

Impact on ROI for Corporate Decision Making with SD-WAN:

An Exploratory Case Study

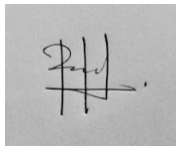
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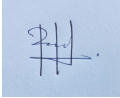
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ACKNOWLEDGEMENT

I would like to express my special thanks and gratitude to my supervisor Dr. Shantha Fernando, research coordinators Dr. Kutila Gunasekara and Mr. Kushan Ratnapala for the guidance and immense support to carry out this research.

Further I would like to express my deep and sincere gratitude to the IT Department of the Organization who helped me with the collection of information for this exploratory case study on their infrastructure.

Also, I extend my gratitude to multiple organizations who helped and provide opportunity to gather information during and after my tenure (for the case study) at Fentons Limited. Their support in collecting information on adopting SD-WAN and providing their input helped me immensely. Finally, to my current employer Visolit Colombo on encouraging me and providing exposure for SD-WAN.

ABSTRACT

Advancements in networking appear to be in the forefront of the technology revolution of the modern world. Software Defined - Wide Area Network (SD-WAN) technology is one of such advancements which has been promoted by networking solution vendors to replace the widely used but increasingly dated Multi-Protocol Label Switching (MPLS) technology. Before the SD-WAN's appearance, businesses used MPLS, a protocol with reliable and steady network traffic between two or more locations. SD-WAN has been enriched with various features developed to compete with MPLS as well as with competitor products in the market. SD-WAN challenges the consequences of MPLS in terms of network expenditure, capacity, agility, and visibility. The technology promotes dynamic path selection over multiple data services (MPLS, broadband and wireless Communication) and offers direct cloud access possibilities. On-demand provisioning and a pay-as-you-grow model offer flexibility for enterprises where they can simply update or upgrade by accessing new links without altering their infrastructure or network.

This research has been carried out with the intention of investigating the impact on the return on investment (ROI) from the adoption of SD-WAN by large scale Sri Lankan organizations. In this research, it has been attempted to identify the key factors affecting the decision-making process of migration from MPLS to SD-WAN. The research has been inferred on a preliminary survey and a case study conducted within the Sri Lankan context. Throughout the case study, discussion was carried out on whether SD-WAN has the capability to significantly reduce MPLS expenditure by minimizing the hassle of managing infrastructure and connectivity. Further by using software-based management, enterprises can force automation to phase out expensive routing hardware, enhance IT productivity and decrease network operating expense.

A large-scale Sri Lankan organization with the potential to adopt SD-WAN, which has already started evaluating SD-WAN to explore the factors affecting the investment decision, has been subjected to the case study. This organization being one of the leading and scaled out organizations in Sri Lanka, it is believed that the findings and conclusion of the case study can be referenced by similar scale organizations during their evaluation on the adoption of SD-WAN technology.

TABLE OF CONTENTS

Declaration	ii
Copyright statement	iii
Acknowledgement	iv
Abstract	i
Table of Contents	vi
List of Figures	ix
List of Tables	x
List of Appendices	xi
Abbreviations	xii
1. Introduction	1
1.1 Investment and ROI	1
1.2 Challenging Operating Environment	1
1.3 The Impact of Wide-Area Network for Sustainability	2
1.4 Motivation.....	3
1.5 Research Scope	3
1.6 Research Objectives.....	4
1.7 Research Questions.....	4
1.8 The Significance	5
1.9 Chapter Outline.....	5
1.10 Summary	5
2. Literature Review	6
2.1 Introduction.....	6
2.2 The WAN Technologies	6
2.3 The Significance of WANs.....	7
2.4 MPLS as a WAN Technology	8
2.5 MPLS Pros and Cons	9
2.6 SD-WAN as WAN Technology.....	12
2.7 SD-WAN Pros and Cons	13
2.8 SD-WAN vs. MPLS as WAN Technology.....	15
2.9 Impact of WAN on ROI.....	18
2.10 Summary Table of Literature Sources	19

2.11	Summary	22
3.	Methodology.....	23
3.1	Introduction.....	23
3.2	Research Approach	23
3.3	Case Study Approach.....	24
3.4	The Case Study Area	26
3.5	Research Methodology - Flow Diagram.....	27
3.6	Preliminary Survey	28
3.7	Data Collection Method	28
3.8	Target Population and The Sample Size.....	29
3.9	Mapping Diagram	32
3.10	Interviews and Obtaining support from “Proof of Concept.”	33
3.11	Research design diagram for exploration of case study.....	33
3.12	Data Analysis	35
3.13	Summary	35
4.	Results & Observations	36
4.1	Introduction.....	36
4.2	Data Collection	36
4.3	Assessment of Interviews	37
4.4	Discussing Responses of Each Segment of Interviews.....	37
4.4.1	Group 1 - Segment 1 : Users at Head Office : Direct decision-makers on both financial and technical aspect.	39
4.4.2	Group 1 - Segment 2 : Users at Branch Offices : In-direct decision-makers on both financial & technical aspect.....	40
4.4.3	Group 1 - Segment 3 : Users at Head Office : In-direct decision-makers on both financial & technical aspect.....	41
4.4.4	Group 2 - Segment 1 : User at Head Office : Who have an impact on daily operations.....	43
4.4.5	Group 2 - Segment 2 : User over WAN, Branch Office : Who have an impact on daily operations.....	43
4.4.6	Analysis of the Responses of the Groups	43
4.5	Summary of Interview Responses	46
4.6	Observations	51
4.7	Summary	51

5. Discussion.....	52
5.1 Discussion.....	52
5.2 Summary	54
6. Conclusion and Recommendations	55
6.1 The Conclusion	55
6.2 Recommendations.....	60
6.3 Restrictions & Limitations	63
6.4 Future Work.....	63
7. References	64

LIST OF FIGURES

Figure 3.1 : Research methodology flow diagram.....	27
Figure 3.2 : Mapping diagram of factors affecting SD-WAN adoption	32
Figure 3.3 : Design diagram for exploration of case study	34
Figure 4.1 : Group I (All segments) - Financial impact on SD-WAN investment	49
Figure 4.2 : Group I (All segments) - Technical impact on SD-WAN investment	50
Figure 6.1 : All segments - Technical impact on SD-WAN investment	56
Figure 6.2 : All Segments - Financial impact on SD-WAN investment.....	56

LIST OF TABLES

Table 2.1 : Summary of factors/references (this table continues to two pages)	20
Table 3.1 : The stratified representation of the sample data	31
Table 4.1 : Summary of extracted words/sentences and thematic coding (this table continues to two pages).	37
Table 4.2 : Themes with reflection in mapping diagram	38
Table 4.3 : Segment description (referring table 3.1)	46
Table 4.4 : Legend for “Table 4.5”	47
Table 4.5 : Summary of responses from each segment	48

LIST OF APPENDICES

- Appendix I - Preliminary Survey Questions
- Appendix II - Interview Questions for Case Study
- Appendix III - Thematic Codes Summary
- Appendix IV - Interview Response Summary
- Appendix V - Tables for Graphical Interpretation

ABBREVIATIONS

ACL	-	Access Control Lists
BGP	-	Border Gateway Protocol
CIO	-	Chief Information Officer
CTO	-	Chief Technology Officer
CEO	-	Chief Executive Officer
CE	-	Customer End
CAPEX	-	Capital Expenditure
DMVPN	-	Dynamic Multipoint Virtual Private Network
DSL	-	Digital Subscriber Line
FD	-	Fixed Deposit
FIB	-	Forwarding Information Base
IT	-	Information Technology
IP	-	Internet Protocol
IOPS	-	Input Output Per Second
LIB	-	Label Information Base
LSP	-	Label Switching Path
LFIB	-	Label Forwarding Information Base
LAN	-	Local Area Network
LTE	-	Long-term Evolution
MAN	-	Metropolitan Area Network
MPLS	-	Multi Protocol Label Switching
NaaS	-	Network as a Service
OPEX	-	Operational Expenditure
PoC	-	Proof of Concept
PPF	-	Public Provident Fund
PE	-	Perimeter End
QoS	-	Quality of Service
RIB	-	Routing Information Base
ROI	-	Return of Investment
SaaS	-	Software as a Service
SDN	-	Software Define Network
SD-WAN	-	Software Define Wide Area Network
TW	-	Traffic Engineering
VoIP	-	Voice Over IP
VPN	-	Virtual Private Network
VRF	-	Virtual Route Forwarding
VLAN	-	Virtual Local Area Network
WAN	-	Wide Area Networking

1. INTRODUCTION

1.1 Investment and ROI

Based on the investment portfolio, any investment has common and specific objectives despite the economic sector in which the investment lies. Compared to the financial ability, that has been invested, most of the firms spend in return for something more than the initial. By forecasting the possible benefits, they may calculate the utility of investment where this will help determine whether to engage in a particular avenue or not, both in a long and short time as per the business cycle (Klasnic, 2003). However, to recognize the scheme's performance pattern, that may also examine the previous ROI for the strategy to meet challenges.

Whether it achieves the forecast returns or higher, the performance of the scheme is deemed outstanding. For this purpose, return on investment or ROI is essential for fixed-income assets such as PPF or FD and equity-based investment instruments such as equity funds. Therefore, ROI is a comparative measure that will help comprehend the investment return aspect and maximize financial portfolio accordingly (Andromeda, & Gunawan, 2020).

1.2 Challenging Operating Environment

The stability of the current global business environment revolving around the pandemic appears to rely mainly on public funding than the organizational profitability. Even though recently the private investment has improved, the consumption rates have not picked up resulting in lower aggregate demand in comparison to the pre-pandemic levels.

Global business leaders have found the maximum investment degree since the pandemic started and even before, as per the previous pandemic scenarios which have been exhibited. Business leaders in Europe, North America and other fostering countries report further severe problems than others; Europeans, for example, are increasingly anxious about unemployment. Also, these respondents, though, are less downbeat than in the previous quarter. Looking forward, the aspirations of the respondents are steadily optimistic for their home economies: 61 % suggest that six months from now, global economic conditions would be more robust, up from 51 % in mid-October 2020.

1.3 The Impact of Wide-Area Network for Sustainability

As per the Software-defined Wide Area Network (SD-WAN), a virtual WAN design permits business to control any combination of services including MPLS, LTE and broadband internet services to connect users to applications more securely. However, the conventional WANs based on conventional routers which were never designed for the Hybrid and cloud native applications. Moreover, they naturally entail backhauling the entire traffic, including cloud-dined traffic, from branch offices to a center station (hub) or headquarters data center where advanced security inspection services can be applied. The delay caused by backhaul impaired application performance resulting in a weak user experience and lost productivity which will not help meet the business objectives (Alouneh & Abed, 2010).

The SD-WAN model is built to serve applications located inside local data centers, the public or private clouds, and SaaS services such as Salesforce.com, Workday, Office 365, and Dropbox while providing top performance in applications, as opposed to the conventional router-centered WAN architecture. Moreover, the SD-WAN uses a centralized control mechanism to direct traffic through the WAN safely and intelligently. However, this improves the application's performance and offers a high degree of customer interface that increases business competitiveness, resilience and reduces the cost of IT. SD-WAN technologies are being used to transform an enterprise's performance by exploiting the WAN as well as multi-cloud connectivity for high-speed applications on the WAN edge of the branch. One of SD-WANs key advantages is the dynamic path with compared to MPLS. This facilitates in 4G/5G, or broadband connectivity solutions, which provides access to essential business cloud applications rapidly and conveniently (Radcliffe, Furey & Blue, 2019).

1.4 Motivation

SD-WAN technologies have become common because enterprises need rapid, scalable, and versatile connectivity between various network environments and attempt while retaining user experience, to minimize overall total ownership costs (TCO). However, the incorrect SD-WAN approach will dramatically deter an organization, not least because it causes fresh security headaches, from responding rapidly to evolving business demands (Kaur & Gobindgarh, 2015). Businesses need to adapt operations to succeed in today's technology-driven global economy. It must be more flexible to adapt to developments in the industry rapidly. To draw and represent clients, they must be more receptive. However, that must collaborate, exchange data with staff, stakeholders, and vendors to leverage the brightest, the most creative ideas. The cloud is essential to achieve its objectives. By hosting enterprise software in the cloud, corporations are relieving capital-intensive private data centers, enabling them to distribute information technology to places and constituents anywhere they are consistently, safely, and cost-effectively. The cloud delivers scalable, on-demand computes and storage resources with pay-per-use price structures (Albini et al., 2019).

1.5 Research Scope

The investigation is based on an exploratory case study on the impact on ROI for corporate decision making in Sri Lanka for large scale organizations with SD-WAN, and the scope of the case study is as follows.

- i. A preliminary survey across 25 large enterprises to identify the of feasibility of adopting SD-WAN. This was done by interviewing senior IT personal/Decision-makers on the IT budget. Currently there is no proper research found in Sri Lankan context in this regard. However, this should not be treated as a research but a supporting survey for the case study.
- ii. Explore the proof of concept for SD-WAN solution with Fortinet (PoC was carried out by the third-party vendor, conducted for 20 branch offices in the selected Organization). Moreover, the exploration was live for 90 days in parallel to MPLS connectivity. Exploration case study to be carried out with interviews for 5 locations including head office.
- iii. Interviewing IT personal (Both Management & Operation layer) to determine the Manageability & Security, Initial Investment & Operational & maintenance cost.

- iv. Interviewing end-users who are highly engaged with SAP HANA and Intranet Web Portal applications to determine the application startup/application response times and operational latencies.
- v. Analysis of the projected ROI for the implementation of SD-WAN throughout the exploratory Exploration (and actively involved in implementing SD-WAN) by extracting information from Interviews.

1.6 Research Objectives

The research objectives are as follows.

- To examine the factors affecting the ROI for SD-WAN adoption over an exploratory case study on one large-scale enterprise in Sri Lanka.
- To examine the level of acceptance to adopt SD-WAN as a WAN technology by large-scale organizations in Sri Lanka.
- To provide appropriate recommendation for large scale enterprises with remote offices in Sri Lanka on selecting a WAN method based on the projected ROI.

1.7 Research Questions

In this research, it has been attempted to obtain solutions to the following questions.

- What factors affect the implementation of SD-WAN as a WAN technology in large-scale organizations in Sri Lanka which affects the ROI?
- What is the level of acceptance for SD-WAN, in large-scale organizations in Sri Lanka?
- Is it possible to provide a recommendation to other large-scale organization on the implementation of WAN method based on ROI?

1.8 The Significance

This research strives to understand the value and ROI of an effective WAN system to large-scale industries in Sri Lanka. The success of this research will also significantly aid in future decision making in terms of choosing the form of WAN for similar scale organizations.

1.9 Chapter Outline

Chapter one, introduction of the study, chapter two, literature review, chapter three, the methodology, chapter four, data analysis and presentation, chapter five, discussion and finally chapter six, the conclusion and recommendations based on the case study on the impact on ROI for corporate decision making in Sri Lanka for large scale organizations with SD-WAN, an exploratory case study with proof of concept.

1.10 Summary

This chapter represented the research context with the motivating factors which were established, and problem statements which were created for this exploratory case study. At the same time, the field of research and the purpose of this research is described.

2. LITERATURE REVIEW

2.1 Introduction

Today, the Wide Area Network (WAN) connectivity has become essential for the efficient communication in large organizations. In the event of an organization expanding with subsidiaries, e-commerce platforms, multinational activities, a single local area network (LAN) is insufficient. WAN innovations fulfil the diverse requirements of companies where the network is generalized in several respects. However, WAN access also pose other considerations such as the protection of the network and control addresses. Therefore, it is not easy to create a WAN and select the best carrier network networks (Warf, 2018). This chapter addresses some of the alternatives open to build WANs, the technologies available to incorporate them, and the language used and discusses on choosing the corresponding WAN technology, facilities, and devices to satisfy an emerging company's changing market needs. The related WAN technology can be defined and listed, allowing integrated WAN services through the multi-local corporate network (Panchal, Long & Mason, 2020).

2.2 The WAN Technologies

LANs are usually linked to workstations, printers, and other equipment inside a geographically restricted area, for example, a building. LAN devices are collectively operated by the owner of that LAN, such as a small-scale business or an educational organization. WANs are networks that contain a wider metropolitan area and typically require a common transporter's service. Frame-relay, ATM, and DSL are instances of WAN technologies and protocols (Dhanabalan, & Narayanan, 2020). WANs differ in several mechanisms with compared LANs. WAN enables the transference of data over more considerable geographical distances, while a LAN ties machines, peripherals, and other appliances in one building or a smaller geographic area. Furthermore, to use WAN carrier network services, a company must contract with a WAN service provider (Aryaka Networks, 2020). The corporation or entity that uses LANs usually own them while The WAN uses the telecommunication provider or carrier's equipment to interconnect an entity's site, positions of other organizations, external services, and remote customers, for example by a telephone or cable system. WANs provide the network to serve traffic with activities such as voice, video, and data that are critical (Rafique, Qi, Yaqoob, Imran, Rasool & Dou, 2020).

2.3 The Significance of WANs

LAN technologies maintain speed and cost-effectiveness for data transmission in relatively limited territorial areas of organizations. However, WAN is essential if an organization requires remote site communication, including intercommunication, where staff must be in a role to interact and exchange resources with the central location within the geographical or branch departments of a business (Kaur & Gobindgarh, 2015). WAN is also helpful for organizations who seek to exchange knowledge with other organizations within a broad area or distance, for instance, computer suppliers regularly supply vendors marketing their goods to end customers with details about products and promotions. Furthermore, staff travelling for business often must access details to their company networks (McGillicuddy, 2018).

Moreover, with the increase in the domestic usage of computers for regular activities, efficient and secure transmission of data has become vital, such as banking, shopping and educational communications and materials. As machines around a nation or across the world clearly cannot be linked in the same manner that they are connected to cables in a LAN, numerous technologies have developed to serve this need (Aryaka Networks, 2020). The internet is an accessible option for WAN connectivity because it is widely available and relatively with cost effective approaches. Companies have modern technologies that provide their Internet communications and transactions with encryption and privacy. WANs used alone or combined with the internet allow groups and people to fulfil their broad-based communication requirements (Wang, 2018).

2.4 MPLS as a WAN Technology

MPLS, known as Multiprotocol Label Switching (MPLS), is a technology for data transmission that allows increased network traffic flow and acceleration. With MPLS, information is driven by a label route instead of getting detailed data in a routing table at each stop. This technique functions independently and use protocol as Internet Protocol (IP) with compared to Asynchronous Transfer Mode (ATM). If a traditional IP network is used to generate data, it shifts between network nodes based on long network addresses. With this strategy, each router that lands a data packet need to use the routing tables to decide on the following network stop (Aryaka Networks, 2018).

In contrast, MPLS assigns a label to include a default path for each packet. The high-powerful WAN technology Multiprotocol Label Switching (MPLS) enables data transmission from a router to another. The MPLS relies on short path labels more accurately than any other mechanism available to transport of packets. MPLS has a lot of unique characteristics. It is MPLS that can transmit IPv4, Ipv6, Ethernet, ATM, DSL, and traffic relays where labels present the packet to a router (Upasani, 2011). MPLS is highly effective WAN technology provided by a service provider because it is highly reliable compared to traditional WAN methods' uses VRFs to isolate Virtual Local Area Networks (VLANs) to communicate and between remote locations with the support of heavy routing protocols such as Broder Gateway Protocol (BGP). Data transmission is chosen using packet forwarding technologies and marking (MPLS is often referred to as Layer 2.5). The label should be established between Layer 2 (data link) and Layer 3 headers Leased lines provide connectivity between locations with a cost, which uses different mechanisms to transport packets between locations (Yassin & Yalcin, 2019). However, any packet may be delivered via MPLS between sites too. MPLS may encapsulate packets of popular network protocols. It supports many technologies, such as OSPF Traffic Engineering (OSPF-TE) Link, ethernet carrier, ATM, framework relay, and DSL. It also supports many wireless technology systems (Alouneh & Abed, 2010).

2.5 MPLS Pros and Cons

MPLS, Ipv6 and BGP has played an essential part in the next generation networking. A significant feature set of Multiprotocol Label Switching (MPLS) transporting packets efficiently to the packet's destination based on the packet's network-layer header. MPLS provides a healthy operational level to prevent packet failure and maintain an enterprise's most critical traffic flow. This durability of packet is particularly critical to keep protocols like Voice over IP quality in real-time (VoIP). Due to the labels used for transmission, MPLS also guarantees security. MPLS providers can often offer specific network traffic a higher priority (Upasani, 2011). These advantages offer the network a sense of traffic predictability. Network paths are specified by design, so packets only follow the paths in which they are guided. Bandwidth prices are a drawback in MPLS (Kaur & Gobindgarh, 2015). Consumers today are steadily eager to find multimedia bandwidth-hogging content such as videos and virtual reality and to stop the high cost per megabit from MPLS. Finally, an MPLS network does not provide integrated data security, as it will expose the network to bugs if inappropriately applied (Dhanabalan, & Narayanan, 2020).

Considering the advantages, accessibility is significant where switching or MPLS multi-protocol label is entirely scalable compared to other alternatives. MPLS has an incredibly scalable function hence it has been instrumental for businesses which demand high-performance telecommunications. An MPLS network is also simple for the IT team to manage and refine while it can be scaled up for hundreds of numerous locations (Alouneh & Abed, 2010). MPLS has been a reliable technology for more than two decades serving different business areas due to the mentioned facts. Interconnectivity growth is another area where it will allow without purchasing new hardware; MPLS connects all the networks (Upasani, 2011). To link all the networks, MPLS needs a minimum amount of hardware. Moreover, the quality of service (QoS) and a considerable number of solutions apply to MPLS while it will improve efficiency with VoIP. Remote connections are another segment where MPLS is significant in those new remote connections which can be added without purchasing new hardware (Miercom, 2001) saving a lot on cost. The MPLS hosts the whole cloud such that there is no point-to-point connectivity required for MPLS. Uptime has also improved in the last few years since MPLS offers separate network alternative routes for a request. This automatically increases the uptime of the network with lower traffic congestion.

Furthermore, users must encounter heavy traffic congestion via old frame relay networks. The queries are split into separate network routes. It also serves to prevent obstruction in heavy traffic. MPLS is aimed at enhancing the end user experience by providing numerous services such as VOIP. Therefore, the end-user can experience more with low cost. MPLS is the technology of Layer 3, where users can share the sources in the network, and may also path the consumer data privately through MPLS. Like the other public internet services, it has all the cost benefits. Compared to other technologies, MPLS also has better security. It is also ideal for the operation of comprehensive network services. Large-scale services may be applied at relatively low prices (Magazine, Dhanabalan & Narayanan, 2020).

Routing of the traffic of MPLS is the most significant function. When the consumer exits the network, MPLS operates by applying marking to data packets. The network reads the IP header information in standard technologies to interpret its portion. However, MPLS scans the MPLS label for the network route to be decided. Moreover, this tends to improve the MPLS' reliability. Predicting the traffic of a network becomes very straightforward. The swapped label paths or LSPs are pre-fixed (Miercom, 2001) therefore the data packets go on the predetermined routes. Moreover, this varies considerably from IP routing, where the packet's route will vary by network conditions. Service level agreements or SLAs are supplied with the multi-protocol label switching or MPLS services. There are different points in these SLAs, such as assured availability. This functionality is not included with other choices, such as cable or ethernet. Bandwidth is improved and the MPLS separates traffic into separate networks. Therefore, this automatically enhances the bandwidth of the network where in very little time, data can cross the whole network (Yassin, & Yalcin, 2019).

However, few disadvantages with MPLS can be identified as well. The most prominent being the sub-standard level of fault tolerance, a significant QoS aspect which threatens the network survival. It is the property of a device that indicates if the network operates correctly and if any of its component's malfunction. Since its connection-oriented design, the MPLS network is very susceptible to failures. Moreover, only point-to-point connectivity is optimized for MPLS.

MPLS is not suitable for consumers in the cloud. The Software as a service (SaaS) or Google Cloud Platform (Cloud) applications cannot be reached directly with MPLS. Very few cloud services provide this service in the sector. However, to have this service, users must pay a substantial amount. If offices are based in various countries or states, the deployment of MPLS can take some time. Connecting all the offices will take much longer and incur a significant cost. To streamline the distribution, MPLS often needs WAN optimization (Kousalya, Balakrishnan & Raj, 2017). Therefore, in comparison to the previous implementations, these would introduce additional costs. MPLS is pricey relative to Ethernet alternatives as well.

Even though it costs less than the T-carrier which is the digital transmission of multiplexed (T1) lines, MPLS would not have full network control of the problem. The service provider will design both networks and therefore the company will support the dynamic routing provider. DMVPN and framework relay are three of the most influential WAN technologies in the market, based on many studies on the WAN MPLS whereas Frame Relay is considered relatively conventional. Nevertheless, MPLS is the market leader and DMVPN is the simplest and cheapest solution to adopt in the next generation. DMVPN and MPLS stand out based on the performance but do not provide ISP functionality like MPLS. It can also provide customers with both encapsulated in the transport protocol (MPLS) (L2 and L3) VPN service, and it reduces the need for BGP in the middle of the Internet service provider (ISP) networks. Most DMVPN connections are linked over the internet and rely on the efficiency of the internet therefore, considering the quality of service, MPLS is better than DMVPN. Therefore, MPLS earns few more points in terms of consistency than DMVPN (Kaur & Gobindgarh, 2015). In terms of security, DMVPN and MPLS can protect the VPN route via a group of networking protocols used for establishing secure encrypted connections (Ipsec), and high-performance WAN protocol (Frame Relay) does not receive Layer 3 Attacks since it is Layer 2 and may drop the excess explosive traffic in the event of the explosion of traffic attacks. MPLS is more scalable than DMVPN and Frame Relay; when introducing additional customer sites, DMVPN requires fewer setups. WAN still becomes better every day as the internet gets stronger.

In addition to the Internet, WAN technology is needed for businesses to link their offices to subsidiaries in one area. With the latest Ethernet VPN sort, MPLS is growing, which was started for interconnection of Data Centers. It is an ultra-fast multi-point solution introduced in 2014. In the next generation networks, MPLS plays a significant function. Dynamic-Multipoint VPN is becoming common since it provides them with the cheapest solution, when generated over the internet, to free online networking platform or more offices to each other. Although DMVPN can be generated via MPLS networks, it can be more expensive than on the internet. Frame Relay is on its last few days since it needs a different Service Provider system and MPLS and DMVPN routers to function. The WAN-solutions MPLS and DMVPN are to be used widely in the coming years (Luciani, 2019).

2.6 SD-WAN as WAN Technology

Software defined networking is progressing at the same level as cloud computing & virtualization and it is a possible strategic solution to turn data center costs run down over the last few years. SD-WAN incorporates numerous active branch connections, smart traffic paths through ties and unified WAN policy management (T-Systems International GmbH, 2012). It promises to convert IT connection to WAN and WEN's partnership with the organization where it can handle various low-cost services (including Internet and 4G wireless) and conventional WAN services including MPLS are in charge. The capacity for change is not adequate. For this transition, IT must develop an appealing business case where cost is the key driver of the change (John Burke, 2016). SD-WAN strives to eliminate the high cost of service born for WAN. Connectivity is not the only area where SD-WAN saves money; it eliminates the branch WAN outages due to wireless line failures and reduces the troubleshoot costs by 90 % by delivering quicker, more transparent, and automated failover (Vmware Inc, 2019).

Due to the less expensive and faster Internet broadband delivery, companies merge a range of connections to have adequate network bandwidth to distribute their software and services (Vmware Inc, 2019). These connections do not have MPLS QoS or throughput assurances but provide organizations additional management capability in their WANs configuration (Awasthi, 2020). Some businesses utilize the SD-WAN technology along with MPLS and broadband connectivity.

This provides IT teams with the flexibility to allocate company critical traffic to a less costly broadband network with a more reliable MPLS connection and manage other traffic. Packet forwarding technologies using labels to allow data transmission, is one of the primary areas discussed on the adoption of SD-WAN (Vmware Inc, 2019). Branches, campus networks, metro-ethernet services, and companies needing a quality service (QoS) for real-time applications are the most popular users of WAN. Many network suppliers agree that SD-WAN will not do away with the need for MPLS for a long time. Avant Communications, a cloud service provider specialized in SD-WAN (Michael Cooney,2019) has stated that around 83 percent of services utilizing or acquainted with MPLS expected to increase their MPLS network infrastructure and 40 % state that they would “substantially increase” their usage. However, the critical blow on MPLS is how pricey the service is and how difficult it is to implement. Therefore, the choice has become important to the IT and networking practitioners worldwide, to explore WAN architecture in detail to find areas with greater bandwidth or lower costs or improved efficiency, or all three. Therefore, it is worthwhile to evaluate if SD-WAN indicates substantial possible savings over time and produce a market report focused on the numbers and other operating savings which would aid in decision making (Awasthi, 2020).

2.7 SD-WAN Pros and Cons

SD-WAN provides a range of advantages over conventional MPLS networks. The SD-WAN decreases regional borders and improves visibility, scalability, efficiency, and power contrary to MPLS where there are no bandwidth penalties on SD-WAN. Given there are no modifications required to the existing infrastructure or network, consumers can quickly update by inserting new connections (Burke, 2016). The prospect of cost-effective mixing and matching network links by content form or priority is probably the most significant selling point for SD-WAN. Both wireless Internet and mobile phones are less costly than MPLS, enabling users to pick these connections for low priority traffic rather than the expensive MPLS network. Security virtualization is also a significant benefit of SD-WAN where companies favor network architectures incorporating security, political affairs, and orchestration. SD-WAN facilitates this by the convergence of protected connectivity approaches. With the SD-WAN architecture, the whole network, including the Internet, benefits from end-to-end encryption (Futuriom, 2019).

Credits to its scalable key exchange feature and software-defined security, all devices and endpoints are entirely authenticated. Another advantage of SD-WAN is the generalization of edge connectivity using the virtualization of WAN which brings all the connections into a single pool in one location where capacity is available to all services. One or more logical WANs are overlaid on the pool of connectivity, where the behavior and topology for each overlay WAN is defined to suit the needs of specific types of network services, locations, or users. Also, SD-WAN is policy-driven due to which it is centrally managed providing a significant flexibility in traffic management for performance and security with SD-WAN. SD-WANs can enhance the efficiency of traffic in many directions; primarily, they can selectively route traffic across links based on measures such as link performance.

SD-WAN Improves business applications and makes them agile compared to older architectures. Officials will have the ability to determine the minimum and maximum bandwidth limits to better utilize available network bandwidth and inexpensively prioritize applications, which also enhances the user experience and efficiency for cloud and SaaS applications for modern use. It also gives the network's independence across 3G/4G LTE networks, MPLS, etc. Frequent tasks such as provisioning, and formations are automated within the network which enhances traffic management for organizations. The integrated dashboard provides system administrators system of measurement on network performance. SD-WAN design Contains next-generation firewalls (NGFWs) along with malware protection to defend against malicious cyber threats. Stateful inspections of data packets occur as they reach the perimeter of the firewall and vendor service-level agreements offer guarantees of reliable user experience within the network.

However, there is no on-site security functionality. Safety measures will still need to be applied to ensure that network continues be protected and not exposed to outside hazards. One straightforward data breach could compromise the entire enterprise. Hence IT staff will still be required in deploying and maintaining this technical solution. If the internal teams lack competence, outsourcing of competence will be an additional cost. Added to that the SD-WAN networks are unaffected to slow performance. QoS being another significant fact to consider. There is no genuine end to end QoS if using just SD-WAN.

Another pitfall is that the SD-WAN vendors tend to differ and frequently do not connect what is originally intended for software-based networking. SD-WAN forwarding appliances offer Ethernet connections to interface with the WAN and LAN, but not traditional WAN circuits. If a time-division multiplexer is necessary to support a network, the existing WAN router will need to be retained to support the SD architecture. SD-WAN however requires less investment on connectivity. Increase in MPLS spending can be eliminated, and annual costs can be reduced by switching Internet links for MPLS. Either way SD-WAN can improve the uptime. Overall Research data on usage of WAN technologies, indicate a 92% reduction in WAN outages at SD-WAN sites. SD-WAN can reduce IT WAN management costs as well. And data show a 95% reduction in WAN trouble tickets (John Burke, 2016).

2.8 SD-WAN vs. MPLS as WAN Technology

Some businesses have reassessed MPLS usage, the most common wireless transmission technology, owing to SD-capacity WANs to traffic through several connections. MPLS offers quality service (QoS) policies to guarantee network performance that controls performance, delay, and jitter which can deviate from true cyclicity of a presumably periodic signal of the network. However, MPLS is costly, and it can take months to supply and run an MPLS link. Due to the less expensive and faster Internet broadband delivery, companies merge a range of connections to have adequate network bandwidth to distribute their software and services. These connections do not have MPLS, QoS or throughput assurances but provide organizations additional handling in their WANs configuration.

Some businesses are utilizing their SD-WAN technology using MPLS and broadband connectivity. This choice makes IT teams allocate company critical traffic to a less costly broadband network with a more reliable MPLS connection and other traffic. Like in any new investment, expenditure on SD-WAN will increase costs in the short run, but it will have long-term benefits and operating efficiency since these implementation costs are gradually amortized. While the WAN circuit's actual costs do not adjust immediately in the short term, more software licensing may be required with this latest software layer. Since current WAN management strategy of SD-WAN changes the WAN status quo, which may need comprehensive preparation for IT staff. IT advocates cannot just drop an SD-WAN and encourage teams to operate it.

IT agencies must, therefore, ensure that their preparation expenses are provided sufficient funds for the development. As per the security, since they are external and dependent on transport from beyond the firewall, WANs reflect substantial exposures. Unintended security issues can emerge from the implementation of some new WAN technology. In comparison, all WAN layers now have vulnerabilities. Complexity is another area where WAN connections are usually a single provider service. SD-WAN incorporates an external component on top, which causes complexity in an overlay of the current WAN link – the underlay. Considering software, WAN favored hardcode functions over hardware for more reliability in years because the software is more vulnerable to glitches, bugs, and crashes. If customers migrate to SD-WAN, their service would be highly scalable, but it will not cost software particularities and limitations. Issue for the solution through problem-solving, SD-WAN requires an underlay and an overlay in the WAN service, it becomes more challenging to solve problems from two vendors. WAN situations then need to investigate in two points until the problem is zeroed in.

There can be substantial impacts on the costs and flexibility of a WAN enterprise on the discrepancies between the MPLS-WAN approaches to network connectivity. For the most part, SD-WAN may use comparatively low-traffic network connections (i.e., broadband Internet) while saving higher, more reliable, and more costly alternatives for application traffic (for example, MPLS circuits). Instead of spending expensive MPLS bandwidth on low-priority services, an enterprise should maximize its network expenditure. SD-WAN often improves WAN flexibility relative to MPLS by the elimination of MPLS circuit restriction. Bandwidth can be extended without any delays in the MPLS circuit provisioning due to the potential to use any transport medium. Optimized routing allows effective transmission of traffic to its destination, not just predefined MPLS circuit routes. Support for broadband Internet and cell networks allows it easy to redirect SD-WAN traffic everywhere, not just where an MPLS provider is open. MPLS offers some benefits, but its high cost and low availability render it a bad option for quickly expanding business networks. SD-WAN is a common MPLS alternative that offers companies numerous advantages. Both SD-WAN implementations are, though, not all the same. SD-WAN, like MPLS, is intended to have an advanced security-free networking framework.

It is essential to choose one that comes with software-defined security when choosing an SD-WAN solution to complement its optimized networking capabilities through software. Estimates differ for traditional SD-WAN saves, but the SD-WAN adoption saved 67 % of businesses in link costs in CIMI Corporate surveys. Furthermore, the total cost of SD-WAN connection technology was 58% lower than the edge routers used for MPLS VPN connectivity. Finally, the users estimated that SD-WAN required roughly 25% fewer activities, contributing to an acceptable decrease in operational expenditure, based on the personnel ratios.

Connectivity cost savings from SD-WAN are most significant where Internet access is substituted for Ethernet carrier links, while savings of more than 20 % are also made in sites which maintain Ethernet carrier and only replace MPLS. Higher savings rates were created at foreign sites and sites in thin rural areas. Overall, these connection savings, in most cases are adequate to justify SD-WAN alone, but further advantages need to be achieved. The most common and fascinating emerging network technology and the most popular foundation for new network services have quickly become the software-determined WAN (SD-WAN). In a simple sense, SD-WAN is substituted by an inexpensive alternative to the Internet for costly virtual private networks (VPNs). This specific business argument can be significantly extended with the right product and can perhaps render SD-WAN the most straightforward modern network infrastructure to justify (Dhanabalan & Narayanan, 2020).

2.9 Impact of WAN on ROI

Like any new investment, SD-WAN will increase costs in the short run, but it will have long-term benefits and operating efficiency since the cost of implementation is gradually amortized (Vmware Inc, 2019). While the WAN circuit's actual cost does not adjust immediately in the short term, more software licensing may be required with this latest software layer. Given the current WAN management strategy, SD-WAN changes the WAN status quo, requiring comprehensive preparation for IT staff. It is impractical expect the best performance and savings by just implementing SD-WAN and expecting the internal teams to operate it without sufficient training. IT agencies must therefore ensure that a sufficient budget is allocated for training and preparation as well. WANs reflect substantial exposure since they are external and dependent on transport from beyond the firewall. Subsequently, unexpected security issues can emerge from the implementation of a new WAN technology (Gelhaus & Matthews, 2012). In comparison, all WAN types now have vulnerabilities (Wang, 2018).

However, the complexity of WAN connection is usually incorporated by SD-WAN's external components, which causes complexity in an overlay of the current WAN link. Therefore, WAN vendors have favored hardcode functions over hardware for more reliability in the recent years. One of the reasons being that the software is more vulnerable to glitches, bugs, and crashes. If customers migrate to SD-WAN, their service would be highly scalable, but it will not be at the cost of software particularities and limitations. Moreover, SD-WAN requires an underlay and an overlay in the WAN service, which makes it more difficult to solve problems rising from two vendors. Problematic WAN scenarios then need to be investigated in two paths until the problem is zeroed in. This can lead to substantial impacts on the cost and flexibility of a WAN enterprise due to the discrepancies between the MPLS-WAN approaches to network connectivity. For the most part, SD-WAN may use comparatively low-traffic network connections such as broadband internet while saving higher, more reliable, and more costly alternatives for application traffic which is significant. Instead of spending on expensive MPLS bandwidth on low-priority services, an enterprise should be looking at maximizing its network expenditure. SD-WAN often improves WAN flexibility relative to MPLS by the elimination of MPLS circuit restriction.

Bandwidth can be extended without any delays in the MPLS circuit provisioning due to the potential to use any transport medium. Optimized routing allows effective transmission of traffic to its destination, and not just of predefined MPLS circuit routes. Support for broadband Internet and cell networks allows it easy to redirect SD-WAN traffic everywhere, not just where an MPLS provider is open. MPLS offers some benefits, but its high cost and poor availability render it a bad option for quickly expanding business networks. SD-WAN is a common MPLS alternative that offers companies numerous advantages. SD-WAN, like MPLS, is intended to have an advanced security-free networking framework. It is important to choose one that comes with software-defined security when choosing an SD-WAN solution to complement its optimized networking capabilities through software. Estimates differ for traditional SD-WAN saves, but the SD-WAN adoption saved an average of 67 percent of businesses in link costs in CIMA Corporate surveys. Furthermore, the total cost of SD-WAN connection technology was 58% lower than the edge routers that were used for MPLS VPN connectivity.

Finally, the users estimated that SD-WAN required roughly 25%-30% fewer activities, which may contribute to an acceptable decrease in OPEX, based on the personnel ratios. Connectivity cost savings from SD-WAN are greatest where Internet access is substituted for Ethernet carrier links, while savings of more than 20 per cent are also made in sites which maintain Ethernet carrier and only replace MPLS. Higher savings rates were created at foreign sites and sites in thin rural areas. Overall, these connection savings in most cases are adequate to justify SD-WAN alone, but further advantages need to be achieved. The most common and fascinating emerging network technology and the foundation for the most popular of new network services has quickly become the software-determined WAN (SD-WAN). In simple sense, SD-WAN is substituted by an inexpensive alternative to the Internet for costly virtual private networks (VPNs). This specific business argument can be significantly extended with the right product and can perhaps render SD-WAN the simplest modern network infrastructure to justify with the business cost (Cooney, Rong, & Lamichhane, 2019).

2.10 Summary Table of Literature Sources

Table 2.1 shows a summary of the literature that is linked to factors extracted related to SD-WAN, MPLS and ROI.

Table 2.1 : Summary of factors/references (this table continues to two pages)

No	Reference	WAN	OPEX /CAPEX		Security/ Performance/ Manageability		Case Study	ROI
			MPLS	SD-WAN	MPLS	SD-WAN		
1	Succeed, H. E. (2018). Wide-Area Network Transformation. December.	x	x	x	x	x		
2	Corporation, C. (2018). Exploring the SD-WAN Business Case A special report from CIMI Corporation.				x	x	x	x
3	Kaur, E. H., & Gobindgarh, M. (2015). Comparative Analysis of WAN Technologies. International Journal of Computer Science Trends and Technology (IJCST), 3 (5), 9–20.	x	x	x	x	x		
4	Burke, J. (n.d.). e CIOs Guide to SD-WAN Building the case for a faster, better, and cheaper network.	x			x	x		
5	Findings, K. (2019). SD-WAN Managed Services Trends Conclusion: Rapid Growth for SD-WAN Managed Services.	x		x		x		x
6	Rajendran, A. (2016). Security Analysis of a Software Defined Wide Area Network Solution Security Analysis of a Software Defined Wide Area Network Solution. https://aaltodoc.aalto.fi/handle/123456789/23161	x		x		x	x	x
7	Global, Y., & Network, E. (n.d.). SD-WAN vs. MPLS: Key Considerations for. 1–12.	x	x	x	x	x		x
8	Paper, W. (2019). Demonstrating SD-WAN Business Value; Rethinking WAN for a Modern Age. April.	x		x		x	x	x
9	Klasnic, J. (2003). Calculating return on investment. In-Plant Printer, 43 (3). https://doi.org/10.1201/9781420031201.ch9			x		x		x
10	Alouneh, S., & Abed, S. (2010). Fault tolerance and security issues in MPLS networks. International Conference on Applied Computer Science – Proceedings, 134–138.		x		x			

11	Handbook, D. (2007). Chapter 3: Method (Exploratory Case Study). 301–309.						x	
12	Warf, B. (2018). Wide Area Networks. The SAGE Encyclopedia of the Internet, May. https://doi.org/10.4135/9781473960367.n284	x	x	x	x	x		
13	Paper, W. (2019). Demonstrating SD-WAN Business Value; Rethinking WAN for a Modern Age. April.	x	x		x			x
14	Findings, K. (2019). SD-WAN Managed Services Trends Conclusion: Rapid Growth for SD-WAN Managed Services.	x		x		x		x
15	Network, S. D., Isp, T., Providers, I. S., & However, V. (n.d.). MPLS as a Software- Defined Network.	x	x		x			
16	Albini, A., Tokody, D., & Rajnai, Z. (2019). Theoretical Study of Cloud Technologies. Interdisciplinary Description of Complex Systems, 17 (3), 511–519. https://doi.org/10.7906/indexs.17.3.11			x		x	x	x
17	Awasthi, A. (2020). SDWAN (Software Defined-WAN) Technology Evaluation and Implementation. Global Journal of Computer Science and Technology, 20 (July), 1–16. https://doi.org/10.34257/gjcstcvol20is1pg18	x	x	x	x	x		x
18	Paper, W. (n.d.). Three Use Cases for Transforming Branches With Fortinet Secure SD-WAN.		x	x	x	x		
19	Chaki, N., Chaki, R., Bhattasali, T., Chakraborty, M., & Chaki, N. (2014). Future Trends in WAN Security. In Intrusion Detection in Wireless Ad-Hoc Networks (Issue January). https://doi.org/10.1201/b16394-9	x	x	x	x	x		
20	Hollweck, T. (2016). Robert K. Yin. (2014). Case Study Research Design and Methods (5 th ed.). Thousand Oaks, CA: Sage. 282 pages. The Canadian Journal of Program Evaluation, March 2016. https://doi.org/10.3138/cjpe.30.1.108							x

2.11 Summary

The listed literature resources in “Table 2.1” have been examined to identify the factors that may perhaps be needed to be focused upon when implementing WAN and how it relates to ROI. Many significant factors related to investment on SD-WAN were observed from the literature sources mentioned. Circuit Costs & Network Architecture were main factors found on literature which holds the key to SD-WAN adoption. Following motivations were mainly identified as SD-WAN adoption reasons by CIO/CTOs all around the world.

- Increased application/network performance availability
- Less overhead cost with zero touch provisioning for new remote offices
- Increased WAN bandwidth while maintaining WAN transport expenses under control.
- Cloud naiveness with Automation and Agility with Reliability

The following factors have been identified through literature to align with the exploratory case study.

- Capital Expenditure & Operational Expenditure relation to ROI.
- Performance of SD-WAN in relation to ROI
- Security of SD-WAN in relation to ROI
- Manageability of SD-WAN in relation to ROI

3. METHODOLOGY

3.1 Introduction

This Chapter will deep dive into the information related to the methodology used in this exploratory case study of exploration and the ROI on factors affecting the adoption of SD-WAN as a WAN method will be described. The designs or methods of the analysis also apply to the researcher's outline to accomplish the research aims more accurately. The chapter will analyze the data related to the methodology used in this exploratory case study. Further identifying the return on investment (ROI) decision and factors affecting the adoption of Software Defined Wide Area Network (SD-WAN) as a wide area network (WAN) method. The researcher conducted a preliminary survey across a pool of large-scale companies to assess the degree of adoption in SD-WAN to verify the problem area. Then research was carried out with in a large-scale organization where the researcher was a part of SD-WAN solution.

3.2 Research Approach

The research used the case study as the primary approach and explored the proof of concept, implemented by the SD-WAN vendor for this organization. The study had two phases in which a preliminary survey was carried out to support the problem statement and the actual case study to continue with the SD-WAN and impact on ROI. However, this preliminary survey was conducted with the specific organizations and employees to understand effect of exploration to evaluate the degree of acceptance of SD-WAN technology adoption for them. This large-scale business is well-known nationally and active in various industries as Sri Lankan public limited organization. It was conducted using qualitative approach. Since qualitative approaches are used better to understand employees' views of a specific phenomenon, the actual research was focused on qualitative data (Sinha, Chowdhury, Das, & Ghosh, 2020). Since the understanding of this company's present-day business environment was already there, it was agreed to perform in-depth ROI analysis for existing WAN technology during the PoC (numeric ROI analysis was not in the scope of exploratory case study).

However personal involved in ROI analysis with both technical and financial were considered in the focused group for interviews to share their analysis outputs). As stated, the primary step of the analysis was chosen as an exploratory case study to observe the phenomenon of proof of concept because the case study was performed on a large-scale company for new technology adoption.

3.3 Case Study Approach

A case study research strategy usually requires qualitative methods, but quantitative methods are occasionally used. Case studies are useful for illustrating, comparing, evaluating, and understanding different aspects of a research problem. One or more data collection methods are used in certain case studies where the researcher attempts to obtain answers or influencing factors for questions such as how, why, what on a particular phenomenon. This will be applied in explorations where a case or cases are described in depth and the result of certain exploratory case studies results in multiple outcomes and broader observations. As with any research study, the first stage in conducting a quality focus group is to define the study purpose.

Certain case studies are done based on two or more cases where the focus is on the comparison of the cases (Handbook, 2007). Approaches to data collection of case studies vary depending on the design of the case study. The most frequent approach is the interview method. Interviews can be done in person or via email, Skype, telephone, or any other method that allows participants to answer questions. The best approach to collecting data and how to collect it should be thoroughly evaluated based on the context or the phenomenon explored. There are several steps to analyze case study data. First, the data is organized into specific units, words, or sentences. The next phase in analysis is where coding, combining the text or visual data into categories of information is done. In this phase codes are the key ideas from various sources of data which is then labelled to form aggregates. Ultimately the aggregated codes are reviewed to look for classifications or themes. These themes are extensive pieces of data that consist of quite a few codes that form a common idea which is defined in a factor of research design (Baxter & Jack, 2008).

Once the study purpose has been defined, the study population and sample must be defined. The population represents the people that are to be analyzed. The sample is a subset of the population. Focus groups do not make use of probability or random samples. Focus groups mostly utilize convenience sampling. The sample for a focus group has personalities with characteristics of the overall population and can contribute to facilitating the research to gain a greater understanding of the topic.

3.4 The Case Study Area

The organization which exploratory case study is based on, has spread its business over retail, hospitality, professional services, transport & logistics business segments. Due to the factors of its scale and the level of sophistication in the remote office network, this organization was considered the best suitable environment for carrying out this exploratory case study on SD-WAN adoption. There are more than 150 remote offices connected to central data center of this organization via MPLS. Head office datacenter is where all the centralized systems hosted. Hence the centralized services were delivered to remote offices via the MPLS connectivity.

Services include email services, ERP systems, HRIS systems and VoIP. Since 2009, they have been using Multiprotocol Label Switching (MPLS) as their WAN method and have switched to MPLS because of legacy virtual private network (VPN) connections. They were introduced by a credible Internet service provider (ISP) in Sri Lanka with MPLS in 2009 and had been adopted post a proof of concept (exploration) at that time. The organization therefore is experienced in switching from one WAN technology to another. This organization is well established and growing enterprise in the country as well as in the domains they conquer. Their network infrastructure is not only limited to Sri Lanka. In addition, there are multiple companies operating on the same network infrastructure, where the operational excellence of many business-critical applications significantly depends on the network.

The investigation also involves the researcher as an external consultant in developing the exploration for the organization. As A Result, there will be data gathered from the idea generation (of the PoC) stage to the adoption or implementation of SD-WAN. The sample size, sampling method, target population, and data analysis techniques and how to interpret the data collected of this exploration case study will be elaborated in following paragraphs.

3.5 Research Methodology Flow Diagram

The research flow diagram is representation of the flow of the exploration of the case study. The flow diagram illustrates major phases of by considering the progression of each phase.

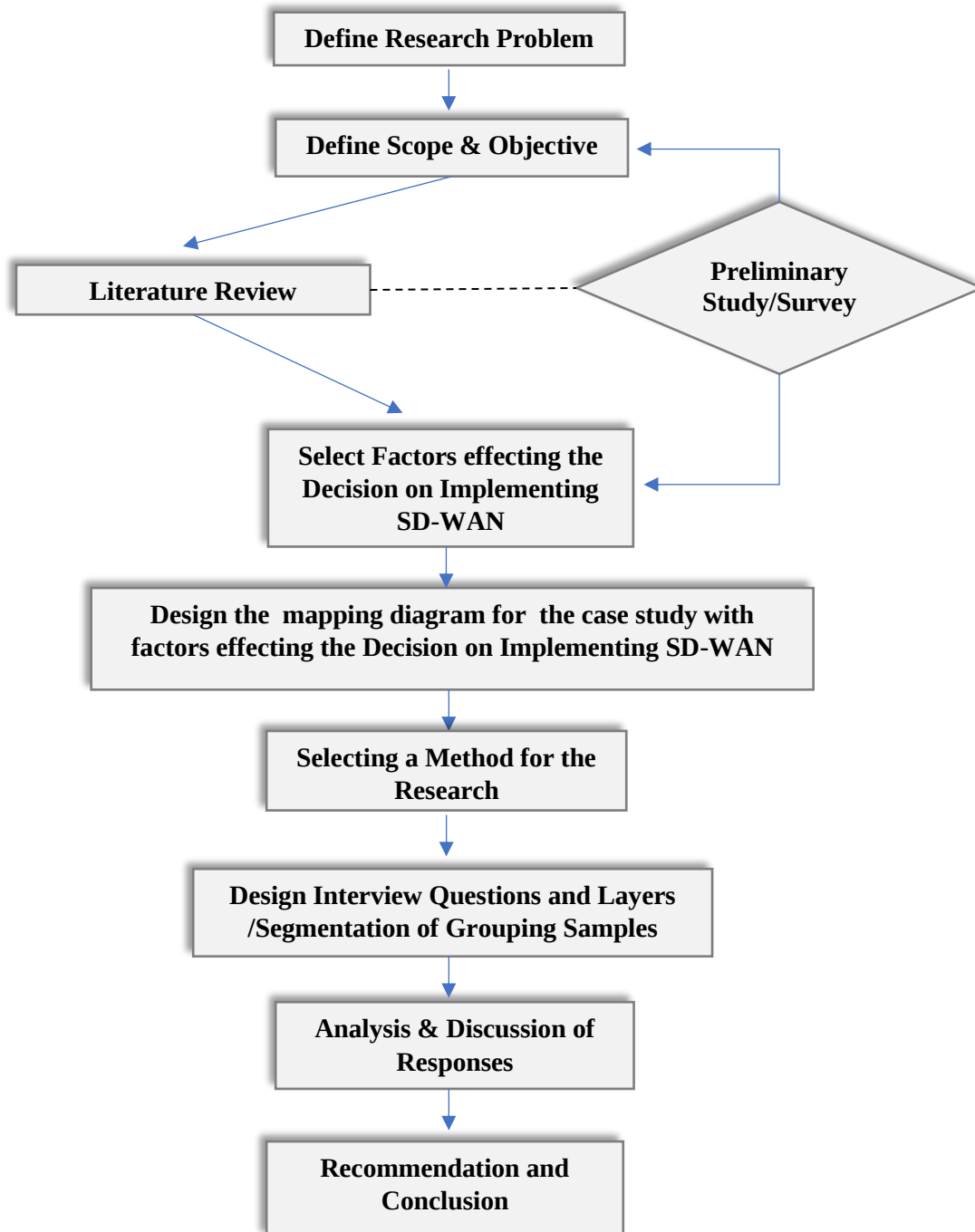


Figure 3.1 : Research methodology flow diagram

3.6 Preliminary Survey

The preliminary survey was essential due to the absence of any research carried out yet in the Sri Lankan context on factors influencing the implementation of SD-WAN and impact on ROI. Therefore, the investigation was initiated with a preliminary interview with selected few other similar scaled organizations, to validate the research questions. The interviews were structured such that the factors identified for the research study from the literature survey were particularly addressed (Zaballos, 2020).

3.7 Data Collection Method

In this case study, data collection is one of the essential functions since the result is heavily dependent on the responses of respondents. It is important to find which data needs to be gathered and from whom data should be acquired during the data collection process. The population, therefore required to understand the technology and the intent of the case study. At all levels of the management hierarchy, multiple concerns were raised on the evaluation of SD-WAN as a WAN method for the organization, therefore, the requirement for proof of concept was initiated in the organization which exploration case study was carried out. However, a very few explorations have been carried out by selected suppliers within Sri Lanka prior to this exercise. Although the suppliers had deployed several SD-WAN environments outside Sri Lanka, a case study of this scale had not been applied within the country. Before evaluating the appropriate WAN method for the selected organization, an investigation was carried out on transforming information technology within the organization as well.

Therefore, richer understanding of the current climate has been achieved prior to this exercise. The exploration of proof of concept is used to analyze the identified factors in mapping diagram shown in figure 2 and the knowledge collected through interviews. Therefore, the exploration outcome by interviews and extracting responses into themes was considered as the data collection and data collection method (Yin, 2014). As there was interest on the exploration on the PoC from all levels of the organization, sample sizes were chosen from each level to carry out the interviews as per the primary approach. This is further explained in “chapter 3.6”. Researchers use purposive sampling in this type of case studies, when they want to access a particular subset of people, as all participants of a survey are selected because they fit a particular profile.

3.8 Target Population and The Sample Size

The population in the research consist of the individuals of the target group which will be interviewed. This population primarily includes people who have rich or moderate level of knowledge on the context, who will be impacted with their daily operations during the exploration and those who will experience the change made by the SD-WAN implementation. The literature review and preliminary survey identified key factors that should be considered during the interviews. Therefore, the selection of the population for this case study was considered by coccidian how the population is compatible with the problem, the statement of purpose and research questions. The sampling technique is selected as purposive sampling (focused groups). This sampling method requires researchers to have prior knowledge about the purpose of their studies so that they can properly choose and approach eligible participants.

In qualitative research with an exploratory case study, the analysis involves individuals who meet the requirements for the case study as explained, for the sample (Nagle & Barry, 2011). Here, the target population was considered as all employees of the organization who work in the primary datacenter on cloud with the centralized systems such as ERP/Emails (SAP-HANA/Office 365/HRIS). Therefore, employees from both on-site (LAN) and off-site (WAN) are included in the population.

There are about 1500 LAN and WAN users, and about 800 of them use LAN to access centralized applications hosted in the Head Office and the rest of them use WAN. For evaluating a WAN technology, this was the ideal target population since the outcome of the exploration demonstrates the feasibility of the proposed approach via the exploratory case study. Except for 1500 individuals, people from both the IT department and top management who will have direct decision-making authority on the WAN method have also been included. Hence the purposive sampling (focused groups) is used when deciding on the sample and focus group is most effective with 7-12 participants (Nagle & Barry, 2011).

As SD-WAN impacted the whole organization structure, researcher defined different segments in organization structure to explore the facts behind the investment decision. Hence, considering that at least 7 participants in each segment the total sample consisted of 88 people (from all segments including the application end users). All of them have computer literacy (IT) from their secondary education. Application end users were interviewed because they were part of PoC, and they were considered important on sharing the daily operational impact.

However, during the analysis, application end users were removed from the discussion as the responses were not adequate. All 1500 users would also be impacted and can be defined explicitly as the target population. Group I with 43 users was considered as the perfect sample for the study. These was discussed in “chapter 4.4.6”. All consumers have been segmented concerning the decision-making factors and how they fit within the case study. The target sample (including the application end users) was then divided into the grouping underneath.

- Sample I (Group I) - Executive/Technical/Finance Users
- Sample II (Group II) - Non-specialist End-Users – Application Users

Table 3.1 : The stratified representation of the sample data

Segment		Category	Functional Area	Sample Size
Group I - Executive/Technical/Finance Users				
Segment 1	Users over LAN (Head Office users) - direct decision-making power on both financial and technical aspect	Top Management	CTO/ Head of Group IT	2
		Technical (Group IT Department)	IT Managers /Managers of Technology Area/Technical Leads/System Engineers	8
Segment 2	Users over WAN (Branch Office users) - In-direct decision-making power on both financial and technical aspect	Technical	Management (IT)	5
			IT – Operations	11
		Non-Technical	Management (Finance)	2
Segment 3	Users over LAN (Head Office users) - In-direct decision-making power on both financial and technical aspect	Technical	Management (IT)	3
			IT – Operations	11
		Non-Technical	Management (Finance)	1
		Total users in Group I		43
Group II - Non-specialist End-Users (Application Users)				
Segment 1	User over LAN (Head Office users) - Impact on daily operations	End user	End Users (without Top management & Group IT)	25
Segment 2	User over WAN (Branch Office users) - Impact on daily operations	End user	End Users (without Top management & Group IT)	20
Total users in Group II				45
Total users two Groups (43+45)				88

3.9 Mapping Diagram

Following diagram illustrates the mapping which was utilized to explore the case study and the interviews. Mapping diagram is designed based on the core contributing factors (which affects investment decision in other countries) discovered from literature survey. Factors demonstrated in mapping diagram were considered as the pre-defined themes while processing the thematic coding as well. Factors are summarized into two main sectors and illustrated in mapping diagram. Elements in mapping diagram will strive to clarify relationship (if there is any) between factors impacting the ROI of SD-WAN adoption and implementation decision in Sri Lanka for large scale organizations.

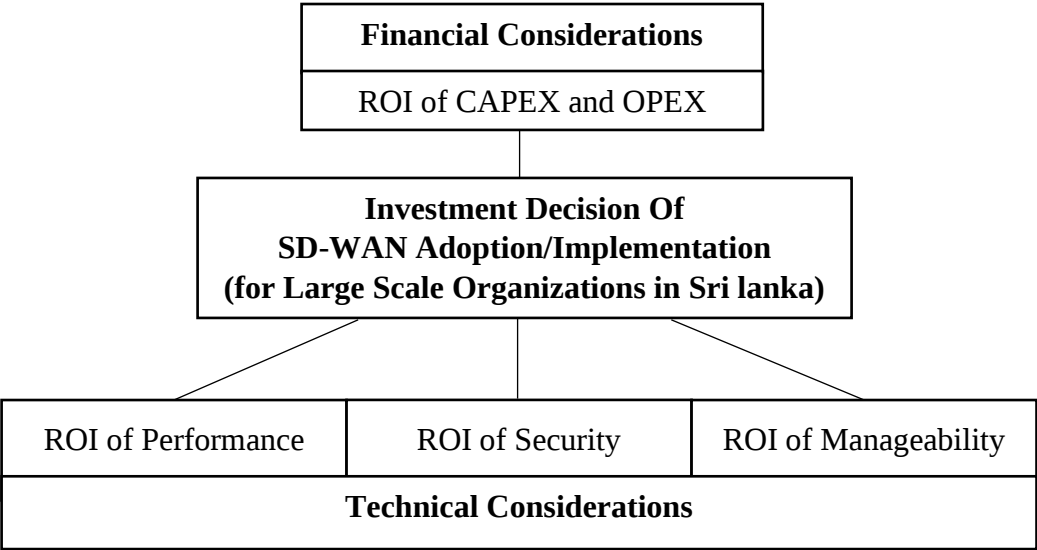


Figure 3.2 : Mapping diagram of factors affecting SD-WAN adoption

3.10 Interviews and Obtaining support from “Proof of Concept.”

Triangulating data & information is essential in case study research and there are many methods of collecting data. For case studies, qualitative researchers may use diverse records, interviews, artefacts, and observations. Semi-structured, structured, or unstructured interviews may be given. Additional information that can be used to complement the data obtained from interviews is provided by accumulating records and artifacts related to the phenomenon being studied. Therefore, the proof of concept for selected product (carried out by the organization itself) was used to obtain feedback and interviews were used. In the way outlined in the table 2, interviews are segmented inside the total sample.

3.11 Research design diagram for exploration of case study

The research presents a case study carried out parallel to proof of concept of SD-WAN in a large-scale organization in Sri Lanka. Hence the design diagram in page 35 illustrates the phases and interconnectivities of each component in detail of the research.

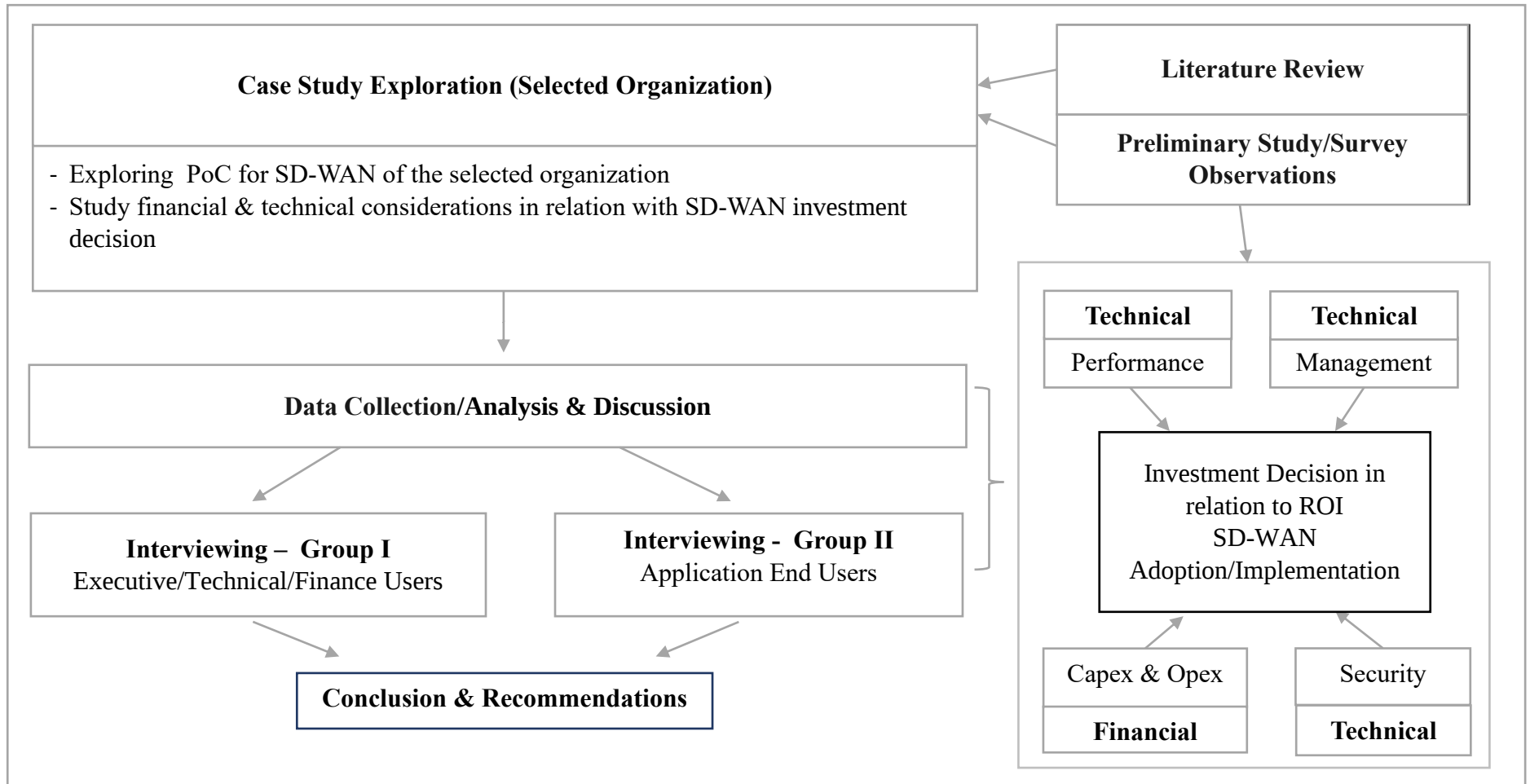


Figure 3.3 : Design diagram for exploration of case study

3.12 Data Analysis

Each segment of the sample from the target population described in “Table 3.1” was interviewed on the experience they had with the proof of concept for SD-WAN on this organization. Hence this was the exploration of the case study for the research work. Data for the analysis were derived from these interviews. Initially, researcher analyzed to the responses to obtain a general idea and to familiarize the data. Transcription was done manually to extract themes. Next step was to organize the responses into specific words, or sentences for the purpose of coding. Then aggregated information (words and sentences) was represented with specific coding. This helped identifying the pattern and to combine several codes with the defined themes. Defined themes were the factors identified from the preliminary survey and literature review (pre-defined themes in mapping diagram). Interview questions are structured to scope the answer with factors identified from the preliminary survey and literature review. The researcher was reviewing the defined themes and found other new themes that emerged during the coding phase.

The analysis and discussion were done in relation to the themes. Each theme was denoted with a qualitative assessment of emphasis. Hence the relationships between themes and investment decision on SD-WAN implementation was analyzed with the help of basic graphs with percentage values derived from qualitative assessment of emphasis on each theme.

3.13 Summary

As described during the methodology chapter, this exploration of case study is based on evaluating the experience of a broader spectrum of users selected from the selected organization which is trying to adopt of SD-WAN as WAN technology.

The chapter it discussed about the methodology which is been designed to this research case study. Also, this study centers on the mapping diagram derived after researching previous related research studies/reports and experiences gathered from industry experience. Also, research tools, population and sample for the analysis, and the data analysis approaches are being discussed to provide a better idea of the procedures of how the exploration is being carried out and aimed to derive a conclusion and recommendations.

4. RESULTS & OBSERVATIONS

4.1 Introduction

One of the challenging elements to write is the results and discussion sections. This section needs to be carefully prepared, as it includes significant information and data which must be clearly and accurately described. Data for this chapter was obtained by the responses after interviews. Analysis was organized after carefully extracting the information by transcription of the responses and extracting themes from the interviews. Extracting the factors related to mapping diagram were done during this stage of the case study.

The aim of a section on results is to present the main research findings. This section highlights the importance or interesting results and to provide both positive and negative findings. Responses to the interviews are formulated and explained to represent the potential highlights and significance of the exploration case study.

4.2 Data Collection

The collection of research data started at the beginning of December 2019 as the case study was initiated with parallel to the organization implementing proof of concept for the SD-WAN in October 2019. Initially it was decided to run the exploration for 3 months. Data collection continued for 6 months. Hence interview process started on last weeks of December 2019 and ended at the end of March 2020. In March 2020 exploration ended and researcher assessed the responses of the interviewees.

As the next phase, the responses were segmented to codes and prepared the themes. Received responses were themed in relation to factors represented in mapping diagram (Which considered as the pre-defined themes). Themes were denoted with qualitative assessment of emphasis of financial, technical, or other factors extracted from the transcriptions. Experience and the understanding of the respondents were discussed and elaborated using the themes and other related findings. The relationships between themes and investment decision on SD-WAN implementation was also analyzed by graphs consisted with percentage values derived from qualitative assessment of emphasis on each theme.

4.3 Assessment of Interviews

Researcher had to listen to each of the recording and build summarize transcripts of the total pool of users interviewed. It was required to understand the experience and extract the exact factors to map the themes accordingly. Hence this phase of the analysis took three weeks to co-relate the answers to the factors defined in mapping diagram of the case study. The eventual objective was to observe the usage of the factors in responses in relation to the SD-WAN adoption investment decision. Researcher observed the factors and mapped relation by listening to each response and then relating it with the functional area of each interviewee. In that approach it is observed that each respondent's functional area had an influence in the response. Analysis was aimed to observe whether the factors represented mapping diagram can be observed in responses. Which are the factors affecting SD-WAN adoption outside Sri-Lanka (observed over preliminary survey and literature survey). If the factors were observed, then those will be discussed to see how and why they affect the SD-WAN adoption in this organization.

4.4 Discussing Responses of Each Segment of Interviews

Assessing an extracting information from the responses was the complicated assignment as it was done manually by listening and writing the responses. Then words and sentences were extracted. Ideas from the various response were themed and coded for final aggregation. Ultimately review the aggregated codes and look for classifications or themes. These themes consist of several codes that form a common idea and that lead to factors in research design or mapping diagram of the case study.

Table 4.1 : Summary of extracted words/sentences and thematic coding (this table continues to two pages).

Phrase Extracted	Code/Category	Aggregation of Theme
Expensive	Monetary Parameter	CAPEX/OPEX
Lot of Money	Monetary Parameter	CAPEX/OPEX
Investment	Monetary Parameter	ROI
Affordable	Monetary Parameter	CAPEX/OPEX
Liability	Monetary Parameter	CAPEX/OPEX
Cost /Costly	Monetary Parameter	CAPEX/OPEX
Waste of Money	Monetary Parameter	CAPEX/OPEX
Total cost of Ownership	Monetary Parameter	ROI

Return on Investment	Monetary Parameter	ROI
Budget	Monetary Parameter	CAPEX/OPEX
Worth	Monetary Parameter	ROI
Lucrative	Monetary Parameter	ROI
Loss/Profit	Monetary Parameter	CAPEX/OPEX
Reliable	Infrastructure & technology	Performance/Security/Manageability
Speed/Fast	Infrastructure & technology	Performance
dependent	Infrastructure & technology	Performance/Security/Manageability
Secured	Infrastructure & technology	Security
protected	Infrastructure & technology	Security
Agile	Infrastructure & technology	Performance/Manageability
Application Centric	Infrastructure & technology	Performance
Software Centric	Infrastructure & technology	Performance/Manageability
High/Low Quality	Infrastructure & technology	Performance/Security/Manageability
User Friendly	Infrastructure & technology	Performance/Manageability
Efficient	Infrastructure & technology	Performance/Manageability
productive	Infrastructure & technology	Performance/Security/Manageability
Affective	Infrastructure & technology	Performance/Security/Manageability
Centralized Management	Infrastructure & technology	Performance/Manageability
Ease of access	Infrastructure & technology	Performance/Manageability
Ease of implementation	Infrastructure & technology	Performance/Manageability
Management	Infrastructure & technology	Manageability
Capacity	Infrastructure & technology	Performance
Bandwidth Saving/Usage	Infrastructure & technology	Performance
Cost effective	Monetary Parameter	CAPEX/OPEX
Time Saving	Infrastructure & technology	Performance
Application Response	Infrastructure & technology	Performance
Application Features	Infrastructure & technology	Performance

The “ Table 4.2” is a summary of how mapping diagram factors will be illustrated with extracted words and Thematic Coding.

Table 4.2 : Themes with reflection in mapping diagram

Aggregation of Theme	Code/Category	Consideration in Mapping Diagram
CAPEX/OPEX	Monetary Parameter	Financial Consideration/Impact
Performance	Infrastructure & technology	Technical Consideration/Impact
Security	Infrastructure & technology	
Manageability	Infrastructure & technology	
ROI	Monetary Parameter	SD-WAN Investment Decision

4.4.1 Group 1 - Segment 1 : Users at Head Office : Direct decision-makers on both financial and technical aspect.

As this segment represented head office users with direct decision-making power on both finance and technical, the responses in average were covering and reviewing passionately on all factors of mapping diagram of the case study. CAPEX/OPEX terms were heavily expressed by both top management and technical people. It was interesting to observe that even the top management was interested in making a return on the investment by adopting SD-WAN. And researcher observed that the impression on SD-WAN of the top management was weak before the exploration and made a significant change after witnessing how it benefited to the organization even during the exploration. Also, it made evident that the top management was well educated on technical aspect of the SD-WAN implementation. Hence in average the response on each of the factors were discussed in-depth by the top management during the interview process. It was also observed that the other interviewees tend to express on each of the factors in general.

The IT Operational people were responding with open mindedly as they are head office users, it was a new experience for them to implement a new WAN technology and observe how it is affecting their daily operations and annual IT budgets. As these interviewees were more involved in technical implementations, operations on infrastructure and application, their responses on performance, security, and manageability towards ROI on adopting of SD-WAN was optimistic. Hence the responses were detailed enough information with both related and unrelated data on implementing SD-WAN. As a result of the information extracted from the IT people of this segment, it reflected that they expressed their views on certain application performances related to on-prem hosted applications/cloud hosted applications and hybrid cloud applications. Hence the researcher had to extract information from the responses only related to applications that relates to factors that can influence the SD-WAN implementation decision.

Applications such as Enterprise Resource Planning – SAP /Emails- O365 /HRM had to be exclusively focused on extracting information about. The answers reflected that those connectivity/IOPs intensive applications heavily dependent on the WAN connectivity. Certain respondents were praising the existing MPLS connectivity and researcher intended to observe the root cause on user's experience as well. And it was identified that these users are over some age who are reluctant to get use to a new technology.

Hence the responses of those user reflected that they are pessimistic about adopting the change and the responses also reflected factors in mapping diagram are not being expressed. Their responses appeared more on adopting new WAN technology is never a requirement but a complete waste investment. The views of Pure technical people were also interesting as they responded on each factor in their expression of adopting new change. And most of them were positive on adopting SD-WAN and expressed excitement of a new learning as well. Hence overall the segment responded to interviews and on average all of them expressed strongly on almost all the factors in mapping diagram of the case study. The segment appears to be agreeing on adopting the SD-WAN and believed in that the change will result in a positive impact in ROI. As this segment represented both Finance and technical, it was observed that responses of this segment was considered as an influential segment towards the adoption of SD-WAN and effect on ROI. And this consideration was proved with the analysis of responses received.

4.4.2 Group 1 - Segment 2 : Users at Branch Offices : In-direct decision-makers on both financial & technical aspect.

As this segment represented branch office users with In-direct decision-making power on both finance and technical, the responses were extremely identical to the segment 3 responses. Even though this segment has an in-direct decision-making power, this segment is again one the critical segment where each of the users are directly having the impact of WAN technology change. Hence the user groups of this segment had a major impact on influencing the decision. The response from the IT management if this segment reflected that they are in a need of changing the WAN technology due to multiple reasons. OPEX of leased lines and Performance of applications were the mostly expressed words of those respondents. And they spoke about investing on a lucrative WAN technology and then leveraging that monetary investment benefit on developing the knowledge and infrastructure.

Therefore, the responses had significant impact on influencing the adoption of SD-WAN. And the experience with exploration was extremely optimistic and this user group was excited on expressing their views on almost all the factors of the mapping diagram of the case study. But the responses of the IT user group of this segment reflected a moderate response to factors. The observation of each response indicated that the experience of the most interviewees is between 1 – 3 and it affected the response.

The responses suggested that some of them have limited knowledge on how WAN technology can make an impact on ROI. The response was overflowing with bunch of unrelated information and pointing to a border spectrum. It reflected that their experience in field of IT-networking affected the response. But it was important to let them understand the adoption and that is where researcher had to explain and describe the exploration to them as an external consultant to the organization. It was critical for them to express their experience and observations of exploration. As IT Administrators of the remote offices their observations had a significant impact on the change on WAN technology. Still the decision-making power was not with this segment even though their observation and experience were what expected on the exploration. This is when researcher decided that it is important to collect the experience using a simple questioner rather than interviewing them. But interviewing them helped to understand their experience of change. At the same time, it was critical for them to respond according to the factors for the researcher to obtain a proper illustration of their experience.

IT management user group responded with positive attitude on almost all the factors as they were the people who were really suffering the circumstances of connectivity issues and budget cut offs. Hence the answers from them reflected that it was a major requirement in the organization to change the Wan technology from the exiting on to a new one which is capable of handling both OPEX and performance simultaneously. On average the answers reflected the factors of mapping diagram of the case study has direct impact on ROI. Hence the overall segment response came to a moderate level response and still reflected that requirement of adopting SD-WAN is a positive affect for the whole organization.

4.4.3 Group 1 - Segment 3 : Users at Head Office : In-direct decision-makers on both financial & technical aspect.

As this segment represented head office users with In-direct decision-making power on both finance and technical, the responses in average were covering and reviewing moderately on all the factors influencing the mapping diagram of the case study. The user group which represents management of this segment expressed strongly on CAPEX/OPEX, as they have an influence in their functional area. It was observed that even though the decision-making power was in-direct, the responses in average were optimistic about factors. That made to believe that this group within segment is positively impact by the change of WAN technology.

The responses of the IT people group on this segment made a significant impact on average of the results produced after analyzing the responses. Most IT people responded with positively on performance/security and manageability as it made a significant improvement in their daily operations in IT. This was observed after analyzing responses made by the IT people. The responses reflected that even though they have no direct influence in decision making, their view will provide an insight to the decision makers to decide on the WAN technology investment. They were quite reluctant on talking about financial aspect of this, as it seems to be that most of them believed in that financial part is never an aspect. And even though it is unusual to observe that specifying that finance has no impact on adopting a change, the age that most of them were in, reflects the reason for answer. As they were with maximum of 1 to 3 years' experience.

By analyzing and comparing the responses with each other within the same group, it was observed that almost all of them were positive on adopting the SD-WAN due to the performance/security and manageability factors. But it was interesting to observe that the finance people with non-IT background spoke more about investment security as they have already under the IT budgeting pressure. As they see IT is always as an overhead where IT services was never accumulating a revenue to the organization. Hence, they believed in that there should be an investment which should eventually reduce the IT overhead that are fighting each year to convince the top management with. Consequently, the response was loaded with information on how they express their selves towards adopting SD-WAN as a WAN technology even though they had limited knowledge on the technology and its usage.

4.4.4 Group 2 - Segment 1 : User at Head Office : Who have an impact on daily operations.

As this segment represented head office users with no decision-making power on both finance and technical but who has direct impact on their daily operation, the responses were strongly pointing towards the productivity of their daily operations. As the responses were reflecting the ease of use and speed of applications, researcher had to extract the responses into performance related information. It is understood that as end users they have no visibility on factors such as capex/OPEX/security and manageability. Hence the answer was purely based on comparing their experience with the past. As an average everyone responded on positively as performance was increased and the impression expressed that adopting SD-WAN will impact the organization in effective manner because it increased the connectivity performance of the applications that they use daily.

4.4.5 Group 2 - Segment 2 : User over WAN, Branch Office : Who have an impact on daily operations.

As this segment represented branch office end users with no decision-making power on both finance and technical but who has direct impact on their daily operation, the responses were identical to the segment 4 responses in general. They also expressed on the productivity they improved with new connectivity method. Their experience reflected mostly on technical aspect with relation to performance. Hence the responses pointing to improved performance and adopting the SD-WAN as WAN technology, which is affecting the organization positively on ROI.

4.4.6 Analysis of the Responses of the Groups

It is important to contrast responses on SD-WAN investment decision with respect to the financial and technical considerations between “Group I” and “Group II”. While observing the responses and the patterns ,it was observed that responses of “ Group I” are more reliable to as the segments in this group was represent by people who are equipped with more knowledge on the SD-WAN as a technology and its relation to both technical and financial impact. Majority of the respondents of this group had a better educational background in IT literacy than the group II respondents.

Majority of the responses within this group were considered realistic and dependable as per their awareness of SD-WAN investment decision with respect to the financial and technical considerations. This assessment was supported by their correlated technical experience and linked educational background to the Investment decision. As this segment represented highly skilled technical people as well as exceedingly experienced financial experts, the responses on a technological advancement investment were considered reasonable to consider for a conclusion in case study area. Most importantly, majority of this group of respondents were directly involved in decision. For an example, the technical people involved in this group were mainly operating in centralized applications hosted in head office and they are aware of the system how system performances/security framework and manageability is impacted over WAN method.

Technical people in this segment responded about financial consideration as it involves in their operation decisions regularly. In this organization, capital expenditures and operation expenditures of their daily operations required to be convinced by technical people to the management. This process affects in educating both management and financial people IT costs. Hence the operational IT people have a moderate or exceeding knowledge in financial consideration of the investment decision. Financial people within the group are also operating IT systems and their experience on technical aspect can be brought as realistic responses to Investment decision. Additionally, this group as a summary contained knowledge affluent respondents in both technical and financial considerations of the investment decision.

Furthermore, this group included with senior management members as well as chief technology officer. Hence the experience in both financial and technical consideration on investment decision reflected the significance of “Group I” on SD-WAN adoption. The respondents in “Group II” expressed their experience and knowledge predominantly about performance and how it affected their daily efficiency. Security ,Manageability was also discussed and mentioned moderately though it was a factor that they could not experience in their daily operations. Majority of the respondents were chosen had an educational background related to IT. Reason for this segment respondents to express an idea about security and manageability by guessing was identified because of their IT educational background.

However, “guessing” and interpreting about a factor that impact investment decision without a proper experience is considered as inaccurate and erroneous response. Hence responses related security and manageability of SD-WAN from “Group II” was neglected for the further analysis. Although security and manageability were neglected, the responses which reflected performance in technical aspect considered significant on investment decision. Similarly, responses related to financial consideration such as CPAEX and OPEX from the respondents of this group was considered as ideas expressed with assumptions.

Hence responses related financial consideration related to SD-WAN investment from “Group II” was neglected for the further analysis. Hence it was decided only to proceed with the performance factor responses for further analysis of this group. The discussion explained that both groups have responded on both financial impact and technical impact on investment decision. Observation of comparison resulted in that “Group I” responses on both financial impact and technical impact considered realistic and dependable. Performance factor related response will only be considered realistic and dependable from “Group II”.

4.5 Summary of Interview Responses

As discussed in each segment, “Group I” highlighted on control or reduce ICT costs in relation to the SD-WAN investment decision. SD-WAN’s high security, improved flexibility was expressed regularly by the people who were highly involved in IT management and operational tasks. Also, guaranteed reliability and performance in relation to managing application performance was pointed out by many respondents. Many IT people spoke about cloud connectivity, managing bandwidth with dynamic load balancing in relation to the investment decision on SD-WAN. Also, each segment in “Group I” discussed how important it is to adopt centralized and automated management to provide better visibility and reporting/analytics for the operational efficiency and productivity throughout the organization. Both segments in “Group II” mainly focused on elaborating in how SD-WAN adoption influenced the daily operation. Which reflected that this group responded mainly on technical impact. It is also reflected that this group has limited knowledge on SD-WAN and the responses are not that reliable specifically on factors like security, manageability aspects.

Hence the summary of the responses in relation to factors (thematic coding) in mapping diagram with behavior is interpreted in graphical approach using Qualitative Assessment of Emphasis indicator. Graphical interpretations were derived with proportionate figures of how each segment has expressed the themes in their responses. This was carried out the impact level of each consideration (financial or technical) with relation to SD-WAN adoption decision.

Table 4.3 : Segment description (referring table 3.1)

Target Segment	Segment Description
Group I – Executive/Technical/Finance Users	
Segment 1	Users at Head office with Decision Making Power (on SD-WAN Investment)
Segment 2	Users at Branch Offices with Decision Making Power (on SD-WAN Investment)
Segment 3	Users at Head office with-out Decision Making Power (on SD-WAN Investment)
Group II – Application End Users	
Segment 1	Users at Head office with effect on Daily operations
Segment 2	Users at Branch office with effect on Daily operations

In following table, if any of the user from the segment (that he or she represents) responded on each factor either from financial or technical theme in relation to ROI theme (SD-WAN investment decision), will be represented in “x” symbol. This Qualitative Assessment of Emphasis will be used to identify and segregate the users depending on their response weightage (positive or negative towards SD-WAN investment). For an example if a user from segment 1 responded about “performance” with a positive moderate approach, it will be represented in a “xxxx”. Which means that depending on the influence of response (positive or negative), it will be represented on the “Table 4.5” as “x, xx, xxx, xxxx and xxxxx”. The legend table represented underneath is being used in “Table 4.5” to represent the overall response of each segment from both groups.

Table 4.4 : Legend for “Table 4.5”

Legend for Segment Table 11	
Response	Qualitative Assessment of Emphasis – Indicator
Strongly Agreed	xxxxxx
Moderately Agreed	xxxxx
Neutral Response	xxx
Disagree	xx
Strongly Disagree	x

In “Table 4.5”, responses on OPEX/CAPEX and represents only a one column because that was how it was aggregated in to one theme while coding the response. Due to interrelated usage nature, CAPX and OPEX were aggregated into one theme which represented as Financial Impact. In fact ,on-average almost all the response reflected that whoever responded expressed on both factors at the same weight as it must be. Since those two are very much inter-related. Same applied for Performance/Security and Manageability as well due to majority of the respondents answered and expressed their views on those factors in a consolidated terminology. And that was reflected while coding and aggregating the response related those factors.

Due to interrelated usage nature, Performance/Security and Manageability were aggregated into one theme which represented as Financial Impact. According to figures illustrated in table 7, each sub part of each segment has responded relating to all the themes. It illustrates those factors have been addressed by each segment.

Table 4.5 : Summary of responses from each segment

Seg: No	Segment	Category	Qty	Qualitative Assessment of Emphasis on Average on Each Segment		
				Financial Considerations (CAPEX/OPEX)	Technical Considerations (Performance/Security /Manageability)	ROI Impact on SD-WAN Investment
1	Users over LAN (Head Office users), but have a direct decision-making power on both financial and technical aspect	Top Management	2	Strongly Agreed - xxxxx	Strongly Agreed - xxxxx	Strongly Agreed - xxxxx
		Technical (Group IT Department)	8			
2	Users over WAN (Branch Office users) who have In-direct decision-making power on both financial and technical aspect	Technical	5	Moderately Agreed - xxxx	Strongly Agreed - xxxxx	Neutral Response - xxx
			11			
		Non-Technical	2			
3	Users over LAN (Head Office users) who have In-direct decision-making power on both financial and technical aspect	Technical	3	Moderately Agreed - xxxx	Strongly Agreed - xxxxx	Neutral Response – xxx
			11			
		Non-Technical	1			
4	User over LAN (Head Office users) who have an Impact on daily operations	Application End user	25	Neglected (Reasons Discussed in “ Chapter - 4.4.6”)	Only Performance factor Considered for discussions - xxxx	Neglected (Reasons Discussed in “ Chapter - 4.4.6”)
5	User over WAN (Branch Office users who have an Impact on daily operations	Application End user	20	Neglected (Reasons Discussed in “ Chapter - 4.4.6”)	Only Performance factor Considered for discussions - xxxxxx	Neglected (Reasons Discussed in “ Chapter - 4.4.6”)
Total			88			

“Figure 4.1” is a graphical representation of the responses related to financial impact on SD-WAN investment decision of “Group - I” on each segment.

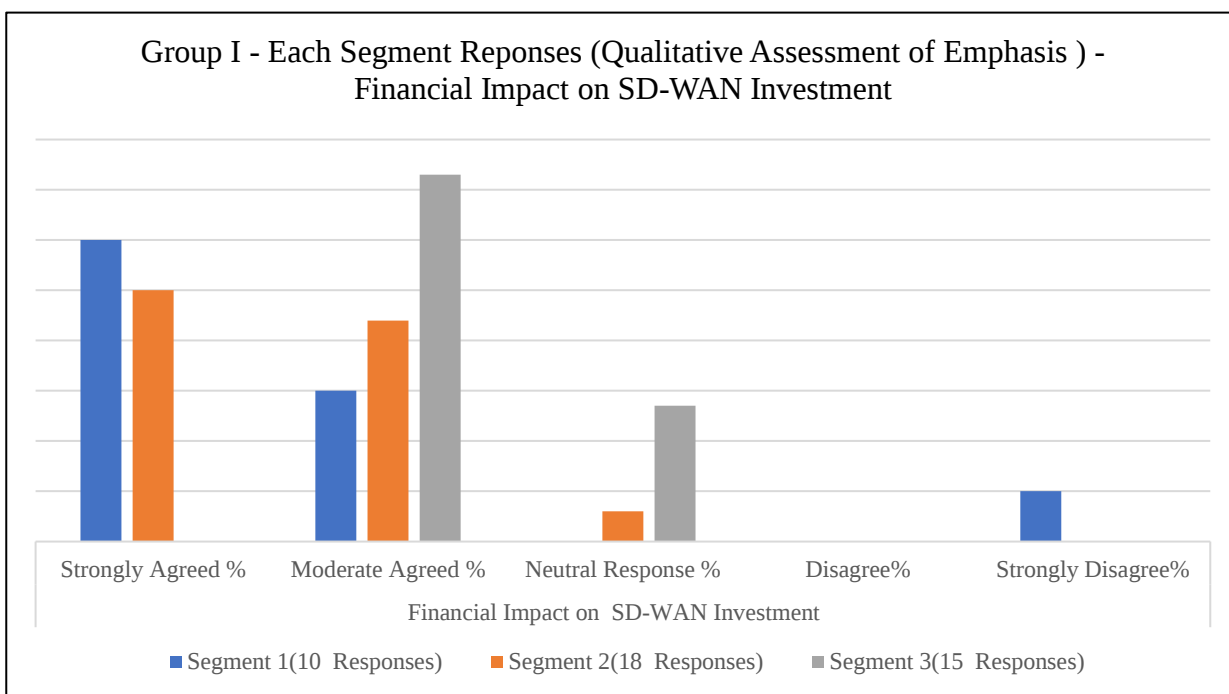


Figure 4.1 : Group I (All segments) - Financial impact on SD-WAN investment

“ Figure 4.1” indicates how each segment responded on financial impact on SD-WAN Investment. It is observed that both segment 1 and segment 2 respondent by agreeing the impact on financial considerations has a significant effect on investment decision of SD-WAN. Consequently, the graph shows that minor percentage of respondent were responding with strongly disagreeing (few people in segment 1). The reason for this response was discussed in chapter 4.4.1. As a summary of the responses illustrated graphically to demonstrates that respondents in group 1 agreed and experienced the SD-WAN investment has positive financial impact. Which also reflects that CAPEX/OPEX factors behind the theme are affecting in SD-WAN investment decision in large scale organization in Sri Lanka in the same way as other countries. Further discussion on all segments and how financial considerations impacted will be done in chapter 6.

“Figure 4.2” is a graphical representation of the responses realted to technical impact on SD-WAN investment decision of “Group - I” on each segment.

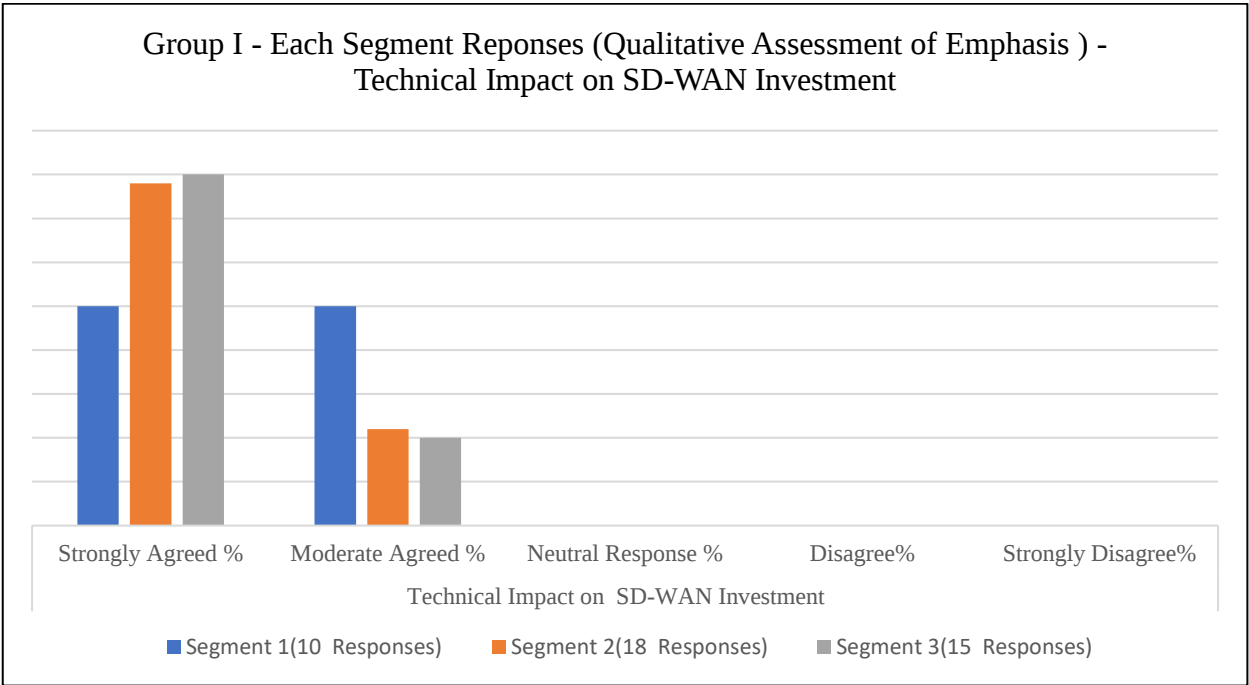


Figure 4.2 : Group I (All segments) - Technical impact on SD-WAN investment

“ Figure 4.2” indicates how each segment responded on technical impact on SD-WAN Investment. It is noticed that both segment 1 and segment 2 respondent by agreeing the impact on technical considerations has a significant effect on investment decision of SD-WAN. In fact, all three segments agreed strongly on impact with technical considerations towards SD-WAN investment decision. As a summary of the responses illustrated explicitly in “Figure 4.2”, it demonstrates that respondents in group 1 agreed and experienced the SD-WAN investment has positive technical impact. Which also reflects that Performance/Security and Manageability factors behind the technical theme are affecting in SD-WAN investment decision in large scale organization in Sri lanka in the same way as other countries. Further discussion on all segments and how technical considerations impacted will be done in chapter 6.

4.6 Observations

Two significant factors were observed throughout the case study exploration. One was that CAPEX and OPEX factors have been frequently affecting the SD-WAN decision as a single component as they reflected similar output towards ROI. Each time the discussion arrives on CAPEX, OPEX also comes into the discussion context inevitably. Similar behavior applied in other three factors as well. For SD-WAN investment decision performance, security, and manageability was mostly referred in relation with one or two other factors. For an example when there is response related to investment decision about performance, it also contains either security or manageability related information. Hence in consolidation these three factors had an inter-relationship between each other when the discussion context was around SD-WAN investment decision for this organization.

It is understood in Sri Lankan context on SD-WAN investment decision, these factors have inter-relationships due to several other subordinate elements. It was observed even the large-scale organizations are considering all possible gains and not willing to compromise on anything which even has the thinnest dependency to investment decision. Sri Lankan economy performs a major role on large scale investments even in private sector organizations. Consequences of Inflation reflects in most of the investment decisions in Sri Lankan context. Even though the responses on OPEX & CAPEX looks positive on Investment decision on SD-WAN, CAPEX factor on investment was influenced by the inflation. Due to the SD-WAN product purchase or the CAPEX of this investment is a US dollar transaction, inflation factor plays a major role. And the OPEX after the investment is in local currency the inter-relation of the factors must happen to convince on the investment of SD-WAN. Hence CAPEX and OPEX affects the impact to decision on Investment for SD-WAN as one component in general with in this organization.

4.7 Summary

In this chapter the responses from the respondent answers were analyzed in qualitative approach. Hence qualitative analysis was used to observe the response behavior. During the chapter, interviewing analysis, it is observed that the factors discussed on mapping diagram of the case study has an impact on SD-WAN investment decision.

5. DISCUSSION

5.1 Discussion

As mentioned before, due to the ongoing pandemic, the recovery of the economy tends to depend mainly on public support rather than corporate profitability, according to the current global business climate. Comparatively in both public and private sectors, private investment has increased recently, but there is a lag in consumption, with lower aggregation in demand in all the markets. However, the growth rates and consumption have recently increased, consumption remains low compared to the pre-crisis levels since 2020. As this is the global behavior with pandemic, it was also observed in later part of the case study where this organization understood importance of investment but hesitant to implement SD-WAN in 2020.

Irrespective of the sector, any investment has its own clear goals depending on the investment. As opposed to the financial capacity that has been spent, most organizations reimburse in exchange for something other than the initial investment. They can quantify the utility of investment by predicting the potential benefits, which will help them decide whether to follow a specific path or not, both in the long and short term, depending on the business cycle. However, to understand the policy's success pattern, the previous ROI for the strategy to meet challenges can also be investigated. This was done by both technical management and financial management during the PoC for both MPLS OPEX and SD-WAN investment CAPEX. The organization's efficiency in services offered from central data center was observed remarkably efficient with SD-WAN implementation, whether it matches or exceeds the planned returns in terms of financial aspect. Return on investment is essentially assessed for fixed-income assets and equity-based investment instruments like equity funds to achieve its goal. Hence , ROI is a comparative indicator that can help appreciate the investment return factor and optimize the finances as a result.

Understanding the sustainability impact of the Software-Defined Wide Area Network (SD-WAN) enables companies to use any combination of networks such as exiting MPLS and broadband internet services to link users to applications more securely and more rapidly. On the other hand, traditional WANs use conventional routers that were never designed for workloads such as cloud native applications. And the designs were never supporting application centric environments.

Traditional WANs such as MPLS are more focused on-demand availability of computer system resources use as per most of the technical experts in the organization. Furthermore, they often require the backhauling of all traffic, including cloud-dined traffic, from branch offices to a hub or headquarters data center, where specialized security inspection services may be applied. Backhaul delays harmed application efficiency, resulting in a dreadful user interface and decreased productivity, all of which are incompatible with achieving business objectives. However, the case study's inspiration, SD-WAN technologies, has become popular because businesses need fast, scalable, and flexible connectivity between various network environments while attempting to reduce overall total cost of ownership (TCO) while preserving user experience.

On the other hand, the wrong SD-WAN approach will discourage an organization from reacting quickly to changing market demands, not least because it will raise new security issues (Kaur & Gobindgarh, 2015). To thrive in today's technology-driven global economy, companies must change their operations. It needs to be more adaptable to keep up with market shifts. They must be more receptive to attract and serve clients. However, to exploit the best, most innovative ideas, it must cooperate and share data with employees, stakeholders, and vendors. Therefore, to achieve its goals, the cloud native infrastructure and agile connectivity is needed. Corporations reduce capital-intensive private data centers by storing enterprise applications in the cloud, allowing them to deliver information technology to places and constituents wherever they are consistently, securely, and cost-effectively. With pay-per-use pricing systems, the cloud offers flexible, on-demand computing and storage services. Hence the WAN connectives must also support that initiative. SD-WAN is the only alternative as of now to cater this requirement.

The case study results emphasized specially on organizational strategies, such as WAN infrastructure that links organization's remote and branch offices which has not altered for more than 10 years. Over the years, the organization consolidated various regional data centers into limited highly available data centers. As a result, remote locations had to link to centralized applications over WAN and heavy internet traffic moved through these consolidated data centers. This introduced high bandwidth demands and latency constraints.

Hence the respondents explained that the adoption of a new WAN method like SD-WAN resulted in improved application performance due to its capability of leveraging WAN links efficiently. When remote offices have multiple active links and intelligence to indicate how they are being utilized, employees experience less downtime and more resilience. Such improvements, which most business believe exist, but have a hard time quantifying, should be mentioned as supplementary benefits in any SD-WAN business case. Similarly, efficient IT operations has been mentioned heavily in this case study. SD-WAN's built-in troubleshooting intelligence addresses the WAN connectivity troubleshooting which is currently a time-consuming task. Zero-touch provisioning was one of the main advantages that was expressed by most of the segments. With zero-touch provisioning in branch office, IT personal can rapidly commission the equipment. Hence it helps to achieve speedy system upgrades or network upgrades.

5.2 Summary

As a summary the responses reelected that SD-WAN offers a flexible WAN solution which can support business demands and growth. Response also indicated the Investment decision on SD-WAN is heavily dependent on factors indicated in the mapping diagram of the case study. Opening new offices, upgrading existing infrastructure with a lesser cost is being expressed heavily throughout the responses. Which suggested that themes like CPAEX/OPEX acts a big role in WAN transition within the organization. Aggregation of multiple broadband links, and the intelligence layer that SD-WAN brings into infrastructure was being discussed.

6. CONCLUSION AND RECOMMENDATIONS

6.1 The Conclusion

This research was intended at understanding the factors affecting the most feasible and lucrative WAN technology to a large-scale organization in Sri Lanka. The success of this research will be beneficial in evaluations and decision making in selecting the WAN method for other similar scale organizations in Sri Lanka. The analysis was an exploratory case study which evaluates the effect on ROI of the selected organization on migrating to SD-WAN. However, the foremost research objective was to examine the level of acceptance to adopt SD-WAN as a WAN technology in the selected organization.

When deciding on their WAN connectivity, the IT departments of the organization would first analyze the ROI of their current WAN method. Hence the research objectives were specifically based on the existing concerns on the current method. Along with the outcomes of two key objectives, the researcher aspired to offer an appropriate recommendation to the other large-scale enterprises with remote offices in Sri Lanka on selecting a WAN method based on ROI. As per the results of the responses obtained on interviews it was observed that each segment of the population has a positive outlook on the factors affecting SD-WAN adoption, namely performance, security, and manageability. It has been illustrated in graphical representation in this chapter.

IT as a Service is one of the core elements identified in this organization which helped this group of respondents to response with better awareness of both financial and technical considerations. This IT-as a service helped the centralized IT department to sell the central datacenter services to subsidiary companies for the usage. Hence IT departments of this organization was never considered as a cost center. Exploratory case study responses demonstrated relationship between technical impact with financial impact due to the awareness and knowledge created by IT as a Service concept. The concept of IT as a Service which helped all the IT related personal in the organization to convince their IT budgets to both management and finance. This has created an experienced mixed awareness of the investment decisions. Hence the SD-WAN investment decision on SD-WAN was another technology adoption which required to convince the management by IT personal. This fact was supported well enough by the technical and financial factors identified in SD-WAN adoption.

Group I - All Segments Responses (Qualitative Assessment of Emphasis) -
Technical Impact on SD-WAN Investment

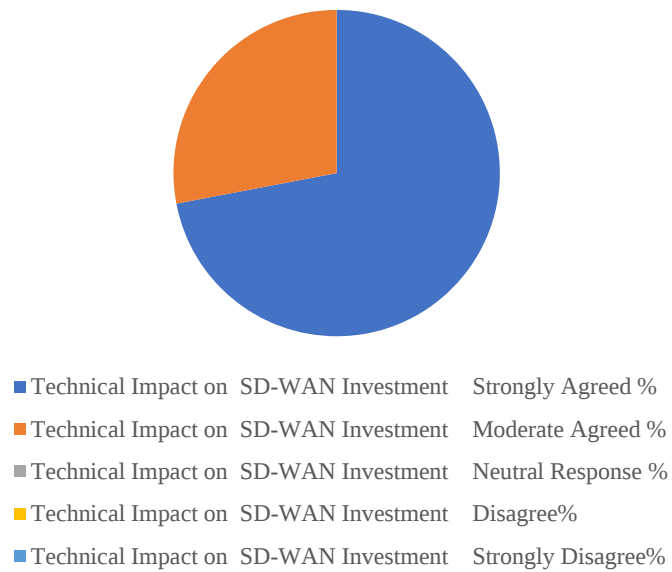


Figure 6.1 : All segments - Technical impact on SD-WAN investment

Group I - All Segments Responses (Qualitative Assessment of Emphasis) -
Financial Impact on SD-WAN Investment

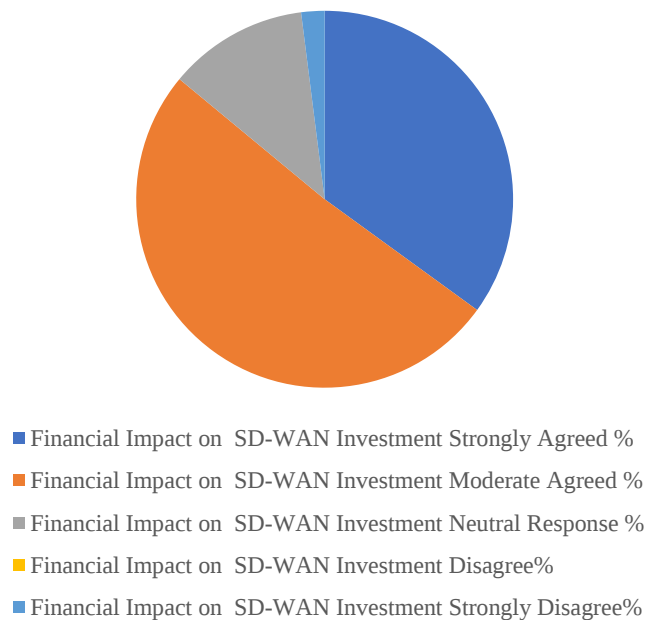


Figure 6.2 : All Segments - Financial impact on SD-WAN investment

“Figure 6.1” graphically demonstrates how much of responses from “Group I” responded on technical impact in relation to SD-WAN investment. It clearly indicates that majority of respondents strongly agreed that SD-WAN investment is affected by technical considerations. Correspondingly, Figure 6.2 graphically demonstrates how much of responses from “Group I” responded on financial impact in relation to SD-WAN investment. It clearly indicates that majority of respondents strongly agreed that SD-WAN investment is affected by financial considerations as well. Operational experience related to Performance factor from “Group II” indicated that SD-WAN is technology which significantly improves the application responsiveness over WAN links. Therefore, it is concluded that the end user experience on performance impact is a considerable factor in SD-WAN adoption decision. Hence the decision derived as that the factors behind the financial aspect such as CAPEX and OPEX are heavily discussed and affected in SD-WAN investment in Sri Lanka like other countries. Similarly, the factors such as performance, security and manageability which derived under technical impact were also discussed and affected significantly in SD-WAN investment in Sri Lanka like other countries.

In contrast of the responses on each financial and technical impact, it is observed that technical considerations have additional impact on the decision with compared to financial impact. The graphical representation in “Figure 4.2” and “Figure 4.1” also reflected the same result. Majority of the responses from whole Group agreed that improvements in technical factors required to be considered in SD-WAN adoption. As elaborated, IT as a Services operation of this organization structure supported the ROI affect in SD-WAN investment. Persuading the management and finance to invest on modern technology is a process that is being practiced throughout the IT-as-a-Service operation. Hence features that enhances the performance and security is being consistently elaborated in relation to how ROI can be improved.

Responses containing information which elaborated positive impact of technical consideration to SD-WAN investment were identified from each segment of both groups. Based on the “Figure 4.2” and “Figure 4.1” graphical representation it was obvious that the focused group identifies the SD-WAN implementation positively based on the factors affecting the ROI. The impact on CAPEX and OPEX was discussed in depth with regards to how it can positively influence the organization’s development.

Furthermore, the performance, security and manageability factors were discussed in consolidation with most of the population pointing to application responsiveness and productivity of their regular operations. In parallel, decisions makers and technical influencers had a positive feedback on SD-WANs capability of adopting to cloud native applications as well as about saving costs in private leased circuits. Therefore, in general the interview responses reflected a positive relationship with factors defined in the mapping diagram of the case study. In contrast to both technical and financial consideration, it was observed that performance/security/manageability factors have a better influence than the CAPEX/OPEX factors.

Furthermore , the responses reflected that a well implemented SD-WAN will experience improved stability, more bandwidth, better throughput, less latency, and reduced jitter with less expensive ISP connections. Furthermore, savings are significant when considering the investment in additional broad-band performance over the alternative of adding more MPLS links. Moving to broadband from MPLS provided a massive cost saving at minimum risk. SD-WAN offered a win-win scenario that will result in an actual reduction in spending over time while boosting efficiency and bandwidth availability. It was learnt during the case study that the cost of broadband decreases over time, creating the non-MPLS solution more attractive. Even when the implementation and maintenance cost of SD-WAN is proven to be less, there is a slight argument to continue MPLS due to its renowned role. The counter argument being the excessive costs associated with it can now be considerably reduced throughout the organization, making way for improved bandwidth at a lower cost.

Finally, exploratory case study concluded that the factors reflected in mapping diagram under both financial and technical consideration are critical factors that will be discussed in investment decision on SD-WAN in large scale organizations in Sri Lanka in the same way as other countries. Furthermore, technical considerations such as performance, security and manageability influenced significantly compared to financial considerations. To conclude the case study by coupling the objectives of the case study with outcomes.

- First objective of the case study to examine the factors affecting the ROI for SD-WAN adoption over an exploratory case study on one large-scale enterprise in Sri Lanka. Therefore, the prior scope of the objective was accomplished by examining the literature review and preliminary survey and the objective was accomplished by observing the responses gathered from the interviews. The conclusion was that the factors such as performance, manageability, security, capex and Opex impact significantly in SD-WAN investment in Sri Lanka like other countries.
- As stated in second objective, the case study was to examine the level of acceptance to adopt SD-WAN as a WAN technology by large-scale organizations in Sri Lanka. Therefore, this objective was accomplished by discussing the responses gathered from the interviews. The conclusion was that the level of acceptance of SD-WAN was high in large scale organizations if they evaluate their existing WAN method in each factor identified in mapping diagram. The evaluation and other considerations are further elaborated in chapter 6.2 in recommendations.
- Finally, the third objective was to provide appropriate recommendation for large scale enterprises with remote offices in Sri Lanka on selecting a WAN method based on the projected ROI. The observations and findings discussed throughout the case study suggested that it is extremely feasible to offer recommendations to similar type of large-scale organizations to adopt SD-WAN considering the financial and technical implications. Following chapter 6.2 is designed to provide the recommendations which observed and concluded after analyzing the financial and technical impact and their behavior towards investment decision.

6.2 Recommendations

Based on the results and observations on Chapter 4, implementing SD-WAN technology grants to sustain organizational development and transforming market requirements that are in high demand. Digital transformation is being adopted as an initiative on large scale organizations to move along with new technology trends. Therefore, the digital transformation incorporates shifting from traditional telecommunications providers, launching serverless applications, adopting cloud platforms and developing cloud native applications.

As a result, software centric network connectivity's are in high demand to adopt digital transformation into large scale organizations. Based on the Assessment of the interview on chapter 4.3, The outcomes of this case study demonstrated that SD-WAN permits enterprises to swiftly enhance and optimize bandwidth to access applications and data in both on-premises and cloud applications. In addition, efficient and secure WAN connectivity was evident throughout the exploration. Organizations may mitigate the impact of downtime, delay in connections, loss of connectivity, and jitter through aggregating several broadband links and wrapping a layer of information with management policies. SD-WAN can outperform dedicated private circuits in terms of reliability, stability, and efficiency by taking advantage of low-cost ties and scalable implementation.

Each segment interviewed expressed the value that SD-WAN brings with performance and security in parallel to the centralized management capabilities. Subsequently the following aspects are important under performance, security and Manageability which are repetitively elaborated in chapter 4 under each segment (chapter 4.3 – Assessment of Interviews)

- Bandwidth (Capacity/Volume) flexibility
- Enhance (with Quality) WAN traffic by latency, jitter, and packet loss.
- Flexibility to use different/multiple networks (connectivity's) for application delivery with policy-based intelligent path selection.
- Reduce WAN-management complexity and Faster WAN provisioning

SD-WAN also delivers OPEX soft-cost savings in supplement to bandwidth savings. Although these are more challenging to measure, they are equally significant, especially for organizations with a regional IT capital. Missed sales due to efficiency and decrease in user efficiency due to network downtime or slow connectivity are examples of soft cost.

SD-WAN encourages IT staff to concentrate on developmental initiatives rather than responding to regulatory criteria. Large scale organizations can save a considerable time diagnosing and tackling WAN outages and performance to enhance the ROI of the business more effectively. Further to the results and observations (reference to Chapter 4) elaborated on CAPEX and OPEX factors, following are important to decide on SD-WAN adoption.

- Internet Connectivity Expenses – Expenses are significantly reduced with intelligently sense network features of SD-WAN technology
- Eliminate unnecessary reliance spend on MPLS and replace legacy, aging edge network equipment (eliminate expensive support contracts with ISPs)
- SD-WAN incorporates zero-touch provisioning – This eliminates costs involved on bringing up connectivity's (On site personal costs)

As per the case study results & observations (Chapter 4) and Discussion (Chapter 5) in previous paragraphs, recommendations can be presented. In conclusion, the researcher recommends adopting SD-WAN as the WAN method in large scale organizations as it significantly improves the ROI of the organization. Additionally, it is recommended to evaluate the product vendor of the SD-WAN solution by conducting a proper proof of concept with each vendor. Each organization will have their own unique environment and conditions. To identify the uniqueness of the SD-WAN solution with respect to changing business requirements of enterprise network, it is recommended to evaluate the decision with both management and operational layers of the organization. It is important to identify the business need by both management and operational layer before the decision of SD-WAN adoption.

The Researcher recommends evaluating the decision on SD-WAN with underneath proposed approach for large scale organizations in Sri Lanka.

- Evaluate Constraints on Existing WAN Method (core network, last/middle mile constraints)
- Evaluate the priority for SD-WAN Solution : Low cost or ROI.
- Develop a framework which elaborates “how network connectivity aligns with business values and how connectivity needs will evolve in next 5 years”.
- Evaluate IT-as-a-Service Operational model within the organization to eliminate IT department as a cost center.
- Engage with multiple SD-WAN vendors to identify a flexible approach to evaluate the solution with a proof of concept.
- Analyze feedback from each operational layer, which affected by the SD-WAN adoption.

6.3 Restrictions & Limitations

The researcher has identified a few limitations in the case study. The case study is performed, focusing only on the large-scale organizations in Sri Lanka, however SD-WAN is a technology which is not limited to the scale of an organization. SD-WAN enables its features irrespective of the size of the organization. Also, same scaled organizations (like the organization for which the case study has been applied to) might have different organizational structures, which would require the approach to evaluate the feedback to be modified accordingly. Additionally, the interview responses from non-technical respondents could have been easily mis-interpreted with the marginally mis-aligned segmentation approach.

6.4 Future Work

This case study can be extended in multiple ways as illustrated. Given that the adoption of SD-WAN is an expensive decision for any organization, identifying the business requirement to do so is one of the key factors in evaluating SD-WAN approach. Therefore, the framework could be developed to incorporate factors such as identifying the value addition to the business goal of the organization and how connectivity could help to enable the business goal. Furthermore, the segmentation could be further developed to gather feedback also during the SD-WAN proof of concept phase. And this can be further developed to identify the factors affecting the SD-WAN adoption decision for small-scaled organizations.

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APPENDIX I

Interview Questions in Preliminary Survey

1. Are you aware of emerging trends in information technology?
2. Are you aware of emerging trends in networking technologies?
3. How many employees in your organization?
Less than 100
Over 100
4. How many Branch offices in your organization?
Less than 10
Between 10 to 25
More than 25
5. Are you familiar with Wide Area Network mechanisms/Protocols?
6. Which WAN method will you prefer for your organization?
ADSL
Internet Leased Line
7. Is the dedicated WAN links have utilized at least 75% of their bandwidth during peak hours in your organization?
8. Is monthly rental from ISP for dedicated WAN links is major expense to an organization?
9. Do you recommend a centrally managed WAN?
10. Have you ever heard of MPLS (Multiprotocol Label Switching)?
11. Is MPLS is a superior technology in terms of performance and security?
12. Is MPLS expensive?
13. Do you recommend investing on MPLS ?
14. Is MPLS easy to deploy and maintain?
15. Is MPLS worthy investment for an organization with:
5 Branch offices
25 Branch Offices
125 Branch offices/Or more than 125
None Branch Offices
16. Have your ever heard of SD-WAN (Software Defined WAN) ?
17. Will you spend time to read about SD-WAN?
18. When did you heard about SD-WAN for the first time?
Before 2012
During 2012 and 2018
Just now!
19. Is SD-WAN expensive?
20. Is SD-WAN not yet developed to compete with MPLS?
21. Is SD-WAN reliable?
22. Do you compare SD-WAN over MPLS if someone propose you SD-WAN for your organization?

23. Is SD-WAN deliver at least MPLS-level reliability and application performance?
Predictability?
24. Is SD-WAN popular as MPLS all over the world, as a WAN method?
25. If answer your is “yes” to previous question, what do think is the reason?
MPLS is still a matured technology than SD-WAN.
SD-WAN is complex solution compared to MPLS.
SD-WAN is expensive compared to MPLS.
SD-WAN is not being marketed well enough by the vendors.
26. If answer your is “no” to previous question, what is the reason?
MPLS is expensive compared to SD-WAN in long run.
SD-WAN has more features compared to MPLS.
SD-WAN is the current trend, so “no” it is popular than MPLS!
27. Is SD-WAN popular as MPLS in Sri Lanka, as a WAN method?
28. If answer your is “yes” to previous question, what is the reason?
Deploying SD-WAN needs a huge initial investment.
There is a huge difference in bandwidths of dedicated links and Shared links in Sri Lanka.
So, SD-WAN is not going to be popular anyway!
Lack of technical competence in SD-WAN
SD-WAN is not being marketed well enough by the vendors.
Other (Please specify)
29. If answer your is “no” to previous question, what is the reason?
WAN link price is quite high for MPLS in Sri Lanka
SD-WAN investment provides less overheads in maintaining branch network.
SD-WAN provides higher manageability/security & performance compared to MPLS.
Other (Please specify)

APPENDIX II

Interview Questions in Case Study

1. Describe your IT literacy using 3 sentences?
2. In which capacity you work for this organization?
3. Are you aware of emerging trends in information technology? Elaborate if you have an idea.
4. Are you aware of emerging trends in IT-Networking? Elaborate if you have an idea.
5. Do you have any responsibility with regards to IT within the organization?
 - Could be IT-Management/IT-Operations/Customer Delivery/Financing
6. What is your recommendation on your organization upgrading /updating the systems/applications you use daily?
7. What is your recommendation, if your organization upgrade/update the Network Connectivity which caters your daily operations with systems you use?
8. Are you aware of the exiting WAN methods used within your organization in terms of Networking?
 - Exiting Connectivity – MPLS
 - Introduced Connectivity – SD-WAN(Can you compare your experience in relation your daily work?)
9. Did your daily operation had any relationship to connectivity type where you are located?
 - Elaborate on the daily operation
 - (Applications/Performance/Security/Manageability)
10. Do you recommend that your organization needs an update on existing WAN method?
11. Does the organization adopt new technology trends?
 - If yes..., how it has been reflecting in organizations development?
 - If not /What is the reason? And does it have impact organizations development?
12. Does SD-WAN implementation make any difference to your daily work?
 - Elaborate on the daily operation (key points to ask on:
Applications/Performance/Security/Manageability
13. Does SD-WAN adoption have increased the overall bandwidth across the organization?
 - By Effectively utilizing and managing bandwidth in branch offices
 - By reducing reliance on costly MPLS links?
14. Does the visibility and direct control of bandwidth reporting helped to improve organizations IT operations?
 - Lower, or at least stabilize, the costs of adding bandwidth
15. Does the network, and existing Infrastructure have now increased reliability? With little or no service disruption? Continue with existing or better levels of quality and security.
16. Do you recommend adopting SD-WAN in your organization to reduce/or to gain more control over ICT costs?
17. What is your experience on adopting SD-WAN in your organization in general?
 - Focus on Capex/Opex/performance/Security/Manageability.

APPENDIX III

Thematic Codes Summary

Word/Sentence Extracted	Code/Category	Aggregation of theme (Relation with Dependent variable)
Expensive	Monetary Parameter	CAPEX/OPEX
Lot of Money	Monetary Parameter	CAPEX/OPEX
Investment	Monetary Parameter	CAPEX/OPEX
Affordable	Monetary Parameter	CAPEX/OPEX
Liability	Monetary Parameter	CAPEX/OPEX
Cost /Costly	Monetary Parameter	CAPEX/OPEX
Waste of Money	Monetary Parameter	CAPEX/OPEX
Total cost of Ownership	Monetary Parameter	ROI
Return on Investment	Monetary Parameter	ROI
Budget	Monetary Parameter	CAPEX/OPEX/ROI
Worth	Monetary Parameter	ROI
Lucrative	Monetary Parameter	ROI
Loss/Profit	Monetary Parameter	CAPEX/OPEX /ROI
Reliable	Infrastructure & technology	Performance/Security/Manageability
Speed/Fast	Infrastructure & technology	Performance
Dependent	Infrastructure & technology	Performance/Security/Manageability
Secured	Infrastructure & technology	Security
Protected	Infrastructure & technology	Security
Agile	Infrastructure & technology	Performance/Manageability
Application Centric	Infrastructure & technology	Performance
Software Centric	Infrastructure & technology	Performance/Manageability
High/Low Quality	Infrastructure & technology	Performance/Security/Manageability
User Friendly	Infrastructure & technology	Performance/Manageability
Efficient	Infrastructure & technology	Performance/Manageability
Productive	Infrastructure & technology	Performance/Security/Manageability
Affective	Infrastructure & technology	Performance/Security/Manageability
Centralized Management	Infrastructure & technology	Performance/Manageability
Ease of access	Infrastructure & technology	Performance/Manageability
Ease of implementation	Infrastructure & technology	Performance/Manageability
Management	Infrastructure & technology	Manageability
Capacity	Infrastructure & technology	Performance
Bandwidth Saving/Usage	Infrastructure & technology	Performance

Cost effective	Monetary Parameter	CAPEX/OPEX
Time Saving	Infrastructure & technology	Performance
Application Response	Infrastructure & technology	Performance
Application Features	Infrastructure & technology	Performance

APPENDIX IV

Summary of Responses from each group using “ Qualitative Assessment of Emphasis.” – Group - I

	User	Functional Area	Monetary Parameter : Theme – Qualitative Assessment of Emphasis on Financial Impact (CAPEX/OPEX)	Infrastructure & Technology : Theme – Qualitative Assessment of Emphasis on Technical Impact (Performance/ Security/ Manageability)	Monetary Parameter : Theme – ROI Impact	Segment
HQ	CTO	CTO/ Head of Group IT	xxxx	xxxxxx	xxxxxx	1
	Head of Group IT		xxxx	xxxxxx	xxxxxx	
	IT Manager – 1	IT Managers of Each Company/ Managers of Technology Area/Technical Leads/System Engineers	xxxxxx	xxxxxx	xxx	
	IT Manager – 2		xxxxxx	xxxx	xxxx	
	IT Manager – 3		xxxxxx	xxxxxx	xxx	
	Assistant Manager IT		xxxx	xxxxxx	xxxxxx	
	Infrastructure Lead		xxxxxx	xxx	xxx	
	SAP Consultant		x	x	xxx	
	System engineer 1		xxxxxx	xxx	xxx	
	System engineer 2		xxxxxx	xxx	xxx	
WAN	IT Manager – 1	Management (IT)	xxxxxx	xxxxxx	xxxx	2
	IT Manager – 2		xxxxxx	xxxxxx	xxxx	
	IT Manager – 3		xxxxxx	xxxxxx	xxxx	
	IT Manager – 4		xxxxxx	xxxxxx	xxxx	
	IT Manager – 5		xxxxxx	xxxxxx	xxxx	
	System Admin – 6	IT – Operations	xxxxxx	xxxxxx	xxx	
	IT Executive – 7		xxxx	xxxx	xxx	
	IT Executive – 5		xxxx	xxxxxx	xxx	

	System Admin – 6		xxxxxx	xxxx	xxx	
	IT Executive – 7		xxxx	xxxxxx	xxxx	
	IT Executive - 7		xxxx	xxxxxx	xxxx	
	System Admin - 9		xxxx	xxxxxx	xxxx	
	IT Executive - 10		xxxx	xxxxxx	xxx	
	IT Executive - 11		xxx	xxxxxx	xxxx	
	System Admin - 12		xxxx	xxxxxx	xxx	
	IT Executive - 13		xxxx	xxxx	xxxx	
	Manager Finance - 14	Management (Finance)	xxxxxx	xxxxxx	xxxx	
	Manager Finance - 15		xxxxxx	xxxxxx	xxxxxx	

Summary of Responses from each group using “ Qualitative Assessment of Emphasis.” – Group - II

	User	Functional Area	Monetary Parameter : Theme - Qualitative Assessment of Emphasis on Financial Impact (CAPEX/OPEX)	Infrastructure & Technology : Theme - Qualitative Assessment of Emphasis on Technical Impact (Performance)	Monetary Parameter : Theme - ROI Impact	Segment
HQ	End Users -1 - Location 1	End Users (without Top management & Group IT)	xxxxxx	xxxxxx		4
	End Users -2 - Location 1		xxx	xxxxxx		
	End Users -3 - Location 1		xxx	xxxxxx		
	End Users -4 - Location 1		xxx	xxxx		
	End Users -5 - Location 1		xxxxxx	xxxxxx		
	End Users -6 - Location 1		xxx	xxxx		
	End Users -7- Location 1		xxx	xxxxxx		
	End Users -8 - Location 2		xxxx	xxxxxx		
	End Users -9- Location 2		xxxx	xxxxxx		
	End Users -10 - Location 2		xxxx	xxxx		

	End Users -11 - Location 2		xxxx	xxxxx		
	End Users -12 - Location 2		xxxx	xxxxx		
	End Users -13 - Location 2		xxxx	xxxx		
	End Users -14 - Location 2		xxxx	xxxxx		
	End Users -15 - Location 2		xxx	xxxxx		
	End Users -16 - Location 2		xxxx	xxxx		
	End Users -17 - Location 2		xxxx	xxxx		
	End Users -18 - Location 2		xxxx	xxxxx		
	End Users -19 - Location 3		xxxx	xxxxx		
	End Users -20 - Location 3		xxxx	xxxxx		
	End Users -21 - Location 3		xxx	xxxxx		
	End Users -22 - Location 3		xxxx	xxxxx		
	End Users -23 - Location 3		xxx	xxxxx		
	End Users -24 - Location 3		xxx	xxxxx		
	End Users -25 - Location 3		xxx	xxxxx		
WAN	End Users -1	End Users (without Top management & Group IT)	xxx	xxx		5
	End Users -2		xxxx	xx		
	End Users -3		xxxx	xxx		
	End Users -4		xxxx	xx		
	End Users -5		xxxx	xx		
	End Users -6		xxxx	xxx		
	End Users -7		xxxx	xxx		
	End Users -8		xxxx	xxx		
	End Users -9		xxx	xxx		
	End Users -10		xxxx	xx		
	End Users -11		xxxx	xxx		
	End Users -12		xxxx	xxx		
	End Users -13		xxxx	xxx		
	End Users -14		xxxx	xxx		
	End Users -15		xxxx	xxx		

	End Users -16		xxxx	xxx		
	End Users -17		xxxx	xxx		
	End Users -18		xxxx	xx		
	End Users -19		xxx	xxx		
	End Users -20		xxx	xx		

APPENDIX V

Percentages used to graphically interpret theme impact on SD-WAN investment decision.

Target Segment : Group I (43 People)	Financial Impact on SD-WAN Investment				
	Strongly Agreed %	Moderate Agreed %	Neutral Response %	Disagree%	Strongly Disagree%
Segment 1 (10 Responses)	60	30	0	0	10
Segment 2 (18 Responses)	50	44	6	0	0
Segment 3 (15 Responses)	0	73	27	0	0

Table: Group I - All Segments - Technical Impact on SD-WAN Investment

Target Segment : Group I (43 People)	Technical Impact on SD-WAN Investment				
	Strongly Agreed %	Moderate Agreed %	Neutral Response %	Disagre e%	Strongly Disagree%
Segment 1 (10 Responses)	50	50	0	0	0
Segment 2 (18 Responses)	78	22	0	0	0
Segment 3 (15 Responses)	80	20	0	0	0

Table : Group I - All Segments - Technical Impact on SD-WAN Investment

Group/Segments	Financial Impact on SD-WAN Investment				
	Strongly Agreed %	Moderate Agreed %	Neutral Response %	Disagree%	Strongly Disagree%
I (43 Responses)	35	51	12	0	2

Table : All Segments - Technical Impact on SD-WAN Investment

Group/Segments	Technical Impact on SD-WAN Investment				
	Strongly Agreed %	Moderate Agreed %	Neutral Response %	Disagree%	Strongly Disagree%
All Segments in Group I (43 Responses)	72	28	0	0	0