, that 0 product were produced at 60 and 120 minutes. The number of products that left the factory for each increase were recorded. This was done continually to generate the table and graph as shown below:

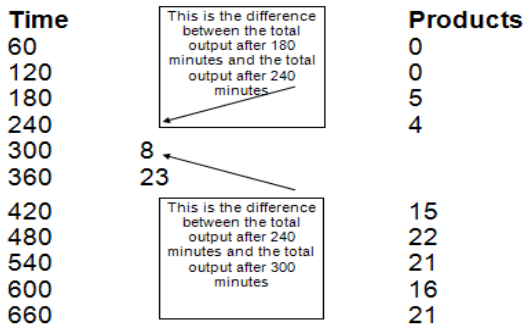


Figure 6.12: Simulation Runs

To show the changes in product output with time; the chart plotted below shows that there is a fairly distinct difference between the number of finished products prior to time 360 and the number of finished products after time 360. This means that before time 360 the simulation was still 'warming up'.

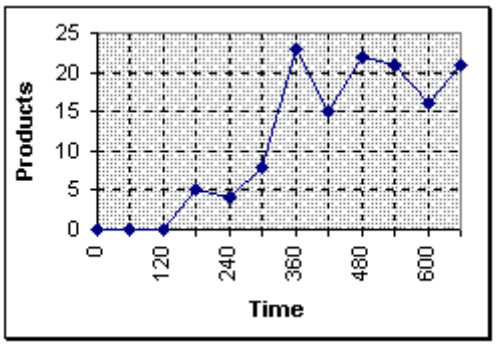


Table 6.8: Product Output Scale

These same steps were carried out on the research models to generate the warm-up-time for each performance of the 15 supply lines. These warm-up times for the models ranged between (3 months) to (7 months) for either of the models.

Step 4: Define safety margin

Once the warm-up times were determined, a 20% safety margin was added. So that the range becomes (3 month and 18 days) to (7 months and 42 days). However, to set the results collection period, (which is the length of time simulation should run collecting results). and knowing that, the simulation will not start to collect results until the warm-up period is finished. So, considering that the data collected for this research covers six consecutive months, 6 months is therefore added to the warm-up-period to give a range of between (9 months 18 days) and (14 months and 12 days) for the models. Based on Hague and Paige, (2000), the only harm in making the warm-up time or Results Collection period too long is that it can take up a lot of your time when running the model. However, this does not affect the quality and accuracy of the simulation result. Therefore, for uniformity, the results collection period for this research for each model is set for three years.

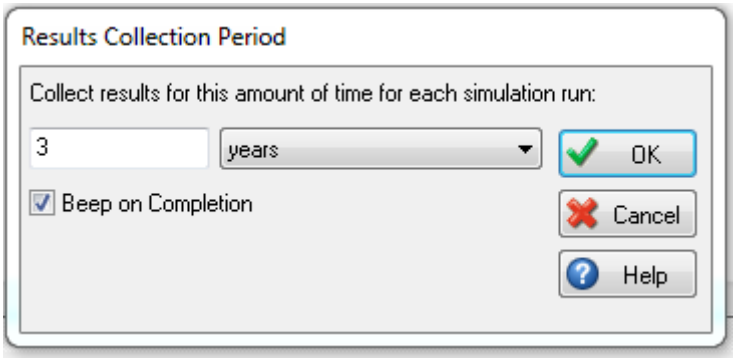


Figure 6.13: Collection Period

Trials runs are carried out on the *As Is* simulation model performed with the same parameters. Each run uses a different random number stream set. This helps to authenticate the process to straighten out for consistency, and analyse results.

Random Numbers are considered in this analysis. It enables the simulation to include the variability that occurs in real life. *Random Numbers* are applied for the input variables - *Cost of Materials, Time of Delivery, Quality and Quantity*. For every run a new set of random numbers are used within the same model analysis and results collection. Simul8 software has an inbuilt facility called *'Auto change'* which allows for different streams of random numbers to be generated and applied for every time the simulation is re-run.

6.11 Model Verification and Validation

To enhance the confidence of the results collected for this study, verification and validation were put in place which enhance the reliability of the analysis and buttress decision making. Validation and verification were carried out on the models to make sure the system is functioning as expected, and accurately.

Conceptual Model, Data, White-Box, Black-Box Validation tests were carried out to ascertain reliability of the systems (Robins, 2013). This is meant to ascertain a high level of accuracy

and also serves as a simplified means for understanding and exploring reality (Pidd, 2003). Verification is the process of ensuring that the model design (conceptual model) has been transformed into a computer model with sufficient accuracy (Davis, 1992; Sargent, 2013). On the other hand, validation serves as a means to ensuring that the model is sufficiently accurate for the purpose of this study (Carson, 1986; Sargent, 2011; Banks *et al.*, 2010). Both tests are adopted hand-in-hand to ensure that the model is sufficiently accurate to satisfy the aims of this work (Sargent 2011, 2013; Oberkampf and Roy, 2010).

In carrying out the *Conceptual Model Validation,* the managers of various sections *(operations, supply chain, production)* of the hub firm participated to authenticate and certify the model. There was continued discussion with participants to keep them actively engaged and updated on the model building process, whilst allowing the verification of the model to occur continuously during its development. The entirety of the *Conceptual Model Validation* entails checking and determining that the contents of the assumptions and simplifications of the model, and affirming it is sufficiently accurate before being incorporated in the supply network model.

A process called *Data Validation* was implemented for this study, where data collected were analysed to ensure consistencies, and any area of information that caused concern was investigated. Various qualitative and quantitative methods were adopted at this stage, ensuring triangulation, and that the data collected were as accurate as possible, whilst ensuring that the sources of data are reliable. *Experimentation Validation* is another key issue that was considered. The warm-up time, and run-length and number replications were ascertained in accomplishing this type of validation. These steps are taken and discussed in

Section 8.3.1. This is done to satisfy the requirements for removing bias as pointed out by Robinson et al. (2011). There are several steps taken to Verifying the model. Verification was continuous throughout the modelling process to ensure that the conceptual model is true to required specification and it functions as expected. In accomplishing this investigation the verifications adopted include; *checking the code* where the entire Virtual Logic (VL) used in the model was checked to ensure each routine was functioning correctly; getting colleagues to read through the code; and getting help from simul8 experts' help-desk service for a second check, and third check.

The model was screened through some *Visual checks* where the model was run severally to watch critically, and check each element and the logic in the model in comparison against the real world characteristics of the hub firms. Approaches to accomplish this are; stepping through the model event by event; stopping the model, predicting what will happen next; running the model on and checking what happens; interactively setting up conditions to force certain events to take place; creating extreme conditions such as a very high arrival rate; to determine whether the model behaves as expected; isolating areas of the model so it runs faster; reducing the time to perform thorough verification and validation; explaining the model as it runs to those knowledgeable about the real system in order to gain their opinion; tracing the progress of an item through the model and watching the model running for various periods of time. This is put in place so as to identify or correct any shortcomings and add credibility to the study.

6.11.1 Comparison with the real system:

There are two major approaches available to choose from in performing the *Black-Box Validation*. The first is to compare the simulation model to the real world; secondly,

comparison with another related model, which is appropriate only when there are no real world data to compare against. However, for this study there are real data collected available for comparison, therefore, the former approach was adopted. This approach claims that to place confidence in the models; when the modelled simulation is run under the same conditions (inputs and variables) as the real world system, the outputs should be sufficiently similar. This is described in Figure 6.13 and Equation 6.1 and 6.2 below:

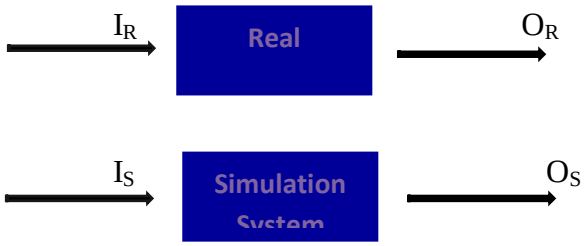


Figure 6.14: Validation Comparison

If, $I_S = I_R$ ……..... Equation (6.1)

Then, $O_S \approx O_R$…….. Equation (6.2)

Where;

Real system is the exact real life situation of the system (supply network)

I_R – the inputs to real system

O_R – the outputs from real system

I_S – the inputs to simulation model

O_S – the outputs from simulation model

To enhance confidence in the model, Equations 6.1 and 6.2 must be satisfied. When the same value of data for variables in the real system (I_R) is placed into the modelled system (I_S) i.e. ($I_S = I_R$) and run under the same conditions as the exact situation of the system (supply

network) then, the output of the simulated model (O_S) should be sufficiently similar ($\approx$) to the real system (O_R) i.e. ($O_S \approx O_R$). In verifying this aspect of the research, the historic data collected from the real system (supply network) performances were compared with the simulation 'As Is' results of the models for each of the supply network. The difference between historical and *As Is* simulation performance means for - Quantity Produced, Throughput and Profit/Loss, are presented in Table 6.8a, and for Quality produced is in Table 6.8b below;

Hub Organisations	**Throughput**	**Output Quantity**	**Profit and Loss**
Planet Earth Catalogue *(Historic Mean)*	0.0373	16905	81132
Planet Earth Catalogue *(As Is Mean)*	0.0413	16910	81134.23
Planet Earth Calendar *(Historic Mean)*	0.177	8254	57758
Planet Earth Calendar *(As Is Mean)*	0.18	8257	57761.8
Grand Oak Lord Dry Gin *(Historic Mean)*	0.21	1453	130505
Grand Oak Lord Dry Gin *(As Is Mean)*	0.23	1445	130508.17
Grand Oak Bacchus Lite *(Historic Mean)*	0.043	7256	978618
Grand Oak Bacchus Lite *(As Is Mean)*	0.04	7259	978622.03
May and Baker spring water *(Historic Mean)*	0.0512	7440	119109
May and Baker spring water *(As Is Mean)*	0.049	7438	119115.61
Gablek Wine Tonic Label Printing *(Historic Mean)*	0.011	29830	59660
Gablek Wine Tonic Label Printing *(As Is Mean)*	0.012	29832	59664.84
Gablek Seamann Label Printing *(Historic Mean)*	0.008	38955	77900

Gablek Seamann Label Printing *(As Is Mean)*	0.009	38957	77902
Gablek Light Weight Packaging Printing *(Historic Mean)*	0.017	15380	15325
Gablek Light Weight Packaging Printing *(As Is Mean)*	0.018	15374	15324.86
Gablek Bank Teller Printing *(Historic Mean)*	0.0216	15145	189526.5
Gablek Bank Teller Printing *(As Is Mean)*	0.022	15141	189525.27
Living Proof Textbook *(Historic Mean)*	1.032	382	57289
Living Proof Textbook *(As Is Mean)*	1	384	57285.89
Living Proof Magazine*(Historic Mean)*	0.46	892	17857
Living Proof Magazine*(As Is Mean)*	0.44	899	17860.57
BET Glass*(Historic Mean)*	0.037	10450	522497
BET Glass*(As Is Mean)*	0.04	10447	522492.4
Ashney Printing Press*(Historic Mean)*	0.03	11901	19643
Ashney Printing Press*(As Is Mean)*	0.04	11906	19644.66
International Distilleries Limited -alcoholic *(Historic Mean)*	0.04	5682	569009
International Distilleries Limited -alcoholic *(As Is Mean)*	0.075	5678	569010.8
International Distilleries Limited -non-alcoholic *(Historic Mean)*	0.17	2155	727295.04
International Distilleries Limited -non-alcoholic *(As Is Mean)*	0.22	2160	727299.04

Table 6.8a: Quantity Produced, Throughput, Profit/Loss Validation Table

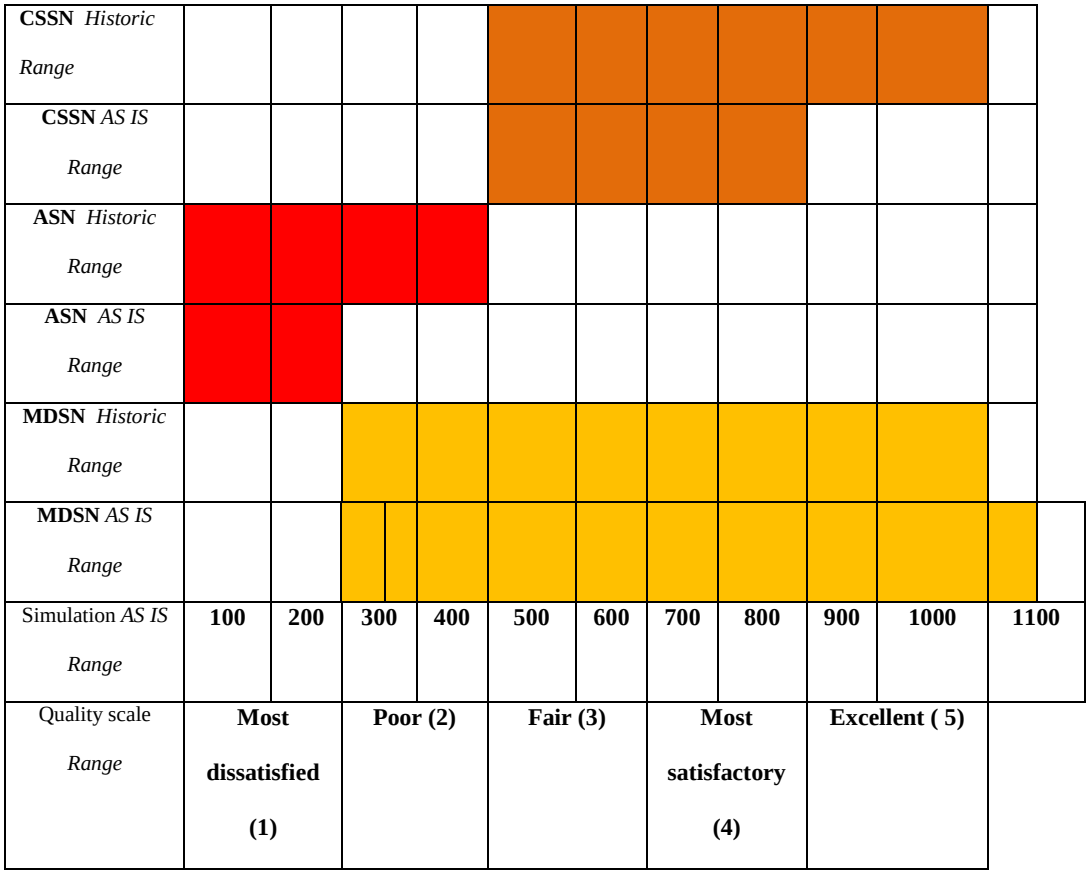


Table 6.8b: Quality Validation Table

Table 6.9b above compares each supply networks Quality performance. It compares the Historic Range (real data) to As Is Range (simulation result) for each supply network. For the Quality delivered which are either Most dissatisfied; Poor; Fair; Most satisfactory, or Excellent as discussed in Section 6.6 Data Collection. These ranges are quantified using simulation as follows; Most dissatisfied as between 100 to 200, Poor is between 300 to 400, Fair is between 500 and 600; Most satisfactory is between 700 and 800, and Excellent is between 900 and 1000. The Cost Saver Supply Network (**CSSN)** hub organisations are - Living Proof Press Limited supply line; Living Proof Printing Textbook, Living Proof Printing church Magazine and Beta Glass Company Plc considering wine bottles production.

Adapter Supply Network (**ASN)** organisation are Ashney Printing Press considering supply line; Ashney Box packaging Printing; Intercontinental Distillers Limited (IDL) with supply lines; Chelsea dry gin (alcoholic), Veleta sparkling fruit drink (non-alcoholic); And for Multiple Driven Supply Network (**MDSN)** the hub organisations are, Planet Earth Printing Company considering the supply line; Planet Earth Catalogue Printing, Planet Earth Calendar Printing; Nigeria Distilleries Limited (NDL) - Grand Oak Limited supply line, Grand Oak Lord Dry Gin, Grand Oak Bacchus Lite, May & Baker Nigeria Plc, considering supply line May and Baker Lily Spring Water, Gablek Reproduction & Print Limited with supply lines; Gablek Light Weight Packaging Printing, Gablek Wine Tonic Label Printing, Gablek Seamann Label Printing, Gablek Bank Teller Printing.

6.11.2 Results Available from the Model

This section presents the result from the simulation in Figures and Tables 6.10a, 6.10b, 6.10c, 6.10d; 6.11a, 6.11b, 6.11c, 6.11d; 6.12a, 6.12b, 6.12c, 6.12d for Quantity Produced, Throughput, Profit/Loss, and Quality performances. These results are presented using graphs and tables for each section. The graphs of the estimated means performances shows the 7 adopted scenarios which are As Is, Balance, All Defenders, All Prospectors, All Analysers. On the other hand, the table reveals the means; standard deviation (measure of spread or dispersion performances.

From the results for quantity produced, it can be deduced that the higher the quantity produced, productivity is improved and performance enhanced. On the other hand, when considering the performance results for profit and loss, *As Is* results are used as the standard in determining improved or reduced performance when the amount generated for the configurations are greater than the amount for *As Is.* It is considered that the performance improved is in terms of gain, however if the amount generated for the configurations is less than the amount for *As Is*, the performance based on profit generated is reduced. Also, for

performance in terms of quality produced, when the performance is greater than As Is, it is considered as an improved performance and vice versa.

In achieving these, the model will consider the *As Is* and *What if* scenarios. The first experimental work is the *'As Is'* scenario. This is the replica, real duplication of each organisation's supply network consisting of the hub organisation, and it is the actual configuration alongside the definite suppliers data collected.

What if scenarios are assumed scenarios, where the suppliers' configurations are varied and the impact on the performance compared and analysed. Seven '*what if*' scenarios were modelled for each supply network. These "what if" scenarios are;

"Balance" (Defender suppliers=Prospector suppliers=Analyser suppliers)

"*All Defenders"* (when all suppliers are Defenders)

"*All Prospectors"* (when all suppliers are Prospectors)

"*All Analysers"* (when all suppliers are Analysers)

"*MDSN"* (when A > D > P) used when the supply network is either CSSN or ASN

"*CSSN"* (when D > A > P) used when the supply network is either MDSN or ASN

"*ASN"* (when P > A > D) used when the supply network is either MDSN or CSSN

To achieve the models for scenarios CSSN, ASN, MDSN, averages of the percentage supplier configuration are used. For details see Chapter 4 Case Study. Where, CSSN *(56%, 11%,*

33%), ASN *(5%, 65%, 30%)* and MDSN *(24%, 13%, 63%)* for (Defender %, Prospector%, Analyser %).

6.11.3 Cost Saver Supply Network

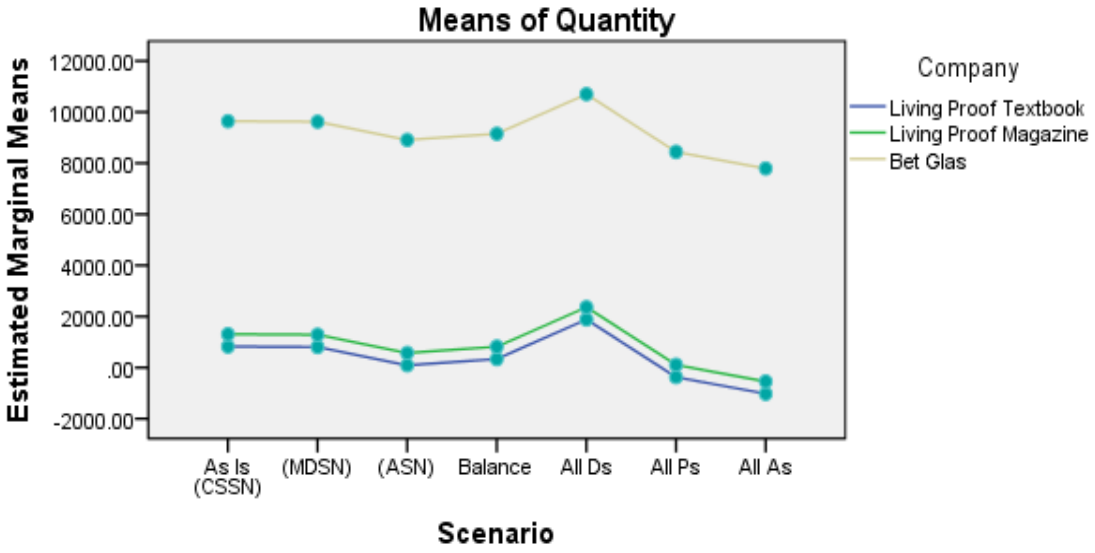


Figure 6.10a: Quantity for Cost Saver Supply Network

Scenario	Mean	Std. Deviation
As Is(CSSN)	***3925***	***5693***
MDSN	3907	5607
ASN	3189	4509
Balance	3435	4921
All Ds	4983	7167
All Ps	2725	3858
All As	2075	2939

Table 6.10a: Quantity for Cost Saver Supply Network

Figures **6.10**a and Table **6.10**a present the results of the various configuration scenarios in comparison to the As Is scenario. Figure **6.10**a shows a graphical presentation of the performances of scenarios - Cost Saver supply network (As Is), Multiple Driven supply network, Adapter supply network, All Defenders, All Prospectors, All Analyser and Balance

for each Cost Saver supply network hub firm. Table **6.10**a, reveals the combined Cost Saver supply network hub firms performances in terms of mean and standard deviation.

However, both Figure **6.10**a and Table **6.10**a, suggest that the Scenario As Is is greater than *All Prospectors, All Analysers, Balance, Adapter supply network, Multiple Driven supply network scenarios; and,* As Is < *All Defenders scenario*. This puts forward that for the Cost Saver supply network the more Defenders suppliers in the configuration, the greater the quantity produced.

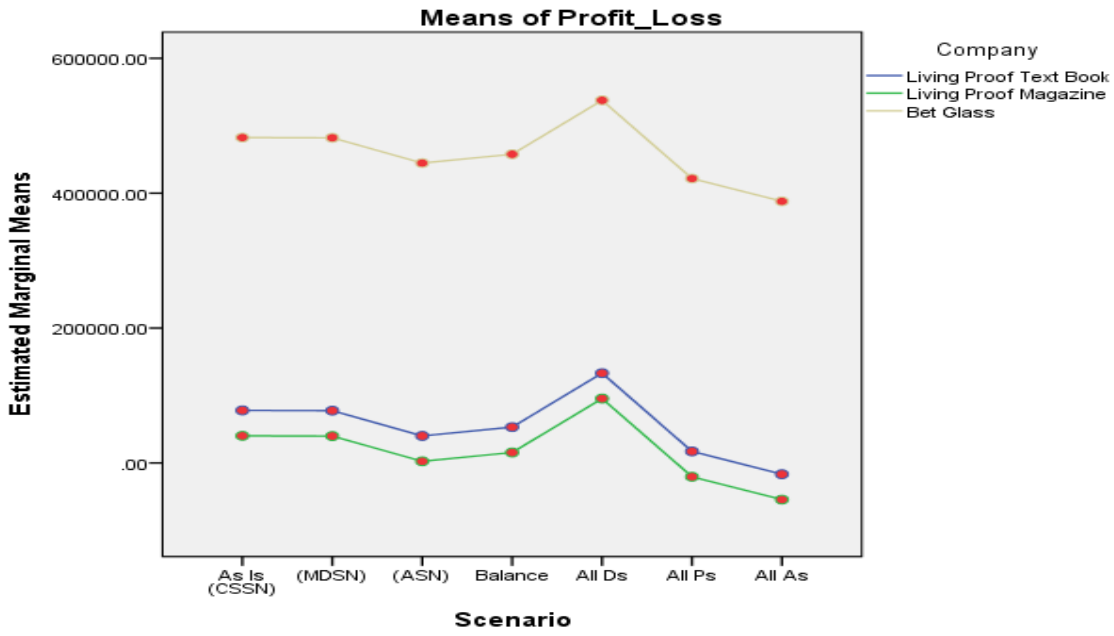


Figure 6.10b**:** Profit /Loss Cost Saver Supply Network

Scenario	Mean (Naira)	Std. Deviation (Naira)
As Is(CSSN)	200,187.89	281,990.68
MDSN	199,853.64	277,265.32
ASN	162,376.58	223,404.45
Balance	175,459.96	243,452.65
All Ds	255,436.44	354,102.92
All Ps	139,454.21	190,631.88
All As	105,642.79	145,499.99

Table 6.10b: Profit /Loss Cost Saver Supply Network

From Figure **6.10**b and Table **6.10**b, it is deduced that for the amount generated As Is is greater than *All Prospectors, All Analysers, Balance, Adapter supply network, Multiple Driven supply network scenarios;* As Is less than *All Defenders scenario*.

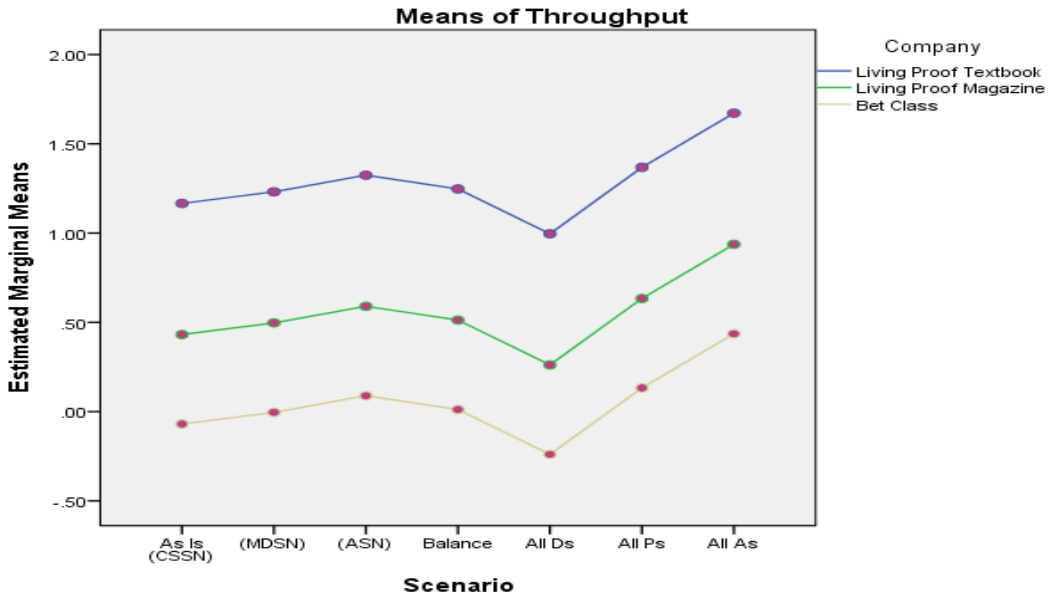


Figure 6.10c: Throughput for Cost Saver Supply Network

Scenario	Mean	Std. Deviation	Difference in mean (compared with As Is mean)	Percentage difference (%)
As Is (CSSN)	0.51	0.499		
(MDSN)	0.575	0.562	-0.065	-12.74509804
(ASN)	0.712	0.692	-0.202	-39.60784314
Balance	0.591	0.58	-0.081	-12.1257485
All Ds	0.339	0.323	0.171	33.52941176
All Ps	0.668	0.675	-0.158	-30.98039216
All As	1.015	1.019	-0.505	-99.01960784

Table 6.10c: Throughput for Cost Saver Supply Network

Going by the definition of throughput in comparison to Figure **6.10**c and Table **6.10**c, the lower the throughput, the higher the performance and vice versa. Therefore, in terms of throughput performances *As Is scenario is greater than All Prospectors, All Analysers, Balance, Adapter Supply Network, Multiple Driven supply network scenarios; As Is scenario is less than All Defenders scenario*.

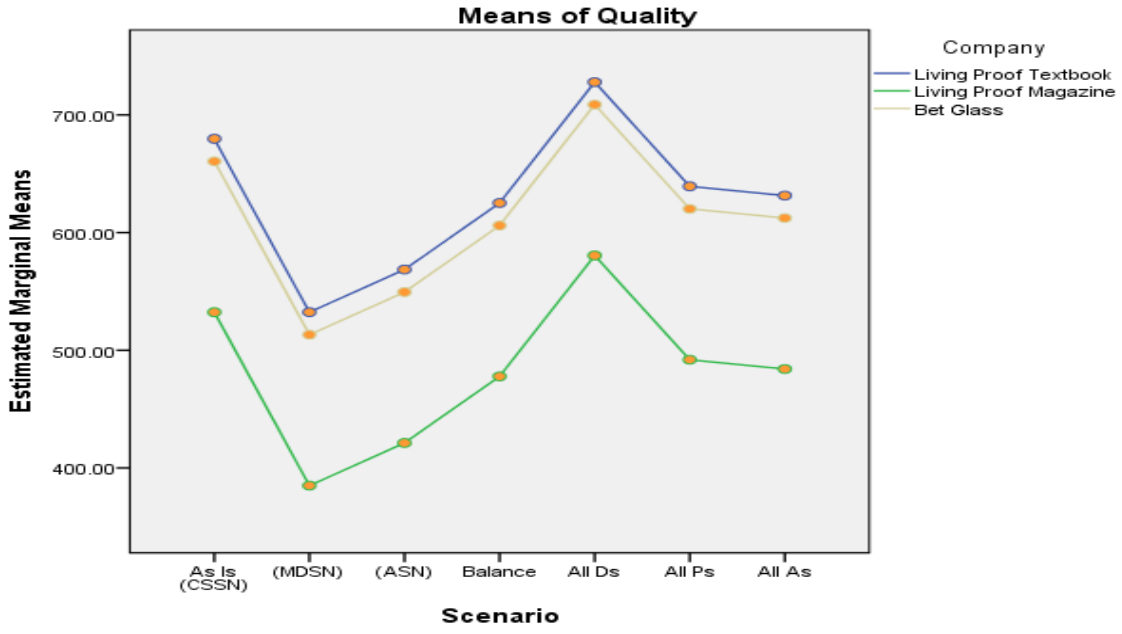


Figure 6.10d**:** Quality for Cost Saver Supply Network

Scenario	Mean	Std. Deviation	Difference in mean (compared with As Is mean)	Percentage difference (%)
As Is (CSSN)	624	95.52		
MDSN	477	58.84	147	23.55769231
ASN	513	69.08	111	17.78846154
Balance	570	77.29	54	8.653846154
All Ds	672	99.83	-48	-7.692307692
All Ps	584	81.88	40	6.41025641
All As	576	78.75	48	7.692307692

Table 6.10d: Quality for Cost Saver Supply Network

Figure **6.10**d and Table **6.10**d shows that for the Quality performances As Is is greater than *All Prospectors, All Analysers, Balance, Adapter supply network, Multiple Driven supply network scenarios;* As Is is less than *All Defenders scenario*.

6.11.4 Adapter Supply Network

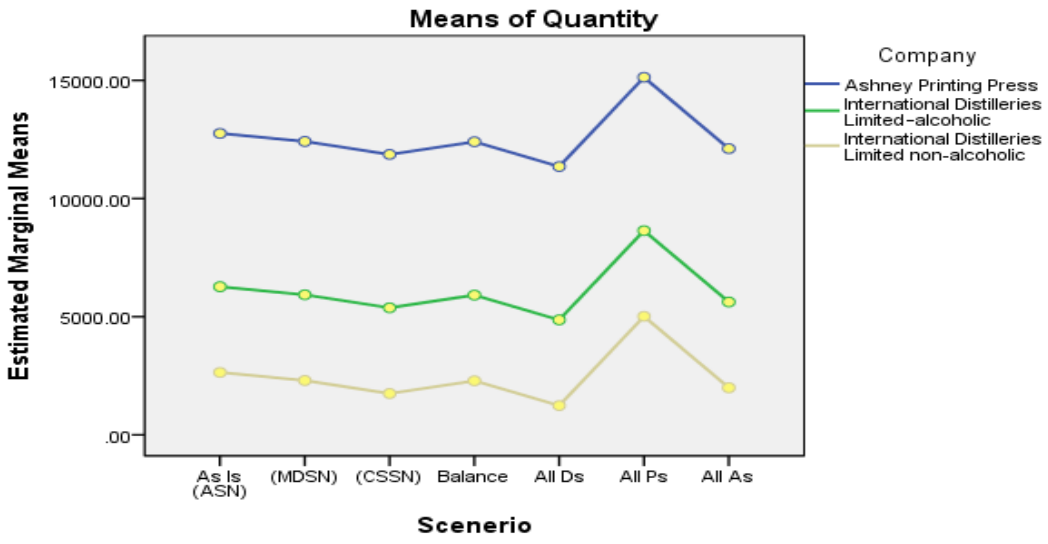


Figure 6.11a: Quantity for Adapter Supply Network

Scenario	Mean	Std.

		Deviation
As Is (ASN)	7223	5583
MDSN	6881	5172
CSSN	6330	4707
Balance	6867	5242
All Ds	5820	4117
All Ps	9596	6118
All As	6575	4938

Table 6.11a: Quantity for Adapter Supply Network

Figure **6.11a** and Table **6.11a** show the results of the various configuration scenarios in comparison to the As Is scenario. Figure 8.6a displays a graphical presentation of the performances of scenarios - Adapter Supply Network (As Is), Multiple Driven supply network, Cost Saver supply network, All Defenders, All Prospectors, All Analyser and Balance for each Cost Saver supply network hub firm. Whereas Table **6.11a** discloses the combined Adapter Supply Network supply network hub firms performances in terms of mean and standard deviation.

Both Figure **6.11a** and Table **6.11a**, suggest that the *performance of* Scenario *As Is is greater than All Analysers, All Prospectors, Balance, Cost Saver supply network, Multiple Driven supply network scenarios; As Is is less than All Prospectors scenario*. Therefore, from this result it indicates that for an Adapter supply network, the scenarios with higher existence of Prospectors suppliers' gives increase in quantity generated when compared with the As Is performance.

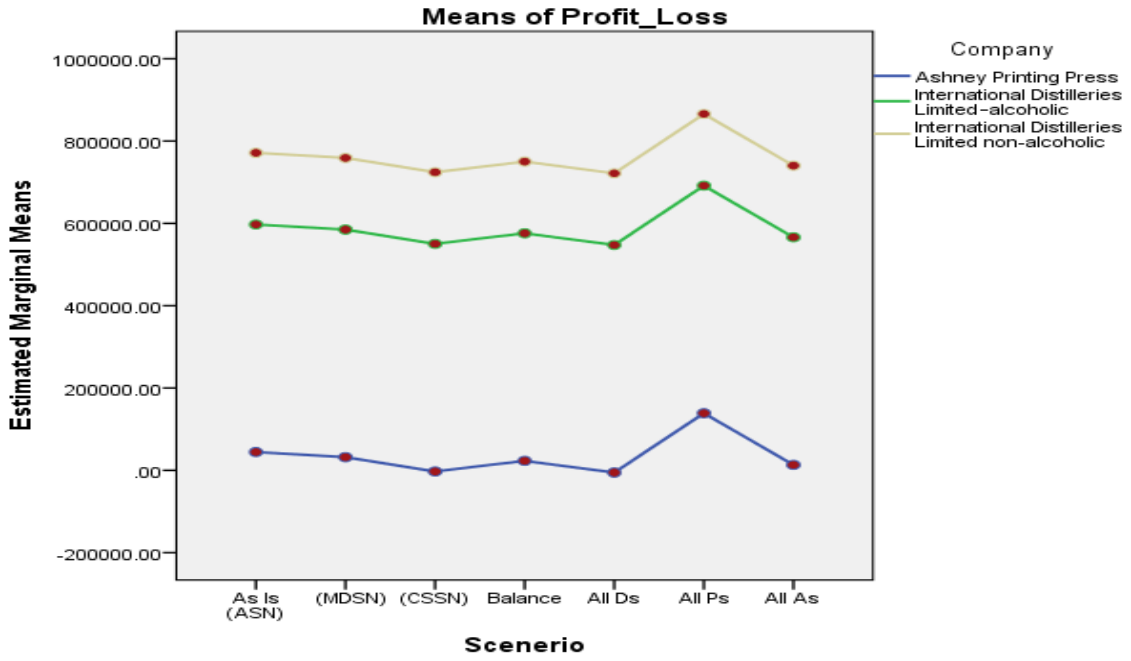


Figure 6.11b: Profit Loss for Adapter Supply Network

Scenario	Mean (Naira)	Std. Deviation(Naira)
As Is (ASN)	471,086.04	394,427.70
MDSN	458,658.28	383,993.04
CSSN	423,882.36	353,707.16
Balance	449,664.28	374,408.96
All Ds	421,240.74	369,875.41
All Ps	565,460.41	415,036.63
All As	439,850.15	369,346.45

Table 6.11b: Profit /Loss Cost Saver Supply Network

In Figure **6.11b** and Table **6.11b**, it can be inferred that for the amount generated for the Adapter Supply Network, *the performance for As Is is greater than All Analysers, All*

Prospectors, Balance, Cost Saver supply network, Multiple Driven supply network scenarios; As Is is less than All Prospectors scenario.

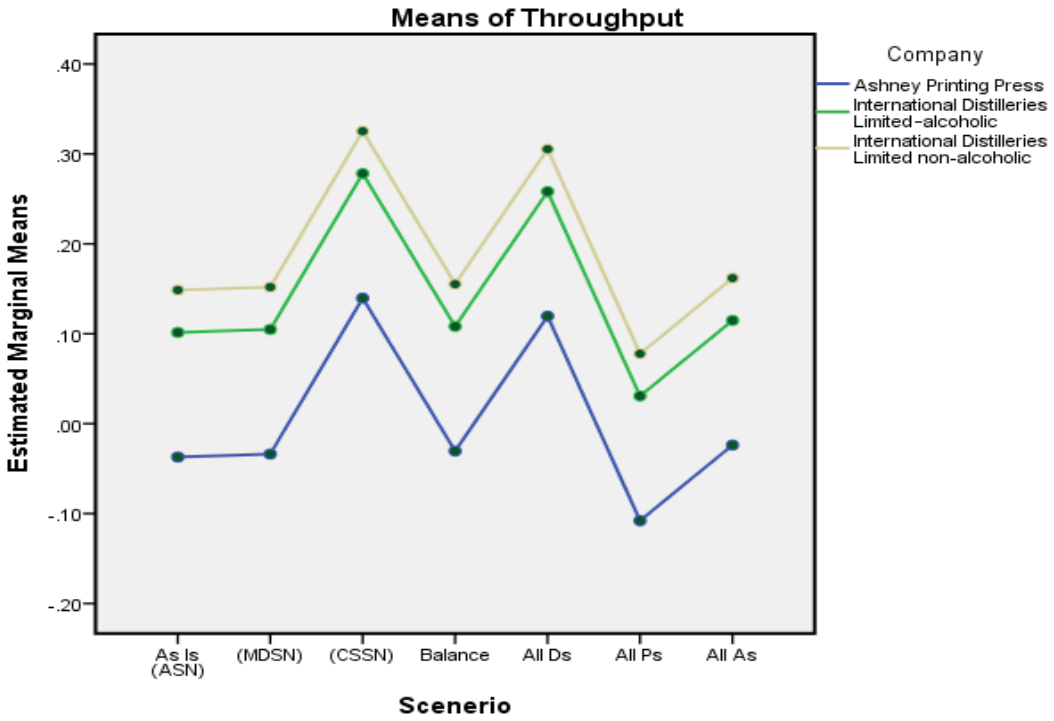


Figure 6.11c: Throughput for Adapter Supply Network

Scenario	Mean	Std. Deviation	Difference in mean (compared to As Is mean)	Percentage difference (%)
As Is (ASN)	0.071	0.08888		
MDSN	0.0743	0.09452	-0.0033	-4.647887324
CSSN	0.2477	0.21572	-0.1767	-248.8732394
Balance	0.0777	0.10017	-0.0067	-9.436619718
All Ds	0.2277	0.23116	-0.1567	-220.7042254
All Ps	0.0002	0.0634	0.0708	99.71830986
All As	0.0843	0.08737	-0.0133	-18.73239437

Table 6.11c: Throughput for Adapter Supply Network

According to the definition of throughput in comparison to Figure **6.11c** and Table **6.11c**, the lower the throughput the higher the performance and vice versa. Therefore in terms of throughput performances, *As Is scenario is greater than All Analysers, All Prospectors,*

Balance, Cost Saver supply network, Multiple Driven supply network scenarios while, As Is scenario is less than All Prospectors scenario.

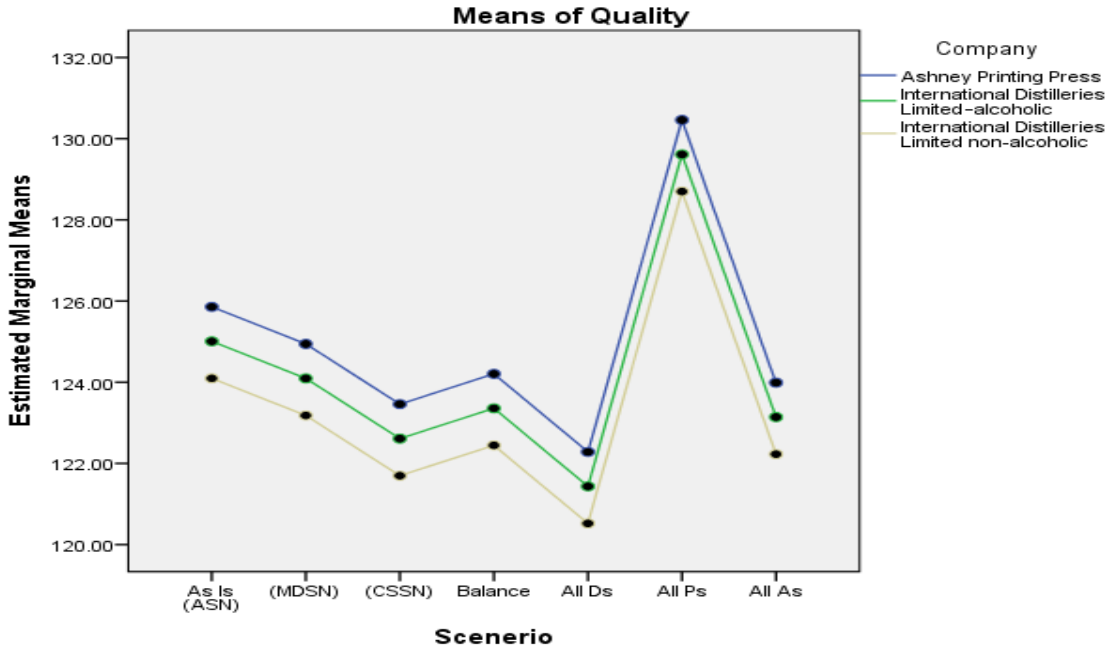


Figure 6.11d: Quality for Adapter Supply Network

Scenario	Mean	Std. Deviation	Difference in mean (compared to As Is mean)	Percentage difference (%)
As Is (ASN)	126	1.19		
MDSN	124	1.21	2	1.587301587
CSSN	120	0.75	6	4.761904762
Balance	121	1.84	5	3.968253968
All Ds	123	0.95	3	2.380952381
All Ps	130	2.69	-4	-3.174603175
All As	122	0.94	4	3.174603175

Table 6.11d: Quality for Adapter Supply Network

From Figure **6.11d** and Table **6.11d** it can be deduced that for the Quality performances *As Is is greater than All Defenders, All Analysers, Balance, Adapter supply network, Multiple Driven supply network scenarios; As Is is less than All Prospectors.*

6.11.5 Multiple Driven Supply Network

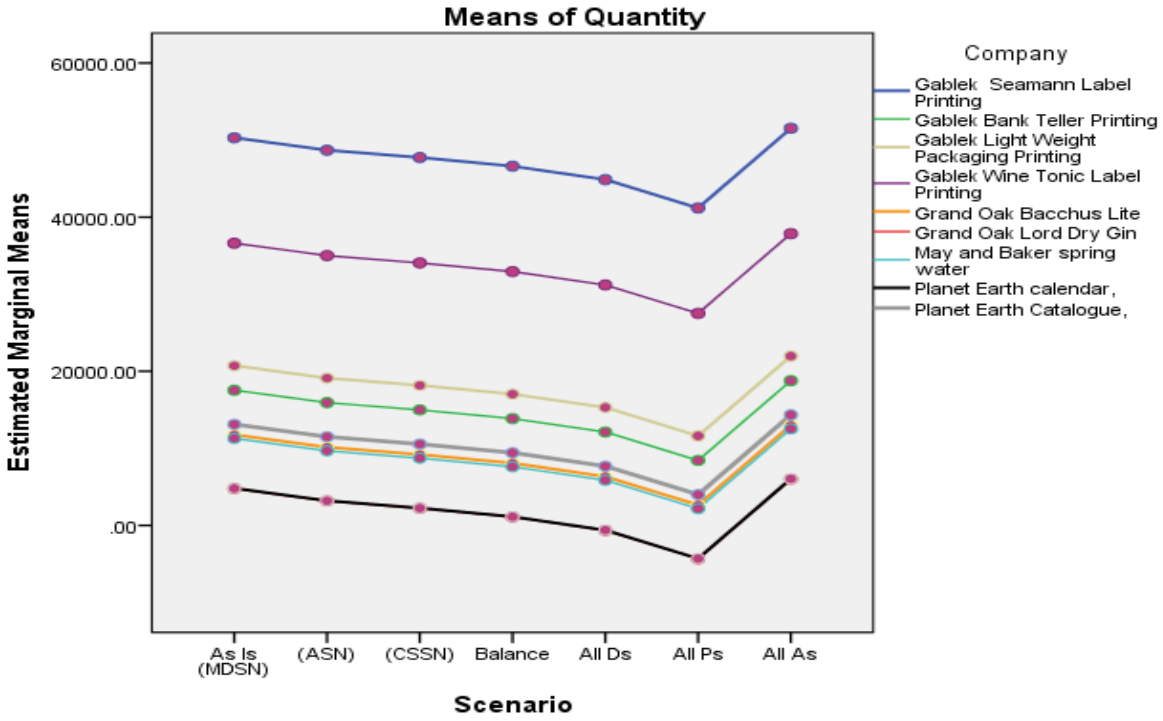


Figure 6.12a: Quantity for Multiple Driven Supply Network

Scenario	Mean	Std. Deviation
As Is (MDSN)	18994	18018
ASN	17386	16299
CSSN	16435	152645
Balance	15311	14518
All Ds	13569	12888
All Ps	9884	10891
All As	20230	19035

Table 6.12a: Quantity for Multiple Driven Supply Network.

Figure **6.12a** and Table **6.12a** present the results of the 7 (seven) configuration scenarios. Figure 8.7a gives a graphical presentation of the performances of scenarios - Adapter supply network (As Is), Multiple Driven supply network, Cost Saver supply network, All Defenders, All Prospectors, All Analyser and Balance for each Cost Saver supply network hub firm. On the other hand, the Cost Saver supply network reveals the combined Multiple Driven supply network hub firms performances in terms of mean and standard deviation.

Conclusively, Figure **6.12a** and Table **6.12a**, suggests that the performances of *scenario* As Is is greater than All Defenders, All Prospectors, Balance (1:1:1), Cost Saver supply network, Adapter supply network *scenarios* and As Is is less than All Analysers *scenario*. This demonstrates that when a Multiple Driven supply network accommodates more Analysers suppliers in its configuration, then the quantity of finished goods produced increases.

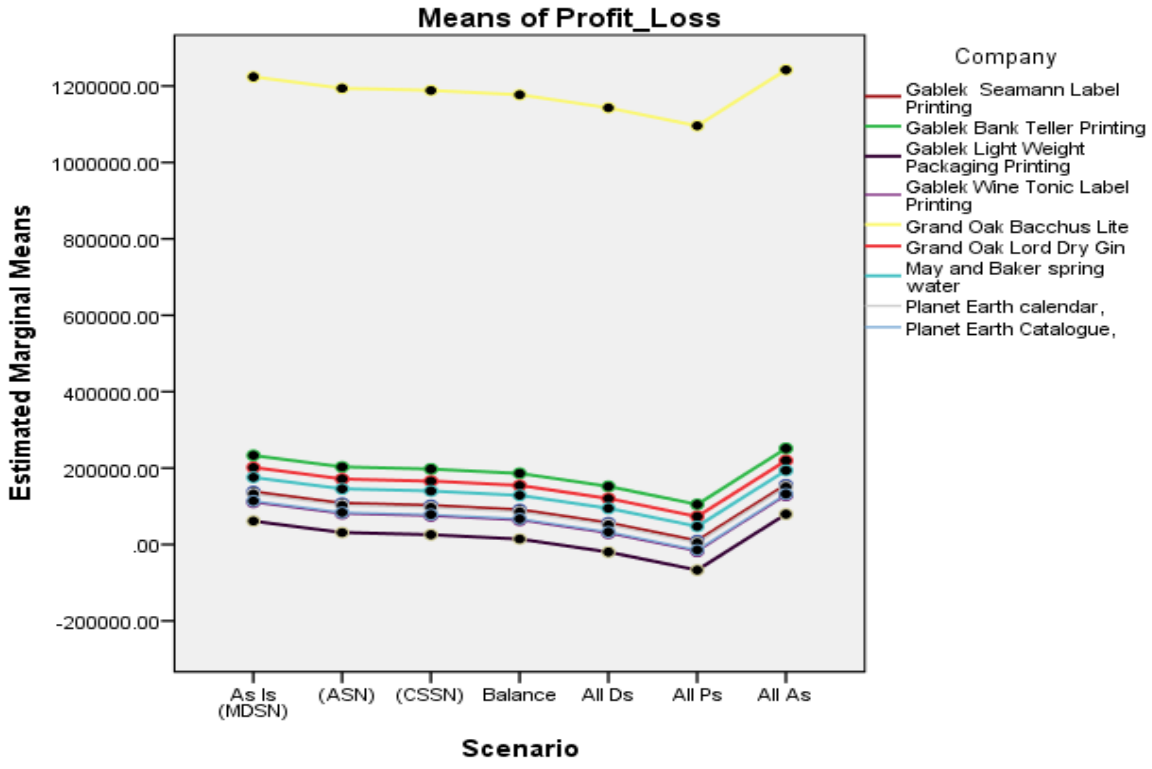


Figure 6.12b: Profit/Loss for Multiple Driven Supply Network

Scenario	Mean (Naira)	Std. Deviation (Naira)
As Is (MDSN)	265,694.08	432,697.23
ASN	235,671.07	374,262.60
CSSN	230,050.87	369,589.06
Balance	218,724.27	356,609.82
All Ds	184,540.37	301,615.764
All Ps	137,384.91	250,683.26
All As	283,876.93	459,651.59

Table 6.12b: Profit/Loss for Multiple Driven Supply Network

Figure **6.12b** and Table **6.12b** suggest that the performances of As Is is greater than All Defenders, All Prospectors, Balance (1:1:1), Cost Saver supply network, Adapter supply network *scenarios* and As Is is less than All Analysers *scenario*.

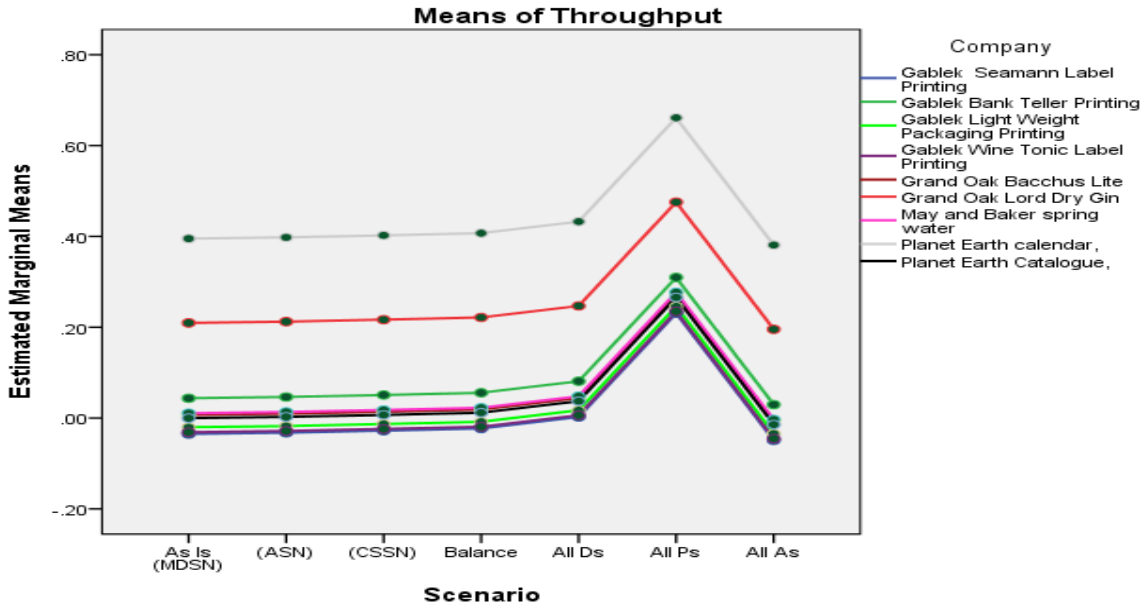


Table 6.12c: Throughput for Multiple Driven Supply Network

Scenario	Mean	Std. Deviation	Difference in mean (compared with As Is mean)	Percentage difference (%)
As Is (MDSN)	0.0643	0.0758		
ASN	0.0715	0.08315	-0.0072	-11.19751166
CSSN	0.1017	0.12889	-0.0374	-58.16485226
Balance	0.0763	0.09073	-0.012	-18.66251944
All Ds	0.0671	0.0778	-0.0028	-4.354587869
All Ps	0.3303	0.58946	-0.266	-413.6858476
All As	0.0503	0.05784	0.014	21.77293935

Table 6.12c: Throughput for Multiple Driven Supply Network

In accordance to the definition of throughput in comparison to Figure **6.16c** and Table **6.16c**, the lower the throughput, the higher the performance and vice versa. Therefore in terms of throughput performances *As Is scenario is greater than All Defenders, All Prospectors, Balance (1:1:1), Cost Saver supply network, Adapter supply network scenarios and As Is scenario is less than All Analysers scenario.*

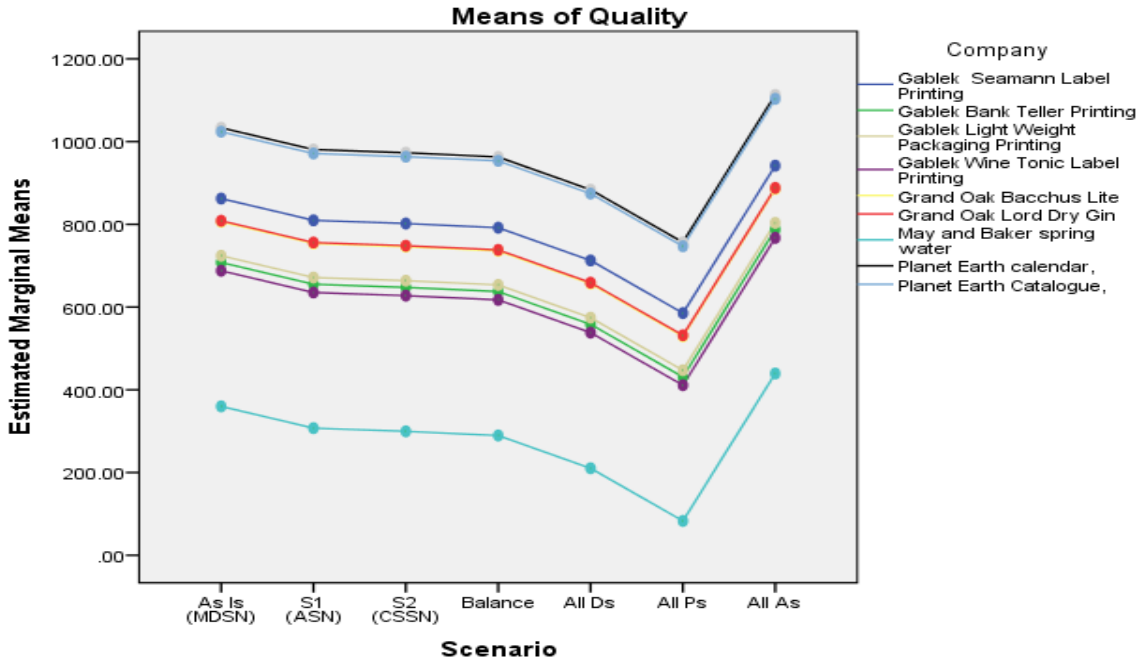


Figure 6.12d: Quality for Multiple Driven Supply Network

Scenario	Mean	Std. Deviation	Difference in mean (compared with As Is mean)	Percentage difference (%)
As Is (MDSN)	780	253.31		
ASN	630	165.89	150	19.23076923
CSSN	719	226.02	61	7.820512821
Balance	709	219.24	71	9.102564103
All Ds	727	226.35	53	6.794871795
All Ps	502	192.67	278	35.64102564
All As	859	285.07	-79	-10.12820513

Table 6.12d: Quality for Multiple Driven Supply Network

Figure **6.12d** and Table **6.12d** presents that for the Quality performances, *As Is scenario is greater than All Defenders, All Prospectors, Balance (1:1:1), Cost Saver supply network, Adapter supply network scenarios and As Is scenario is less than All Analysers scenario.*

6.12 Summary

This chapter explores the result derived from the simulation modelling of the three supply networks of this study. The performances (Quantity Produced, Throughput, Profit/Loss, and Quality) were considered for Cost Saver, Adapter, and Multiple Driven supply network. It shows that for:

Cost Saver supply network *the performances* (Quantity Produced, Throughput, Profit/Loss, and Quality) *of As Is scenario is greater than All Prospectors, All Analysers, Balance, Adapter supply network, Multiple Driven supply network scenarios**;***

*As Is scenario is less than All Defenders scenario**.***

Adapter supply network *the performances* (Quantity Produced, Throughput, Profit/Loss, and Quality) *of As Is is greater than All Analysers, All Prospectors, Balance, Cost Saver supply network , Multiple Driven supply network scenarios**;***

*As Is is less than All Prospectors scenario**.***

Multiple Driven supply network *the performances* (Quantity Produced, Throughput, Profit/Loss, and Quality) *of As Is is greater than All Defenders, All Prospectors, Balance (1:1:1), Cost Saver supply network, Adapter supply network scenarios**;** As Is is less than All Analysers scenario**.***

Each of these supply networks exhibit improved performance when most suppliers share the same strategic typology as the hub firm. Although, the *All Defenders* scenario in Cost Saver supply network; *All Prospectors* scenarios in Adapter supply network; *All Analysers* scenarios in Multiple Driven supply network gives the most improved performances. However, an interview conducted with managers of the companies disclosed that it is almost impossible for an organisation to have all its suppliers having the same strategic typology. Therefore, this research suggests that Cost Saver supply networks should choose more Defenders suppliers that share the same characteristics as its Defender hub organisation. As such, it enhances achieving Cost efficiency and improved performances; while Adapter supply network needs more Prospectors to satisfy flexibility and improved performances. On the other hand, Multiple Driven supply network could accommodates more of Analysers which share the same typology as the hybrid characteristics of the hub firm.

The next chapter expatiates on the facts and knowledge gathered from the Hypotheses, Case Study and Simulation chapters, points out the findings made in this research, and enumerates how it has positively added to knowledge whilst pointing out other areas of further research.

Chapter 7: Conclusions and Recommendations

7.1 Introduction

In this chapter, an overview of this thesis will be reviewed, which includes the research aims, research objectives, and the different research methods adopted, such as case study, simulation and testing of hypotheses to achieve these objectives. Also, this chapter gives a detailed description of the contributions of this study to existing knowledge. It presents the findings of the proposition and hypotheses tests on suppliers' configuration, a case study of 15 production lines and a simulation of supply networks, and how these methods have contributed to achieving the purposes of this work. Furthermore, it discusses the limitations of this research, with recommendations and suggestions to supply network managers. Finally, it points out the necessary required further research based on this study.

7.2 Review of the Research Aim and Objectives

As discussed in Chapter 1, the aim of this research is to examine the interrelationship between suppliers and hub organisations and the effect on performances in Dai and Zhang's (2008) supply networks. To achieve these aims, 8 objectives have been developed which are to;

- Investigate if suppliers in supply networks can be any of Miles and Snow (2008) four typologies: the Defenders, Prospectors Analysers or Reactor.

- Identify if the majority of suppliers in supply networks have the same strategic typology as the hub organisation.

- Examine the strategic typology that is dominant within supply networks.

- Analyse whether equal ratio of the typologies of suppliers in the supply network will enhance the overall performance of the hub organisation.

- Identify the impact on the performance if the suppliers' configuration consists of strategic types that are different to that of the hub organisation.

- Study the performance of the supply network when the ratio of supplier typology are varied.

- Suggest guidelines for selecting the appropriate suppliers' configuration that satisfies customers and organisation needs within the supply networks.

These 8 objectives have been achieved in this research. The later part of this section presents each of these objectives, the methods adopted to achieve the objective, and the chapters that reflect detailed findings that satisfied each objective.

Objective 1: To study Multiple Driven, Cost Saver and Adapter supply networks.

Objective 1 has been successfully achieved. This was done by carrying out a broad review of literature on Dai and Zhang's (2008) supply networks, the concept of supply network and relevant subject areas. This forms the basis of this study, by exploring existing theories and

pointing out the need to fill the gap that this study is intended to satisfy. This is documented in Chapter 2 Literature Review. From Chapter 2, it is concluded that there is a need to extend Dai and Zhang's supply network by evaluating the suppliers' configurations that exist in each of the supply networks; and the effect of various supplier configurations on performance. Furthermore, it is established that for a hub Defender organisation, the supply network is Cost Saver; for a Prospector organisation the supply network category is Adapter; and for an Analyser organisation the appropriate supply network is Multiple Driven.

Objective 2: To investigate if suppliers in supply networks can be any of Miles and Snow (2008) four typologies: the Defenders, Prospectors Analysers or Reactor.

Questionnaires were distributed to all supplier organisations. The results from the questionnaires revealed that each supplier can be any of Miles and Snow's (2008) strategic types, Defenders, Prospectors Analysers or Reactors. However, only a few suppliers' organisations were Reactors. To validate that such organisations are actually Reactor types of Miles and Snow's strategic type, interviews were conducted on these supplier organisations. This interview was conducted because, according to Miles and Snow (2003) these organisation types are very unstable and can easily be wiped out of their market sector. As such, most organisations cannot be in this category. The discussion, results and details of how Objective 2 has been achieved were presented in Chapter 5 Case Study.

Objective 3: To identify if the majority of suppliers in supply networks have the same strategic typology as the hub organisation.

Objective 4: To investigate the strategic typology that is dominant within supply networks.

To satisfy Objective 3, questionnaires were distributed to the hub organisations. From the questionnaire results, Defender organisations were regarded as Cost Saver supply network; Prospector organisations as Adapter supply network, and Analyser organisations were categorised as Multiple Driven supply network. Interviews were conducted to further ascertain the Miles and Snow (2003) strategic category for each of the hub organisations (see details of these findings are in Chapter 5 Case Study).

From Objective 2, where all the suppliers were categorised as either Defenders, Prospectors, Analysers or Reactors, the suppliers' strategic configurations that made up each supply network were validated using quantitative analysis tools – SPSS and Minitab. The tests suggested that in;

- Cost Saver supply network that has an Analyser hub organisation, the occurrence of Defender suppliers are greater than the occurrence of Analyser suppliers; the occurrence of Analyser suppliers are greater than the occurrence of Prospector suppliers.

- Adapter supply network that has a Prospector hub organisation, the occurrence of Prospector suppliers is greater than the occurrence of Analyser suppliers; the occurrence of Analyser suppliers is greater than the occurrence of Defender suppliers.

- Multiple Driven supply networks that have an Analyser hub organisation, the occurrence of Analyser suppliers are greater than the occurrence of Defender

suppliers; and the occurrence of Defender suppliers are greater than the occurrence of Prospector suppliers.

The results of these tests show that the majority of suppliers share the same typology as the hub firm in Cost Saver, Adapter, and Multiple Driven supply networks. This result also satisfies Objective 4, and reveals that the dominant strategic type within each of the supply networks share the same strategy as the hub organisations (see details of suppliers' strategic configuration validation in Chapter 6 Hypotheses).

Objective 5: To analyse whether equal ratio of the typologies of suppliers in the supply network will enhance the overall performance of the hub organisation.

Objective 5 has been accomplished by modelling each supply network. The model was configured with each supply network having an equal occurrence of Defender, Prospector and Adapter suppliers. This is referred to as *Balance* (For More details see Chapter 6 Simulation). In the paragraphs below, the position of *Balance* in the performance ranks is discussed.

The simulation results reveals that;

- In a Cost Saver supply network, an All Defender suppliers' configuration gives the highest performance, followed by As Is (Cost Saver supply networks) suppliers' configuration, Multiple Driven supply networks suppliers' configuration, *Balance* suppliers' configuration, All Prospectors (when all suppliers are prospectors) suppliers' configuration and lastly, All Analyser (when all suppliers are Analysers) suppliers'

configuration. From the results based on improved performances, *Balance* suppliers' configuration gives the 4th improved performances in the Cost Saver supply network.

- In an Adapter supply network, an All Prospectors suppliers' configuration gives the highest performance, followed by Adapter supply networks suppliers' configuration, Multiple Driven supply networks suppliers' configuration, *Balance* suppliers' configuration, All Analyser (when all suppliers are Analysers) suppliers' configuration, Cost Saver supply network suppliers' configuration, and the least performance is All Defender (when all suppliers are Defender) suppliers' configuration. From the ranking, *Balance* suppliers' configuration gives the 4th improved performance.

- In a Multiple Driven supply network, an All Analyser suppliers' configuration gives highest performance, followed by As Is (Multiple Driven supply networks) suppliers' configuration, Adapter supply networks suppliers' configuration, Cost Saver supply networks suppliers' configuration, and *Balance* suppliers' configuration, All Defenders All Defender (when all suppliers are Defender) suppliers' configuration and lastly All Prospectors All Prospectors (when all suppliers are Prospectors) suppliers' configuration. From the results, *Balance* suppliers' configuration is the 5th improved performances in the rankings.

In conclusion, for Cost Saver supply networks and Adapter supply networks, an equal ratio of the typologies of supplier's configuration gives the 4th improved performance, however, it gives the 5th improved performance in Multiple Driven supply networks.

Objective 6: To identify the impact on the performance if the suppliers' configuration consists of strategic types that are different to that of the hub organisation.

Objective 6 was accomplished by the use of simulation experiments. The suppliers' configuration that consists of strategic types that are different from their hub organisation are; All Defenders (all suppliers are Defenders) and All Prospectors (all suppliers are Prospectors) and All Analysers (all suppliers are Defenders). The results from the simulation presents that;

- In Multiple Driven supply networks the performances of As Is (MDSN) suppliers' configuration is greater than All Defenders suppliers' configuration and All Prospectors suppliers' configuration.

- In Adapter supply networks the performance of As Is (ASN) suppliers' configuration, is greater than All Analysers suppliers' configuration, and also greater than All Defender suppliers' configuration.

- In Cost Saver supply networks the performance of As Is (CSSN) suppliers' configuration, is greater than All Prospectors suppliers' configuration, All Analysers suppliers' configuration.

In summary, the simulation results shows that for suppliers' configurations that consist of strategic types that are different to that of the hub organisation, the performance is lower compared to As Is suppliers' configuration for Cost Saver supply network, Adapter supply network, and Multiple Driven supply network (see Chapter 6 Simulation, for more details).

Objective 7: To study the performance of the supply network when the ratio of supplier typology are varied.

Objective 7 has been accomplished, in varying the configuration where each hub organisation takes up the suppliers' configuration of a different supply network. For a Multiple Driven supply network with the hub of an Analyser, the varied suppliers' configurations are: Cost Saver supply network suppliers' configuration and Adapter supply network suppliers' configuration; for an Adapter supply network with the hub of a Prospector, the varied suppliers' configurations are: Cost Saver supply network and Multiple Driven supply network suppliers' configuration, and for a Cost Saver supply network with the hub of a Defender, the varied suppliers' configurations used are Adapter supply network and Multiple Driven supply network suppliers' configuration.

The results from the experiment shows that for:

- Cost Saver supply network the performance of As Is (CSSN) is greater than Adapter and Multiple Driven supply network suppliers' configuration.

- Adapter supply network the performance of As Is (ASN) is greater than Cost Saver and Multiple Driven supply network suppliers' configuration.

- Multiple Driven supply network the performance of As Is (MDSN) is greater than Cost Saver supply network and Adapter supply network suppliers' configuration.

In Conclusion, an As Is suppliers' configuration of each supply network gives greater performance compared to the varied suppliers' configuration. Also, the As Is of each supply network has more occurrence of the same strategic type as the hub in the suppliers' configuration.

Objective 8: To suggest guidelines for selecting the appropriate suppliers' configuration that satisfies customers and organisation needs within the supply networks.

Objective 8 has been achieved. Details of the findings and suggestions on suppliers' configuration that satisfies customers and organisation for each supply network are in Chapter 4 Case Study, Chapter 5 Hypotheses and Chapter 6 Simulation.

Chapter 4 Case Study, illustrates that a Multiple Driven supply network prefers Analyser suppliers, an Adapter supply network prefers Prospector suppliers, while the hub Cost Saver supply network chooses mostly Defender suppliers. It also shows the occurrence of Defenders Prospectors, Analysers, and Reactors in each of these supply networks; that the choice of suppliers is determined by hub organisation performance preferences, which is as a result of their strategy type; and the choice of supplier differs for each of the three supply networks. Also, this study reveals that the hub organisations' choice of suppliers affects the overall performance of the supply network.

Furthermore, the propositions and hypotheses in Chapter 5 validates the configuration for each of the three supply networks. These results suggest that in;

- Cost Saver supply network – the occurrence of Defender suppliers is greater than the occurrence of Analyser suppliers; the occurrence of Analyser suppliers is greater than the occurrence of Prospector suppliers; the occurrence of Prospector suppliers is greater than the occurrence of Reactor suppliers.

- Adapter supply network – the occurrence of Prospector suppliers is greater than the occurrence of Analyser suppliers; the occurrence of Analyser suppliers is greater than the occurrence of Defender suppliers; the occurrence of Defender suppliers is greater than the occurrence of Reactor suppliers.

- Multiple Driven supply network - the occurrence of Analyser suppliers is greater than the occurrence of Defender suppliers; the occurrence of Defender suppliers is greater than the occurrence of Prospector suppliers; the occurrence of Prospector suppliers is greater than the occurrence of Reactor suppliers.

This study makes it known that the occurrence of Defender suppliers is not equal to the occurrence of Prospector suppliers, and is not equal to the occurrence of Analyser suppliers in the suppliers' configuration that make up the Multiple Driven supply network which has an Analyser hub. Although, the hub which is an Analyser is said to adopt a hybrid strategy of Defender and Prospector, maintaining balance between effectiveness and efficiency. However the validation shows that the balance strategy of an Analyser hub does not extend to its suppliers' configuration.

In Chapter 6 Simulation, the results indicate that;

- In a Cost Saver supply network, the performance of an As Is (CSSN) suppliers' configuration, is greater than an All Prospectors suppliers' configuration, All Analysers suppliers' configuration, Balance suppliers' configuration, Adapter supply network suppliers' configuration, and Multiple Driven supply network suppliers' configuration. However, an All Defenders suppliers' configuration is greater than an As Is (CSSN) suppliers' configuration.

- In an Adapter supply network, the performance of As Is (ASN) suppliers' configuration, is greater than an All Analysers suppliers' configuration, and also greater than an All Defender suppliers' configuration, and a Balance suppliers' configuration and Cost Saver supply network suppliers' configuration, and the least performance was a Multiple Driven supply network suppliers' configuration. However, an All Prospectors suppliers' configuration is greater than an As Is (ASN) suppliers' configuration.

- In a Multiple Driven supply network, the performances of an As Is (MDSN) suppliers' configuration is greater than an All Defenders suppliers' configuration, followed by All Prospectors suppliers' configuration, Balance suppliers' configuration, Cost Saver supply network suppliers' configuration, and Adapter supply network suppliers' configuration. However, an All Analyser suppliers' configuration is greater than an As Is (MDSN) suppliers' configuration.

From the findings discussed above, ideas have been deduced on how to suggest guidelines for selecting the appropriate suppliers' configuration that will satisfy customer and organisation needs in each of the supply networks. The findings suggest that the highest performances are achieved when all suppliers have the same typology as the hub firm, i.e. In Cost Saver supply

network, when all suppliers are Defenders; in Adapter supply network when all Prospector supplier configuration and in Multiple Driven supply network when All Analysers supplier configuration. However, the second highest performance is achieved when the suppliers' configuration is As Is (the real suppliers' configuration of each of the supply network).

On the other hand, the case study shows that it is almost not achievable for all suppliers of any of the supply networks to have the same strategic typology but, for each supply network the As Is suppliers' configuration is achievable. Therefore, the As Is configuration for each of the supply network as validated in the Hypotheses chapter gives the highest achievable suppliers configuration.

Therefore, the suggested guidelines for selecting the appropriate suppliers' configuration that satisfies customer and organisation needs within the supply networks is that; an organisation that adopts a Cost Saver supply network should strive to have more Defender suppliers in its supply network; an Adapter supply network should have more Prospector suppliers, and a Multiple Driven supply network should embrace more Analyser suppliers for enhanced performance.

7.3 Conclusions

This research attempts to make an original contribution to the body of knowledge in supply network and supplier management. This is achieved by examining and analysing the relationship that exists between the suppliers' strategic typology, hub organisation and performance within the three types of supply network. This study has contributed in aspects where little or no research has been done, such as;

- Printing, bottled spring water, distilleries and bottle making industries can benefit from these research findings. This could support the management of their supply networks and improve performance through choosing the appropriate suppliers.

- The hub organisations are categorised based on Miles and Snow's (2008) strategic type. This provides an overview of hubs' aims, objectives and expected performance. From this study, it is shown that hub organisations' aims, objectives and expected performance affect their choice of suppliers, which in turn can either improve or reduce their performance.

- The supplier organisations for each of the supply networks are categorised based on Miles and Snow's (2008) strategic type. This gives a general idea of the characteristics and expected performance of these suppliers. From this study, it is revealed that if a hub organisation knows the strategic type for its suppliers, it will give the hub an insight of what to expect from such suppliers in terms of performance.

- The occurrences of Miles and Snow's (2008) strategic type in suppliers' configurations for Cost Saver, Adapter and Multiple Driven supply networks was validated.

- Also, this study is one of the few that verified Miles and Snow's (2008) strategic types in a developing country, which in this context is Nigeria.

- Although, this research focused on Printing, Bottled Spring Water, Distilleries and Bottle Producing organisations. However, as stated in Chapter 2 Literature review, that Dai and Zhang (2008) supply networks and Miles and Snows (2003) strategic

types are not limited to a particular industry. Therefore, the results and findings of this research can be generalisable across other industries.

- This study is the first to use simulation methodology to model the three Miles and Snow strategic types – Defender, Prospector or Analyser, for the 3 types of supply networks – Cost saver, Adapter and Multiple driven.

7.4 Limitations

This research, like any other study, is subject to several limitations that might influence the findings, and these need to be considered in implementing future research. Enumerated below are some of these limitations:

- For the simulation experiment, Cost Saver supply network, Adapter supply network, and Multiple Driven supply network scenarios, were used to represent the configuration of each supply network. The average of the supplier strategic types in percentages derived from the case study analysis were used for the modelling. This is made up of limited supply lines with three supply lines for Cost Saver supply network, three supply lines for Adapter supply network, and nine supply lines for Multiple Driven supply network, which sums up to a total of 15 supply lines studied in this research. The few number of supply lines limits the generalisation of these findings.

- For each of the supplier typologies (Analysers, Prospectors and Defenders) the characteristics and variables considered for modelling are (Cost, the raw materials, Time of arrival, Quantity and Quality). Few studies have been conducted in this area,

so it might be more useful to try other variables for modelling each of the Miles and Snow (2003) strategic groups.

- The performance indicators for each of the supply networks are based on 4 factors which are: quantity produced, profit/loss, quality produced, and throughput. It might be more rewarding and useful to try other performance measures. Also, it could be beneficial to ask for the opinions of supply network or operations managers about their performance preferences.

- Another limitation is that, this work used a conceptual model for the simulation of the supply networks. This has some levels of abstraction that are considered, such as utilisation of the machine, work in progress, and details of the queues in the process of the operations within the supply network.

7.5 Recommendations for Managers

This research provides valuable insights for supply network and supply chain managers about the relationship that exists between the hub organisations, suppliers and performance, and the effect of supplier choices on performance within supply networks. Furthermore, it provides managers with a detailed review about the Cost Saver, Adapter and Multiple Driven supply networks; the importance of choosing suppliers based on strategy; and how the suppliers strategic configuration impacts performance. Thus;

- It is highly recommended that managers give more attention and concern to their choice of suppliers. As we have shown in this research, suppliers are highly associated with performance.

- The results highlight that hub organisations should identify and ascertain their Miles and Snow (2008) strategic type and Dai and Zhang's (2008) supply network. This will be helpful and serve as the initial step to applying the findings of this research; which is, to choose appropriate suppliers that could enhance productivity in their organisations.

- Managers should give specific attention to suppliers before going into a relationship with them. This could be done by the use of the Miles and Snow questionnaire. The questionnaire describes the 4 types of Miles and Snow's strategy; Defender, Prospector, Analyser or Reactor. Where, Defender is referred to as Type A, Prospector as Type B, Analyser as Type C; and Reactor as Type D. The 4 major questions of the questionnaire are;

  Do you anticipate your organisation moving to any of the four 'type Descriptions' within the next 3 years? Yes /No.

  If the above answer is Yes, which description would you anticipate moving toward? Type A, Type B, Type C, Type D.

  Has your organisation moved from any of the other 'Type Descriptions' within the last 3 years? Yes/ No.

  If the above answer is Yes, Please identify which description has the organisation moved from? Type A, Type B, Type C, Type D.

Answers to these questions will give managers an overview of the former strategy, the present strategy and the future strategy of the supplier organisation (for details of the questionnaire, see Appendix B: Miles and Snow Questionnaire). This will also help to make appropriate choices of suppliers.

- Finally, it is suggested that managers should adopt more suppliers that share the same strategic type as their hub organisations. This will serve as a way to manage the supply network and to improve performance.

7.6 Future Directions for this Research

This section opens up areas that need exploration and further study, to expand the findings of this work. Details of some of these areas are explained below:

7.6.1 Number of Industry and Organisations Sampled

Considering the weaknesses pointed out earlier, this research modelled 15 hub organisations and 615 suppliers within 4 manufacturing industries; Printing, Bottled Spring Water, Distilleries and Bottle Producing organisations. Also, the case studies were carried out on 15 supply lines, and hypotheses on 630 suppliers. However, it could be more beneficial to carry out this same investigation on more hub organisations, more suppliers, within various types of industries for more generalisable conclusions.

7.6.2 Application of Other Variables and Performance Measures

In modelling the supplier strategic typologies (Analysers, Prospectors and Defenders) the variables considered are (cost of the raw materials, time of arrival, quantity and quality) and the performance measures for each of the supply networks are: quantity produced, profit/loss, quality, and throughput. However, other researchers and organisations might prefer other variables for suppliers' strategic typology and performance measures. Therefore, it is suggested that further research using different input variables and performance measures be adopted to model the supply networks.

7.6.3 Effect of Reactors that can Impact Performance

This work did not include Reactor suppliers in the simulation modelling. This is because Miles and Snow (2003) explained that organisations that adopt the Reactors strategy are unstable and without market focus, therefore Reactor organisations can easily be wiped out of the market sector. This study validates the minimal occurrence of Reactors in each of the supply networks. However, it might be beneficial to investigate the impact of Reactors on the performance of the hub organisation, i.e. how many Reactors can improve or reduce performance. If this study is carried out, suggestions could be made on the level of Reactor suppliers to be allowed or avoided in each supply network based on the impact on performance.

7.6.4 Detailed Simulation

As mentioned earlier, there are some levels of abstraction in the simulation models. It could be suitable and beneficial to carry out further research, by developing models that focus on the internal operational process of the hub organisation. That includes utilisation of the

machine, work in progress, details of the queues in the process of the operations within the supply network. This could help to measure the performances within the organisation; the utilisation of the machines; the work in progress or on queue; and efficiency of the workers on duty within the hub organisation.

7.6.5 Regional Comparative Studies of Dai and Zhang's Network

This research was carried out in just one particular country. However, it could be more advantageous to carry out the same investigation in different countries. Furthermore, to compare the findings from these various countries. This will help to get a generalisable conclusion of the suppliers' strategic configuration that gives improved performance for Cost Saver, Adapter and Multiple Driven supply network.

7.7 Guide to Practice and Summary

From the above justification, there are 3 major steps to implement the discoveries of this work. The first is for an organisation to regard itself as the hub organisation, then identify the Miles and Snow strategy it belongs to; afterwards to identify its supply network. If the organisation is a Defender, then it falls into the Cost Saver supply networks; if Prospector, it falls into Adapter supply networks and if Analyser it falls into Multiple Driven supply networks. Lastly, the hub organisation should strive to have more suppliers that have the same strategy as itself for enhanced performance. This last chapter of the PhD thesis has given an overview of the research aims and objectives and how it has been accomplished; the contribution of the study to knowledge; limitations of this study; suggestions for supply network managers findings and the necessary areas for future research.

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Appendix A: 11 Scale Questionnaire

Question: ***Choose ONE option Type***

These questions will take 10-15 minutes of your time to fill out. Your collaboration is highly appreciated and will contribute to the success of this study. If you have any question or concern kindly contact:*ainam@coventry.ac.uk*

Kindly tick appropriately:

Question 1:

In comparison to our competitors, the products/services which we provide to our customers are best characterized as:

a. *Products/services which are more innovative, continually changing a broader in nature throughout the organization and marketplace.*

b. *Products/services which are fairly stable in certain units/departments and markets while innovative in other units/departments and markets.*

c. *Products/services which are well focused, relatively stable and consistently defined throughout the organization and marketplace.*

d. *Products/services which are in a state of transition, and largely based on responding to opportunities or threats from the marketplace or environment.*

Question 2:

In contrast to our competitors, our organization has an image in the marketplace as a company which:

a. *Offers fewer, selective products/services which are high in quality.*

b. *Adopts new ideas and innovations, but only after careful analysis.*

c. *Reacts to opportunities or threats in the marketplace to maintain or enhance our position.*

d. *Has a reputation for being innovative and creative.*

Question 3:

The amount of time my company spends on monitoring change and trends in the marketplace can best be described as:

a. *Lengthy: We are continuously monitoring the marketplace.*

b. *Minimal: We really don't spend much time monitoring the marketplace.*

c. *Average: We spend a reasonable amount of time monitoring the marketplace.*

d. *Sporadic: We sometimes spend a great deal of time and at other times spend little time monitoring the marketplace.*

Question 4:

In comparison to our competitors, the increases or losses in demand which we have experienced is due most probably to:

a. *Our practice of concentrating on more fully developing those markets which we currently serve.*

b. *Our practice of responding to the pressures of the marketplace by taking few risks.*

c. *Our practice of aggressively entering into new markets with new types of product/service offerings.*

d. *Our practice of assertively penetrating more deeply into markets currently serve, while adopting new products/services only after a very careful review of their potential*.

Question 5:

One of the most important goals in my company, in comparison to our competitors, is our dedication and commitment to:

a. *Keep costs under control.*

b. *Analyse our costs and revenues carefully, to keep costs under control and to selectively generate new products/services or enter new markets.*

c. *Insure that the people, resources and equipment required to develop new products/services and new markets are available and accessible.*

d. *Make sure that we guard against critical threats by taking whatever action is necessary.*

Question 6:

In contrast to our competitors, the competencies (skills) which our managerial employees possess can best be characterized as:

a. *Analytical: Their skills enable them to both identify trends and then develop new product/service offerings or markets.*

b. *Specialized: Their skills are concentrated into one, or a few, specific areas.*

c. *Broad and entrepreneurial: Their skills are diverse, flexible, and enable change to be created.*

d. *Fluid: Their skills are related to the near-term demands of the marketplace.*

Question 7:

The one thing that protects our organization from our competitors is that we:

a. *Are able to carefully analyse emerging trend and adopt only those which have proven potential.*

b. *Are able to do a limited number of things exceptionally well.*

c. *Are able to respond to trends even though they may possess only moderate potential as they arise.*

d. *Are able to consistently develop new products/services and new markets.*

Question 8:

More so than many of our competitors, our management staffs tends to concentrate on:

a. *Maintaining a secure financial position through cost and quality control measures.*

b. *Analysing opportunities in the marketplace and selecting only those opportunities with proven potential, while protecting a secure financial position.*

c. *Activities or business functions which most need attention given the*

d. *Developing new products/services and expanding into new markets or market segments*

Question 9:

In contrast to many of our competitors, our organization prepares for the future by:

a. *Identifying the best possible solutions to those problems or challenges which require immediate attention.*

b. *Identifying trends and opportunities in the marketplace which can result in the creation of product/service offerings which are new to the industry or which reach new markets.*

c. *Identifying those problems which, if solved, will maintain and then improve our current product/service offerings and market position.*

d. *Identifying those trends in the industry which our competitors have proven possess long-term potential while also solving problems related to our current product/ service offerings and our current customers' needs.*

Question 10:

In comparison to our competitors, the structure of our organisation is:

a. *Functional in nature (i.e., organized by department - marketing, accounting, personnel, etc.).*

b. *Product/service or market oriented (i.e., individual units/departments have marketing or accounting responsibilities).*

c. *Primarily functional (departmental) in nature; however, a product/service or market oriented structure does exist in newer or larger product/service offering areas.*

d. *Continually changing to enable us to meet opportunities and solve problems as they arise.*

Question 11:

Unlike many other similar companies, the procedures our organisation uses to evaluate our performance are best described as:

a. *Decentralized and participatory encouraging many organizational Members to be involved.*

b. *Heavily oriented toward those reporting requirements which demand immediate attention.*

c. *Highly centralized and primarily the responsibility of senior management.*

d. *Centralized in more established product/service areas and more participatory in newer product/service areas.*

Thank you for your participation and time.

Appendix B: Miles and Snow Questionnaire

Organisation Name:

Dear Participants,

I am a research student at Coventry University UK. This questionnaire is part of the steps to the fulfilment of this research titled ***'The effect of suppliers' configuration on an organisations performance within the supply Network: A simulation Approach'.***

Please answer all questions by selecting the best response for each question. All responses will be kept as confidential as possible. These questions will take 10-15 minutes of your time to fill out. Your collaboration is highly appreciated and will contribute to the success of this study. If you have any questions or concerns kindly contact ainam@coventry.ac.uk.

Explanations

Which one of the 4 organisation types described below most closely fits your organisation? _____ (Please note that none of the types organisations listed below is inherently "good or bad")

Organisation Type A

- This type of organisation attempts to locate and maintain a specific section of the industry.
- They tend to specialise in a relatively stable product or service area.
- This organisation tends to offer a more limited range of products or services compared to its competitors.
- It tries to protect its domain by offering higher quality, superior service and lower prices
- This type of organisation is not the forefront of developments in the industry
- It most times ignore industry changes that have no direct influence on its current areas of operation
- The Organisation concentrates on doing the best job possible in a limited range
- Sample of Such Company: *Dell, Wal-Mart*

Organisation Type B

- This type of organisation operates within a broad range of product-market
- It redefines its products or services periodically.
- The organisation is most time the "*first into*" new product and market areas even if these efforts prove to be unprofitable.
- The organisation shift quickly to areas showing signals of new opportunity, and these reactions often lead to a new round of competitive actions.
- This type of organisation may not maintain market strength in all of the areas it enters.
- Sample of such Company*: Sun, Sony, Apple and Nokia*

Organisation Type C:

- This type of organisation tries to maintain a stable, limited line of products or services.
- At the same time it also moves out quickly to follow a carefully selected set of the more promising new developments in the industry.
- The organisation is rarely the "first into" new products or services.
- It carefully monitors the actions of major competitors in areas compatible with its stable product – market base.
- The organisation can be frequently be "second into "new market or services when the product or service is cost - efficient
- Sample of such Company: *Microsoft, IBM*

Organisation Type D:

- This type of organisation does not have a consistent product – market direction.
- The organisation is usually not aggressive in maintaining established products and markets as some of its competitors.
- It is not willing to take as many risks as other competitors.
- However, the organisation responds in those areas where it is forced to by environmental pressures.

Questions

1) Do you anticipate your organisation moving to any of the four 'type Descriptions' within the next 3 years?

○ Yes ○ No

2) If the above answer is ***Yes,*** which description would you anticipate moving towards?

○ Type A ○ Type B ○ Type C ○ Type D

3) Has your organisation moved from any of the other 'Type Descriptions' within the last 3 years?

○ Yes ○ No

4) If you above answer is Yes, Please describe which description has the organisation moved from?

○ Type A ○ Type B ○ Type C ○ Type D

Thanks so much for your time

Appendix C: Semi Structured Interviews for Hub Organisations

This interview was conducted with each of the hub Organisations (focal firm); the questions are directed to know the interrelationship between hub Organisations and their suppliers.

Phase 1

(a) What effect will ***low/more/exact Supply of quantity demanded*** have on the ***quantity of materials*** produced in your company?

(b) What effect will ***low/more/exact Supply of quantity demanded*** on the *time* it will take on produce products ***(Throughput)****?*

(c) What effect will ***low/more/exact Supply of quantity demanded*** how can this affect **loss/profit**?

(d) What effect will ***low/more/exact Supply of quantity demanded*** *on* ***Quality****?*

Phase 2

(a) What effect will ***Cost (Expensive, average etc.)*** have on the ***quantity of materials*** produced in your company?

(b) What effect will ***Cost (Expensive, average etc****.)* on the ***time*** it will take on producing products?

(c) What effect will ***Cost (Expensive, average etc.)*** how can this affect ***loss/profit***?

(d) What effect will ***Cost (Expensive, average etc.)*** *on* ***Quality****?*

Phase 3

(a) What effect will ***Time of delivery (late, earlier or on time)*** have on the ***quantity of materials*** produced in your company?

(b) What effect will ***Time of delivery (late, earlier or on time)*** on the ***time*** it will take on producing products?

(c) What effect will ***Time of delivery (late, earlier or on time)*** how can this affect ***loss/profit?***

(d) What effect will ***Time of delivery (late, earlier or on time)*** *on* ***Quality****?*

Phase 4

(a) What effect will ***low/more/exact Quality delivered*** have on the ***quantity of materials*** produced in your company?

(b) What effect will ***low/more/exact Quality delivered,*** on the ***time*** it will take on producing products?

(c) What effect will ***low/more/exact Quality delivered,*** how can this affect ***loss/profit***?

(d) What effect will *l****ow/more/exact Quality delivered*** *on* ***Quality****?*

(e) What is the grade of the ***Quality produced*** in comparison to other quality or based on the standard quality of this same production, in terms of percentage increase or decrease?

Appendix D: Semi Structured Interviews for Suppliers Organisations

Targeted for Defenders Suppliers

1) Do you prefer organisation suppliers that focus on just one type of supplies? (i.e. they make only one thing at a time or service?

2) Do you prefer suppliers that produce higher quality?

3) Do you prefer with superior service compared with other suppliers even with same product to supply

4) Do you prefer organisation that gives lower prices for supplies

5) Do you prefer organisations that do not move with market trend?

6) Do you prefer best possible service from organisation with limited area of specialisation?

Targeted for Prospectors Suppliers

1) Organisation which delivers wide range of services very modern (re-defining always)

2) Do you prefer supplier with latest technology to offer (but not always expensive their prices varies)

3) Do you produce the best at all times or it varies

Targeted for Analysers Suppliers

1) More average price product, quality and services

Targeted for Reactors Suppliers

1) Do you prefer suppliers that you cannot guarantee their quality and not stable?

2) Do you prefer unstable supplier

3) Do you prefer organisation that are do have a consistent focus or product.

4) Do you prefer organisation that move to and fro due to pressures.

Appendix E: Historic characteristics of Suppliers

Suppliers Name	Date of Order	What was Ordered	Date delivered	Quality ordered	Quality delivered	Quantity ordered	Quantity delivered	Price per Unit	Time agreed for delivery	Time of delivery	Method of Delivery	Where are the materials used	What was delivered	Date agreed for delivery

Appendix F: Simulation Data Structure

Inputs	Levels	Supplier Organisation Characteristics Splits			Process
		Analysers (%)	**Defenders (%)**	**Prospectors (%)**	
Time of delivery	Late	38	9	16	minus 10% on daily output
	Early	31	36	7	plus 5% on daily output
	On time	31	55	77	no negative effect on daily output
Quality	Excellent	63	73	46	plus 20% on Output Quality
	Most Satisfactory	37	27	54	plus 10% on Output Quality
	Fair	0	0	0	no effect
	Poor	0	0	0	minus 5% on Output Quality; minus 2% on Profit
	Most dissatisfactory	0	0	0	minus 10% on Output Quality; minus5% on Profit
Cost of Materials	Very Expensive	0	9	18	plus 5% to unit cost
	Expensive	63	36	64	plus 2% to unit cost
	Normal Price	31	54	18	no effect
	Low Price	0	0	0	minus 2% to unit cost
	Very Low Price	0	0	0	minus 5% to unit cost
Quantity	exact	100	100	100	
	More than expected				
	Lower than expected				

Appendix G: Simulation Control Logic

Before Reset Logic

- **Obeyed immediately user clicks RESET button (before initialization of simulation objects and before On Reset logic)**

Clear Sheet Area ssDailyResults [1,2] , 7 , 4000

- **Obeyed immediately user clicks RESET button (before initialization of simulation objects and before On Reset logic)**

Before *Reset logic* is obeyed immediately user clicks RESET button. The Clear Sheet Area is meant to clear the spreadsheet on every reset before a run as this way the information will be updated just before a run.

End Run Logic

- **'Obeyed when the simulation reaches end of "Results Collection Period"**

Send results to excel

Set in EXCEL ssDailyResult [1,1] , "[SimResults.xlsx]Sheet1" , 1 , 1 , 10 , 1000

ENDRUN is used at the end of a run (during logic) to copy relevant results information to EXCEL. The remaining parameters tell SIMUL8 where to start writing the information into Excel and how many rows and columns to occupy. The daily results is reflect the spreadsheet. The reference tells SIMUL8 what cell The Excel spreadsheet must be saved in the same location as the simulation file while the remaining parameters tell SIMUL8 the Excel cell to start copying from and how many rows and columns of data to copy.

Time Check Logic

- **'Repeated at a set time interval**

SET gblDay = gblDay+1

Set the base values for current day

SET ssDailyResults[1,gblDay+1] = xDailyOutputAve

SET ssDailyResults[2,gblDay+1] = 100

SET ssDailyResults[3,gblDay+1] = xProcessTimePerUnitMins

SET ssDailyResults[4,gblDay+1] = xUnitCost

SET ssDailyResults[5,gblDay+1] = xUnitProfit

This time is set to take effect at the start of each day

Suppliers Logic

At the Entry the simulation suppliers are represented with the variablesLbl_Cost of materials (Cost of materials), Lbl_Quality (Quality of materials), Lbl_supplier ID (supplier type).

VLogic for suppliers Entry Logic

Get Current Object obj_S

SET lclRow =obj_S.CustomProperty["ID"]

SET lbl_SupplierID =lclRow

IF ssSuppliers[1,lclRow] = "A"

SET lbl_TimeOfDelivery =dist_A_TimeOfDelivery

SET lbl_Quality =dist_A_Quality

SET lbl_CostOfMaterial =dist_A_CostOfMaterial

SET lbl_SupplierType = 1

ELSE IF ssSuppliers[1,lclRow] = "D"

SET lbl_TimeOfDelivery = dist_D_TimeOfDelivery

SET lbl_Quality =dist_D_Quality

SET lbl_CostOfMaterial =dist_D_CostOfMaterial

SET lbl_SupplierType = 2

ELSE IF ssSuppliers[1,lclRow] = "P"

SET lbl_TimeOfDelivery =dist_P_TimeOfDelivery

SET lbl_Quality =dist_P_Quality

SET lbl_CostOfMaterial =dist_P_CostOfMaterial

SET lbl_SupplierType = 3

ELSE

Display Message "Error: Supplier type not recognised."

Proc_ Make Copies Of Suppliers

- **From the dialog make the correct number of suppliers of each type**

  Delete any old copies

LOOPOBJECTS all WORK ENTRIES with obj_S

IF obj_S.CustomProperty["ID"] > 1Erase Simulation Object obj_S

Create new copies

Get Object Location Supplier 1 ,lclX , lclY

SET lclX1 =lclX

SET lclY1 =lclY

IF xNumberOfSuppliers> 1

LOOP 2 >>>LoopVar>>>xNumberOfSuppliers

Copy Simulation Object Supplier 1, obj_S

Set Object Location obj_S ,lclX , lclY+70

SET lclY = lclY+70

SET obj_S.CustomProperty["ID"] = LoopVar

SET obj_S.Name = "Supplier "+LoopVar

(Disabled) Link Simulation Objects obj_S, Queue for HUB Organisation, 0

IF [LoopVar = 10] | [LoopVar = 20] | [LoopVar = 30] | [LoopVar = 40] | [LoopVar = 50] | [LoopVar = 60] | [LoopVar = 70] | [LoopVar = 80] | [LoopVar = 90] | [LoopVar = 100] = 1

SET lclX = lclX+60

SET lclY = lclY1-70

Supplier Settings On OK Dialog CALL

proc_MakeCopiesOfSuppliers

-'Set the types of suppliers in a table and then set the images to match

'Convert % values to sum to 100

SET lclFactor = 1/ [[xApercent+xDpercent]+xPpercent]

SET xApercentConvert =xApercent*lclFactor

SET xDpercentConvert =xDpercent*lclFactor

SET xPpercentConvert =xPpercent*lclFactor

SET xApercent = [xApercent*lclFactor]*100

SET xDpercent = [xDpercent*lclFactor]*100

SET xPpercent = [xPpercent*lclFactor]*100

'Set the number of % of suppliers to be type

SET lclA = ROUND[xNumberOfSuppliers*xApercentConvert]

SET lclD = ROUND[xNumberOfSuppliers*xDpercentConvert]

SET lclP = ROUND[xNumberOfSuppliers*xPpercentConvert]

SET lclss_Data[1,1] = lclA

SET lclss_Data[1,2] = lclD

SET lclss_Data[1,3] = lclP

Find Maximum Value in Sheet Area lclss_Data[1,1] , 1 , 3 , 1 , lclRow

'If rounded to under total then add to most popular type to make up total number

IF [lclA+lclD]+lclP<xNumberOfSuppliers

IF lclRow = 1

SET lclA = lclA+1

ELSE IF lclRow = 2

SET lclD = lclD+1

ELSE

SET lclP = lclP+1

'If rounded to greater than total then subtract from most popular type to make up total number

```
IF [lclA+lclD]+lclP>xNumberOfSuppliers

IF lclRow  =  1

        SET lclA  =  lclA-1

ELSEIF lclRow  =  2

        SET lclD  =  lclD-1

ELSE

      SET lclP  =lclP-(Disabled) Display Message    [[[["A = "+lclA]+". D = "]+lclD]+". P = "]+lclP

Clear Sheet    ssSuppliers[1,1]

     SET lclRow  =  1

     SET lclCount  =lclA

WHILElclCount<>  0

      SET ssSuppliers[1,lclRow]  =  "A"

      SET lclRow  =  lclRow+1

      SET lclCount  =  lclCount-1

      SET lclCount  =lclD

WHILElclCount<>  0

     SET ssSuppliers[1,lclRow]  =  "D"

     SET lclRow  =  lclRow+1

     SET lclCount  =  lclCount-1

     SET lclCount  =lclP

WHILElclCount<>  0

    SET ssSuppliers[1,lclRow]  =  "P"

    SET lclRow  =  lclRow+1

    SET lclCount  =  lclCount-1

    SET lclCount  =  lclCount-1

'Apply image to all start points

LOOPOBJECTS all WORK ENTRIES with obj_S
```

SET lclRow =obj_S.CustomProperty["ID"]

SET lclImageName =ssSuppliers[1,lclRow]+"_Supplier"

SET obj_S.Image =lclImageName

Set Route In Discipline HUB Organisation, Collect, Set Collect Number Queue for HUB Organisation, xNumberOfSuppliers , HUB Organisation

Refresh Windows

Reset before next run

Hub Organisations Process

VL queue for Hub Organisation On Entry Logic

- ***Obeyed just after a work item enters the Queue***

Copy current results for the day

SET lcl_Output =ssDailyResults[1,gblDay+1]

SET lcl_Quality =ssDailyResults[2,gblDay+1]

SET lcl_ProcessTime =ssDailyResults[3,gblDay+1]

SET lcl_UnitCost =ssDailyResults[4,gblDay+1]

SET lcl_UnitProfit =ssDailyResults[5,gblDay+1]

-Determine the influence of each incoming supplier on the output parameters

'Rules for hub type – Adapter

Time of Delivery

IF xHubType = 1

IF lbl_TimeOfDelivery = 1

'If late

SET lcl_Output =lcl_Output*0.98

SET lcl_ProcessTime =lcl_ProcessTime*1.02

ELSE IF lbl_TimeOfDelivery = 2

'If early

SET lcl_Output =lcl_Output*1.01

SET lcl_ProcessTime =lcl_ProcessTime*0.98

ELSE

'If on time

SET lcl_Output =lcl_Output*1.02

Quality

IF lbl_Quality = 5

SET lcl_Quality =lcl_Quality*1.0

ELSE IF lbl_Quality = 4

SET lcl_Quality =lcl_Quality*1.02

ELSEIF lbl_Quality = 3

SET lcl_Quality =lcl_Quality*1

ELSEIF lbl_Quality = 2

SET lcl_Quality =lcl_Quality*0.98

SET lcl_UnitProfit =lcl_UnitProfit*0.9

ELSE

SET lcl_Quality =lcl_Quality*0.95

SET lcl_UnitProfit =lcl_UnitProfit*0.95

Cost of Material

IF lbl_CostOfMaterial = 5

SET lcl_UnitCost =lcl_UnitCost*1.02

ELSE IFlbl_CostOfMaterial= 4

SET lcl_UnitCost =lcl_UnitCost*1.01

ELSE IFlbl_CostOfMaterial = 3

SET lcl_UnitCost =lcl_UnitCost*1

ELSE IFlbl_CostOfMaterial = 2

SET lcl_UnitCost =lcl_UnitCost*0.99

ELSE

SET lcl_UnitCost =lcl_UnitCost*0.98

<u>Rules for hub type – Defenders</u>

Time of Delivery

IF xHubType = 2

IF lbl_TimeOfDelivery = 1

'If late

SET lcl_Output =lcl_Output*0.95

SET lcl_ProcessTime =lcl_ProcessTime*1.0

ELSE IF lbl_TimeOfDelivery = 2

'If early

SET lcl_Output =lcl_Output*1.03

SET lcl_ProcessTime =lcl_ProcessTime*0.98

ELSE

'If on time

SET lcl_Output =lcl_Output*1.02

Quality

IF lbl_Quality = 5

'Excellent Quality

SET lcl_Quality =lcl_Quality*1.05

ELSE IF lbl_Quality = 4

SET lcl_Quality =lcl_Quality*1.02

ELSE IF lbl_Quality = 3

SET lcl_Quality =lcl_Quality*1

```
ELSE IF lbl_Quality  =  2
      SET lcl_Quality  =lcl_Quality*0.95
      SET lcl_UnitProfit  =lcl_UnitProfit*0.95 ELSE
      SET lcl_Quality  =lcl_Quality*0.9
      SET lcl_UnitProfit  =lcl_UnitProfit*0.9
```

Cost of Material

```
IF lbl_CostOfMaterial  =  5
      SET lcl_UnitCost  =lcl_UnitCost*1.05
ELSE IF lbl_CostOfMaterial  =  4
      SET lcl_UnitCost  =lcl_UnitCost*1.02
ELSE IF lbl_CostOfMaterial  =  3
      SET lcl_UnitCost  =lcl_UnitCost*1
ELSE IF lbl_CostOfMaterial  =  2
      SET lcl_UnitCost  =lcl_UnitCost*0.9
ELSE
     SET lcl_UnitCost  =lcl_UnitCost*0.95
```

'Rules for hub type – Prospectors

Time of Delivery

```
IF xHubType  =  3
IF lbl_TimeOfDelivery  =  1
       'If late
       SET lcl_Output  =lcl_Output*0.93
       SET lcl_ProcessTime  =lcl_ProcessTime*1.02
ELSE IF lbl_TimeOfDelivery  =  2
        'If early
        SET lcl_Output  =lcl_Output*1.05
```

SET lcl_ProcessTime =lcl_ProcessTime*0.98

ELSE

'If on time

SET lcl_Output =lcl_Output*1.02

Quality

IF lbl_Quality = 5

'Excellent Quality

SET lcl_Quality =lcl_Quality*1.02

ELSE IFlbl_Quality = 4

SET lcl_Quality =lcl_Quality*1.01

ELSE IFlbl_Quality = 3

SET lcl_Quality =lcl_Quality*1

ELSE IFlbl_Quality = 2

SET lcl_Quality =lcl_Quality*0.99

SET lcl_UnitProfit =lcl_UnitProfit*0.99

ELSE

SET lcl_Quality =lcl_Quality*0.98

SET lcl_UnitProfit =lcl_UnitProfit*0.98

Cost of Material

IF lbl_CostOfMaterial = 5

SET lcl_UnitCost =lcl_UnitCost*1.0

ELSEIF lbl_CostOfMaterial = 4

SET lcl_UnitCost =lcl_UnitCost*1.005

ELSE IF lbl_CostOfMaterial = 3

SET lcl_UnitCost =lcl_UnitCost*1

ELSE IF lbl_CostOfMaterial = 2

SET lcl_UnitCost= lcl_UnitCost*0.995

ELSE

SET lcl_UnitCost =lcl_UnitCost*0.99

- **Update current results for the day**

SET ssDailyResults [1, gblDay+1] = ROUND [lcl_Output]

SET ssDailyResults[2,gblDay+1] = ROUND[lcl_Quality]

SET ssDailyResults[3,gblDay+1] = ROUND[lcl_ProcessTime]

SET ssDailyResults[4,gblDay+1] = ROUND[lcl_UnitCost]

SET ssDailyResults [5, gblDay+1] = ROUND [lcl_UnitProfit]

HUB Organisation Route In After Logic

- **Determine the throughput for that day**

SET xActualOutput = ssDailyResults [1,gblDay+1]

- **Determine the profit for that day**

SET ssDailyResults [6, gblDay+1] =

ssDailyResults [5,gblDay+1]*ssDailyResults[1,gblDay+1

Appendix H: Letters to Hub Firms

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Telephone 024 7688 7688

Professor Paul Ivey
Dean of Faculty

PhD student: Maria Oluwatoyin Aina
Coventry University
Department of Engineering Management
Priory Street, Coventry, CV1 5FB
United Kingdom
ainam@coventry.ac.uk

Date; 30th May 2012

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The next stage of this work needs;

→The work process flow chart of within the organisation

Your continued participation in the success of this research will be greatly appreciated. If there is any need for any inquiry about this research, do not hesitate to contact the researcher.

I can assure you that the study will not disrupt the working environment in any way and any data collected will remain confidential.

Many Thanks for Your Support and Cooperation

Yours Sincerely,

Some materials have been

Maria Oluwatoyin Aina

Faculty of Engineering & Computing
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Managing Director

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Appendix I: Organisation's Process

Semi structured interview "Questions"	**"Process"**
Q. If you have a type hub organisation, and it receives a delivery that is late how will it influence output?	It will have influence on the output values in 2 ways; the daily output for that day will decrease (minus), by 2% and the Lead time will increase (plus) by 2%.
Q. If you have a type hub organisation, and it receives a delivery that is earlier how will it influence output?	It will have influence on the output values in 2 ways, plus 1% on daily output; decrease LT by 2%.
Q. If you have a type hub organisation, and it receives a delivery that is On time how will it influence output?	It will have influence on the output values in 2 ways, plus 2% on daily output.
Q. If you have a type hub organisation, and it receives a delivery that of excellent raw materials how will it influence output?	It will have influence on the output values in 2 ways, plus 5% on Output Quality.
Q. If you have a type hub organisation, and it receives a delivery that of most satisfactory raw materials how will it influence output?	It will have influence on the output values in 2 ways, plus 2% on Output Quality.
Q. If you have a type hub organisation, and it receives a delivery that of fair raw materials how will it influence output?	It will have influence on the output values in 2 ways, no effect.
Q. If you have a type hub organisation, and it receives a delivery that of poor raw materials how will it influence output?	It will have influence on the output values in 2 ways, minus 2% on Output Quality; minus 2% on Unit Profit.
Q. If you have a type hub organisation, and it receives a delivery that of Most dissatisfactory raw materials how will it influence output?	It will have influence on the output values in 2 ways, minus 5% on Output Quality; minus 5% on Unit Profit.
Q. If you have a type hub organisation, and it receives a delivery that of very expensive priced raw materials how will it influence output?	It will have influence on the output values in 2, ways plus 2% to unit cost.
Q. If you have a type hub organisation, and it receives a delivery that of expensive priced raw materials how will it influence output?	It will have influence on the output values in 2, ways plus 1% to unit cost.
Q. If you have a type hub organisation, and it receives a delivery that of normal priced raw materials how will it influence output?	It will have influence on the output values in 2, ways no effect.
Q. If you have a type hub organisation, and it receives a delivery that low priced raw material show will it influence output?	It will have influence on the output values in 2, ways minus 1% to unit cost.
Q. If you have a type hub organisation, and it receives a delivery that of very low priced raw materials how will it influence output?	It will have influence on the output values in 2, ways minus 2% to unit cost.