INTER-ORGANIZATIONS TECHNOLOGY SYSTEMS' DATA ANALYTICS, CORRIDOR PERFORMANCE MONITORING USING THE NORTHERN TRANSPORT CORRIDOR OBSERVATORY

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DECLARATION

This Project report is my original work and has not been presented for a degree in any other University.

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This research project report has been submitted with my approval as the University Supervisor.

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DEDICATION

My dedication goes to my wife, Faith Soi, our lovely daughter Tamara and my siblings who have continuously encouraged and supported me during the entire period of the study. I dedicate this also to my Dad who always encouraged us to invest in education.

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

ATRI   American Transportation Research Institute

CCTFA   Central Corridor Transport Facilitating Agency

CCTO   Central Corridor Transport Observatory

COMCEC   Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation

FHWA   Federal Highway Administration

FPM   Freight Performance Measures

GPS   Global Positioning System

ICT   Information Communication Technology

ITF   International Transport Forum

KWATOS   Kilindini Waterfront Automated Terminal Operating System

NCHRP   National Cooperative Highway Research Program

NCTA   Northern Corridor Transit Agreement

NCTO   Northern Corridor Transport Observatory

NCTTCA   Northern Corridor Transit Transport Coordination Authority

OECD   Organisation for economic co-operation and development

PMAESA   Port Management Association of Eastern and Southern Africa

RESW   Rwanda Electronic Single Window

SASEC   South Asia Sub-regional Economic Cooperation

SSATP   Sub-Saharan Africa Transport Policy Program

TCD   Time–Cost–Distance

UNCTAD   United Nations Conference on Trade and Development

U.S   United States

LIST OF TABLES

ABSTRACT

Over the past recent years, institutions have adopted various mechanisms for measuring operational performance in their areas of operations with the key objective of improving efficiency and gaining competitive advantage. The important role Information technology data analytics play in measuring the efficiencies is unquestionable. This has made organizations to adopt tools and techniques in Innovation technology for measuring efficiencies. The evaluation of the effectiveness of Information technology systems' data analytics in measuring corridor performance was the key objective of this study with the case study being the Transport Observatory project of the NCTTCA. The research also looked into the effectiveness of the adopted transport observatory of northern corridor in measuring corridor performance. The research design adopted was descriptive analysis using both primary and secondary data. Data collected through the structured questionnaires were analyzed using SPSS, Microsoft Excel and SQL. The study established that use of data analytics in measuring corridor performance is most effective and provide reliable information to decision makers and stakeholders. The findings give approval ratings of 79% of the respondents who believes that use of data analytics for measuring corridor performance is the most effective. The findings from secondary data indicated that the adopted transport observatory tool is quite effective in measuring corridor performance with the measure of corridor efficiency increasing from 92.6 (least efficient) in 2014 to 49.5 (more efficient) in 2017 indicating improvement in the corridor performance. However, the findings noted some of the challenges associated with use of data analytics and the adopted transport observatory as corridor monitoring tool. Notable challenges from the findings include; unreliability of data providers in sharing data, complexity of consolidating different data, availability of data gaps in the shared data, complexity of processes of data analysis. Inefficiency of dissemination tools and lack of awareness are other notable challenges identified. The research contributes more to the use of data analytics in measuring performance. With the ever changing and innovation of technology, the research finds that there is more valuable information generated through automation which can be used for measuring performance. The study recommends that more focus should be put on integrating related automated processes to assist in generating data for use in measuring corridor performance.

CHAPTER ONE: INTRODUCTION

1.1. Background of the study

The concept of a transport corridor lacks a precise definition. It can be viewed either in the physical dimension or functional dimension (COMCEC, 2017). In terms of physical components, a corridor is composed of one or more routes that connect centres of economic activity. Physical aspects include: Routes, which connect centres of economic activity, have common transfer points and are connected to the same end points; Links, over which the transport services travel; Nodes, which interconnect the transport services; Gateways, which are origin and end points that allow traffic with sources or destinations outside the corridor and its immediate hinterland to enter or exit the corridor (Arnold, 2005). In the dimension of functional component, corridors can be considered as a link connecting two or more adjacent countries by providing a link to the sea for the landlocked countries (Kunaka et al, 2014). Transport corridors empower locales and nations to offer transport frameworks of high capacity and services that reduce trade and transport costs by creating economies of scale. A transport corridor is however not only a route or a set of routes, but also a group of means of transport covering these routes.

From an economic perspective, transport corridor is meant to facilitate trade within and between countries by providing a more reliable and effective logistical services (Douma, 2003). As a way of ensuring focus is placed on activities meant to improve the quality of transport and other logistical services in the corridor, some routes has been designated as part of transport corridor routes (Patrick, 2014). Transport corridors are the key routes that link the landlocked countries to regional and international markets through other non-landlocked countries.

In Kenya, The northern Corridor is the major road network that runs from the Port of Mombasa to other countries of Uganda, Rwanda, Burundi, Democratic Republic of Congo and South Sudan. The route connects the major towns of all the countries, including major towns in Kenya, to the Port of Mombasa which is the main point of entry through the ocean (NCTTCA, 2012). Economic performance of any country requires high quality transport logistics.

High quality logistics is key for the economic performance of any country. For a country to achieve better national competitiveness, it requires a high quality and functioning logistical network both locally and internationally (ITF, 2016). According to Enagnon (2017), factors that contribute towards quality of a transport corridor includes time it takes to transport goods from one point to another (transit time), the transport cost for shipping goods, the reliability of the services, and the flexibility and diversity of established operational tools for services along the corridor. From a trader's perspective, corridor performance is all about transport costs, transit time and delays as well as predictability and efficiency associated with the seamless movement of freight along transport corridors (NCTTCA, 2017). Performance of a transport corridor is determined by complex combination of factors both from private and public entities like policy enforcers, operational service providers, Freight operators, clearing agents as well as available hard and soft factors which includes quality of infrastructure, transport facilities, policies and legal frameworks and established practices and procedures along the transport corridor (Sirali, 2015).

Problems encountered by different stakeholders when transporting goods along the transport corridor are numerous, and include long distances of moving cargo from the ports of entry, insufficient transport systems and process, and inefficient transport policies along the corridor (Hansen, 2007). Over many years, various studies on transport corridors have shown that the inefficiency and unreliability of the transport corridor system is the major obstacle faced by

stakeholders in trade. The costs of an inefficient transport corridor are extensively high and form the biggest bottleneck towards enhancing economy (UNCTAD, 2011). Inefficiency of the transport corridors depresses trade by making the corridors to be Costly and unreliable (Arvis, 2011). This leads to making exportation of goods through the port to be less competitive and makes the imports to be more expensive. All this have got negative impact to the economy.

In an effort to address the challenges facing stakeholders along transport corridors, there is a need for an accurate and reliable data which provides information on specific areas of intervention. Policy makers need to be informed by most accurate information on areas that needs intervention to ensure challenges are addressed and efficiency of the corridor is achieved. Accurate and reliable data can assist in pinpointing specific impediments along the logistical chain that needs interventions and policy reforms as well as operations improvements that need to be implemented. For this to be achieved, it is critical that systems data on the operational systems are collected and analysed. (Gaël Raballand et al, 2008).

In order to enhance and improve the competitiveness of transport corridors and improve the operation efficiencies, efforts have been put in place to work towards identifying causes of inefficiencies so as to come up with appropriate solutions which will guide towards achieving efficiency. Monitoring tools have been put in place to assist in identifying various challenges and bottlenecks that contribute to inefficiencies. This involves use of operational data to measure arrays of defined indicators which includes Clearance time at the points of entries, Transit times, delays at specific points, costs incurred and productivity. Corridor Transport Observatory is one of the monitoring tools which have been adopted by various corridors to monitor corridor efficiencies. The objective of corridor transport observatories is to guide in pinpointing specific obstacles that hinders efficiency of the transport corridor so that relevant actions be defined and implemented to eliminate the obstacles. In Kenya, Northern Corridor

Transport Observatory is the corridor monitoring tool established for monitoring efficiency of the northern corridor. Northern Corridor Transport Observatory is used to measure efficiency of the northern corridor and guiding in identifying causes of inefficiencies so that it guides the policy makers in putting in place measures to address the challenges (NCTTCA, 2012). It consists of decomposing the corridor processes into transport chains, selecting specific chains, assessing these chains through a set of key performance indicators, and then aggregating the performance of identified chains to give the corridor-level performance using proper measures (Ntamutumba, 2010).

This research is aimed at establishing the effectiveness of using inter-organizations systems' data analytics in measuring corridor performance. The study also looked into the effectiveness of the transport Observatory adopted by NCTTCA for measuring corridor performance along the transport northern corridor in Kenya and bring out the challenges and recommended ways of resolving the identified challenges. The study used the case study approach in evaluating how data analytics gathered from various stakeholders are used in measuring corridor performance and establish its effectiveness, challenges and areas of improvement.

1.1.1 Inter-organization systems' data

An inter-organizational systems' data is consolidated data drawn from a number of organizations systems for use jointly for a specific purpose (Loshin, 2003). Inter-organization systems' data can be defined as raw data extracted from different stakeholders' systems and put together for common purpose. Inter-organizational systems rely upon information technology to enable the flow of data and information between two or more organizations (Alexander et al, 2007). Inter-organizations systems' data can be utilized jointly to assist in measuring operation efficiency by enabling identification of bottlenecks and assist in decision making. For joint utilization, operational data are extracted from different organizations

systems where the data from each organization represents part of transactional process carried out in the whole logistics chain. Data from entry points like the ports are extracted to measure processes involved in clearing of goods, customs data represents customs clearance processes, Transporters data representing operational processes between two transactional points and so on (Brian et al,2000). All the data when put together gives a continuous picture of the processes within a given logistics chain from entry point to destination points. The data is used to measure efficiency of every processes along the corridor by measuring performance of defined indicators that forms the basis of measuring performance. The indicators include times and delays, productivity and efficiency of tools and specific processes, quality of infrastructure as well as rates and costs associated with different sections and processes.

Automation of operational processes by different stakeholders along transport corridor allows collection of data from different sources which are then stored into a single central database system to be used jointly in measuring corridor and do predictive analysis and forecasting for decision making. Automated operational processes in every organization contribute to the overall activity carried out within a specific operational area (Raisinghani, 2004). In this regard, every process recorded contributes to the overall process in a given area.

In the case of transport corridors, different stakeholders play different interdependent roles. All the roles combined contribute to the overall chain of logistic process along a corridor. Data from these organizations systems can be used jointly to assist in giving an insight into processes and performance efficiencies.

Different stakeholders along transport corridors have automated their respective operational activities by investing in different information technology systems. In 1991, Germany government with an intention of improving service delivery along Atlantic corridor adopted custom information system (OECD, 2012). The system was successful in reducing trade

barriers and increasing operational efficiencies long the corridor. In Mexico they have adopted customs administrations systems which perform two basic functions: customs control and trade facilitation with neighbouring nations (Brian, 2011). In Africa, South Africa (SA) international custom electronic service system linkage has become increasingly important component in Africa business economic hub (Keen & Mansour, 2010). The systems have been of significant in reducing clearance time and increasing transparency with other countries trading with along the corridor (Hammergren, 2009). Also, South Africa has a good internal customs electronic system that make eliminate several complains originating from clearance of goods (Igbanugo et al, 2011). In Rwanda, the Revenue Authority installed Rwanda Electronic Single Window (RESW) which responds to the need of managing its borders more effectively and thereafter facilitate efficient cross - border trade of goods moving along the transport corridor. In Kenya, automation of port process through the adoption of system called Kilindini Waterfront Automated Terminal Operating System (KWATOS) has led to improved port operations and contributed towards corridor efficiency. All these automations of operational processes by different stakeholders results in generation of enormous amount of operational data which can be used in measuring efficiencies at various points which jointly contribute towards monitoring corridor efficiency.

1.1.2 Data Integration, Analysis and reporting

Data Integration is concerned with collecting data from multiple sources, cleaning, merging and consolidating them into a single storage to have a single view over all these sources for use for a specific purpose. The purpose of data integration is to facilitate and have sufficient data that can be used for querying and reporting on different business activities (Business intelligence), carrying out online data analytics processing and data mining for the purposes of

decision making, forecasting, and planning with a sole goal of gaining sustainable competitive advantage (Clarke et al, 2014).

The purpose of data integration is to develop an effective official statistical data repository system. The purpose of consolidating data from different sources provides an insight verifiable information (Clarke, 2014). With integration of data, it assist in establishing underlying relationships between various aspects of the society, hence improving our knowledge and understanding about a particular subject. Data integration plays a key role in determining the efficiency of an organization or interconnected processes, be it at the level of backend systems integration or integration of processes, administrative tasks, and databases. Embedding of integrated data into the platform allows end users to create analysis which can be applied in measuring performance efficiencies in a given operational chain.

After integrating data from different sources, there is a need to carry out processes of cleaning, transforming, merging, converting, harmonizing and modelling into a single data repository or database to be used in decision making. Data Analysis entails application of statistical and logical techniques to integrated data to aid in decision making. Data analysis is about arranging, cleaning, transforming and modelling of the recorded data to assist in retrieving meaningful information from it (Loshin, 2003). Data analysis involves exploring data to extract meaningful insights, which can be used to better understand and improve business performance (Clarke, 2014). The objectives of data analysis is to obtain necessary and useful information from collected data and consequently utilizing them for active control and decision making (Zdenka et al, 2011)

Data reporting involves visualization of already analysed data that gives meaningful information to the targeted audience. It is the process of sharing and disseminating the fact findings from processed data of the information to the targeted audience by acting as a link

between raw data and synthesizes information (Rebecca Bartlett, 2003). With this process, meaningful information from analysed data is presented to provide an insight on how different areas of a business are performing. Data reporting make use of various technological tools to aide in disseminating acquired information from analysed data. Among the online tools includes use of dashboards, web portals and Business Intelligence tools.

1.1.3 Transport Corridor monitoring and Performance

The complexity of transport corridors can bring barriers and impediments to the movement of trade as a basic function of transport corridors. Corridor performance concerns about cost of moving cargo, time and efficiency of process for the seamless movement of freight along transport corridor (Olivier, 2013). Transport corridor performance relies on a complex combination of factors involving public and private entities (transporters, policy makers, and regulators) as well as infrastructure facilities, policies in place and procedures. Improving corridor performance requires therefore a good understanding of the obstacles to trade in order to determine the causes for lack of performance and not just the symptoms (Sara et al, 2014),). The objective of measuring corridor performance is to help in reaching that thorough understanding of the obstacles and inefficiencies of processes so that remedial actions be identified and implemented. The whole point of measuring corridor performance is that it is a pre-requisite to increasing corridor efficiency.

The performance of a corridor can be evaluated from two main perspectives: infrastructure perspective and service perspective. In infrastructure perspective, it looks into the physical capacity of roads network and the specific nodes/stations and how they interrelate and utilized. On a service perspective, it looks into the efficiency and the quality of the services provided for operational processes along the corridor routes (Ferdinand, 2013). To measure performance of transport corridor involves looking into the average time it takes to move freight as well as

transport costs incurred. The measure of these factors can be done for specific sections or points along the corridor where performance of each section or points contribute to the overall corridor performance (Arnold, 2005). For trade facilitation, service perspective which looks into efficiency and quality of services is the focus points which allow to benchmark with other corridors and evaluate the quality of services offered.

Transport corridor performance needs to be analysed from various perspectives using different techniques and making use of information technology and leveraging on the automation of operational processes (Enagnon H. Fanou et al, 2017). Monitoring of corridor performance is geared towards increasing efficiency, accessibility and mobility; improving transportation safety; accelerating information dissemination to corridor users; advancing coordination amongst institutional partners; and improving network management. Efficiency is the key performance indicator in every transport corridor. Transport Observatory is primarily an analytical tool that uses data analytics from operational systems extracted from different organizes to analyse corridor performance in its multiple dimensions.

1.1.4 Northern Transport Corridor

The Northern transport Corridor is a major trade and transport corridor route linking the landlocked countries of the Great Lakes Region with the Kenyan maritime sea port of Mombasa (www.ttcanc.org). The Northern Corridor is the transport network routes which start from the port of Mombasa to the landlocked countries of Uganda, Rwanda, Burundi, and Eastern Democratic Republic of Congo, as well as Northern Tanzania and Southern Sudan. With the sole objective of facilitating transit transport and trade along the corridor, the northern corridor Member States established an agreement called "Northern Corridor Transit Agreement (NTCA)" in 1985. Implementation of the NCTA was enacted on 28 May 1986, after its ratification by the initial member states of Burundi, Rwanda, Uganda and Kenya (NTTCA,

9

2012). In 1987, the Democratic Republic of Congo (DRC) acceded to the NTCA agreement becoming one of the members of the Northern Corridor Transit Agreement. In 1987, the NCTA was revised in Nairobi, Kenya with the new provision of ensuring transformation of the corridor. The revised NCTA defined the objectives of the NCTA as to: Facilitate and ensure there is free movement of cargo among the member states of the corridor, Guarantee seamless access to and from for the landlocked Member states, Facilitate and advocate development of efficient transport facilities and services and Facilitate and advocate for inter-regional trade.

The Transport Observatory is a corridor performance monitoring tool for the Northern Corridor that informs interventions geared towards reducing costs and delays of transportation and other related logistics challenges. The Northern Corridor Transport Observatory was established and is run by the Northern Corridor Transit and Transport Coordination Authority (NCTTCA). The Northern Corridor Transport Observatory (NCTO) uses operational systems' data collected from array of stakeholders' information systems along the corridor Member States including; Revenue Authorities, Roads Authorities, Ports, Railway Authorities, Transport Associations & Transporters and Private Sector institutions closely affiliated to trade and transport. Northern Corridor Transport Observatory make use of operations raw data from information technology systems to measure the corridor efficiency (Sirali, 2014). Operational data collected is analysed and processed to provide trend performance of specific defined indicators. Indicators measured using the operational systems' data are Transit times and delays. These are indicators on the Transit times, delays at specific points and overall turnaround time.

1.2. Statement of the problem

Monitoring performance and management of transport corridors requires development of appropriate monitoring tools to provide adequate information for good decisions making. One

of the most promising monitoring tools for measuring and evaluating transport corridor performance is the transport observatory (Enagnon, 2018). Transport observatory is corridor performance monitoring tool that uses raw data extracted from different operational systems. Systems data from different systems have great potential to help produce new and insightful information. (Jerica et al, 2010).

However, Inter-organizations systems' data comes in different data formats, and hence the challenge of consolidating to a single format. The systems are dis-integrated and are designed with a sole purpose of automating operational processes, with little or no regard to the use of the data generated for monitoring purposes. Different data sources have different formats, and it has opened up a new challenge of ensuring conformity and harmonization in the field of business intelligence (New Zealand, 2009). Data gathering from diverse sources is obviously much more expensive and complex process. For this reason, there is a need to establish an automated means of collecting road transport data which can be done through surveys or already established systems for automation of operational processes (NCTO, 2012).

The transport Observatory being used by the NCTTCA to measure efficiency of the Northern corridor is the only monitoring tool in the Kenya which uses raw data from stakeholders' systems. Progress has been made in the establishment and improving the corridor monitoring tools. However, transport Observatory tool for monitoring corridor efficiency has experienced a lot of challenges. With the dynamic nature of information technology tools used in the industry, systems data keeps changing in terms of structure and format posing challenges of data integration. Resistance by some of the key stakeholders to share data, complex processes of extracting and sharing of data and complexity in diverse data formats has been a major challenge towards establishment of a transport observatory tool. With these challenges and the

on-going innovations, there exist a lot of areas of improvement that will make the transport observatory more robust and efficient.

A number of studies have been done regionally and globally on the use of information technology systems in measuring corridor efficiencies, bringing out its effectiveness, achievements and challenges. A research was carried out by Sub-Saharan Africa Transport Policy Program with an objective of evaluating the benefits of measuring corridor performance (Raballand et al, 2008). The research was conducted by collecting feedback from different stakeholders on the importance of the initiative. The research found out that the core of monitoring activities of the transport corridor should mostly rely on existing consolidated data (customs and port data) and limited surveys (freight forwarders, major trucking companies, truckers and transport unions), to benchmark corridor performance.

Another research on corridor diagnostics (Kunaka et al, 2014) looked into how Information technology data can be used to measure delays along transport corridor. From the study, the authors argued that for systems data to be used in measuring corridor performance, they must be having specific attributes of timestamps which can allow measuring delays and time associated with specific process. The focus of the study was having robust, reliable and cost effective data sources to guarantee efficient corridor management.

A research by northern corridor secretariat outlined the challenges associated with the use of data from different sources to measure corridor efficiency. The report noted that there still exist some gaps in the availability of up-to-date data needed to complete the measure of all aspects in the corridor.

Central Corridor Transport facilitating agency (CCTFA) in its initial stages of establishing Transport observatory for monitoring efficiency of the central corridor, conducted study on the best transport observatory practices (CCTFA, 2014). From the study, they established the best

means of measuring corridor efficiency is through the use of systems' raw data extracted from systems of major stakeholders in the corridor. Identified stakeholders are the customs authorities and the port operators. However, the study runs short of explaining the effectiveness of using the systems' data analytics and the challenges.

Limited studies have been done on how effective is the use of the data analytics from different systems in measuring corridor performance. With the use of data from automated processes, a research could be carried out to provide enough evidence on the effectiveness of systems' data analytics in measuring transport corridor performance as well as outlining the challenges that comes with it. All these gaps in research leads to the study to evaluate the effectiveness and challenges associated with the use of systems data analytics to measure corridor performance, having Northern Corridor Transport Observatory as the case study. The research was guided by the questions: How effective is the use of systems' data analytics in measuring performance of transport corridor? What are the challenges associated with the use of integrated systems' data analytics?

1.3. Objectives of the Study

The main objective of this study was to evaluate the effectiveness of the use of ICT operational systems' data analytics in measuring performance of transport corridor, having Northern Corridor Transport Observatory as the case study.

The research was guided by the following specific objectives:

1. To establish perceived effectiveness of information systems data analytics in measuring transport corridor performance.

2. To establish effectiveness of the adopted Transport Observatory tool in measuring corridor performance.

3. To establish the challenges associated with the use of technology data within NCTTCA Transport Observatory and possible are of improvement in the use of technology to monitor performance.

This study focused on evaluation of NCTTCA's usage of ICT systems' data analytics and determines if it has met its full potential in achieving efficient way of monitoring performance along the northern corridor whilst pointing out areas where it can be improved in order for it to be more effective.

1.4. Value of the Study

The study will provide an insight understanding to stakeholders and general public on the use of systems data in measuring corridor performance and identifying bottlenecks. This will enable the stakeholders to have more understanding on the importance of the data in their custody in improving corridor efficiency.

The research will provide information to policy makers which guides in having clear understanding on the performance of corridor by understanding the processes in the use of systems' data in measuring corridor efficiencies. With the research findings, the policy makers in the corridor will be able to identify other areas of improvement in measuring corridor performance. This will guide in improving the quality of decisions made towards achieving an objective of having an efficient transport corridor.

The findings of the study will also help NCTTCA in identifying areas of improvement and identify how to utilize technology more in measuring efficiency. Findings may assist in redefining the usefulness of data analytics through technology and identify areas of improvement.

With little research have been carried out in the use of data analytics to measure transport corridor performance, this study will add content to the existing researches on the benefit of transport corridor performance monitoring. The findings of this research can be used by other researches for further studies.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter outlines theoretical as well as empirical studies from a number of sources on relevant topics to the research problem. It examines what various scholars and authors have written about usage of Information Technology systems' data in measuring performance. Secondary materials like books, journals, websites and articles containing previous research work on the study topic were also reviewed.

2.2 Theoretical review

Decision theory in data analytics is about making appropriate decisions in the face of uncertainty with the help of data. Statistical data sheds light on some of the uncertainties involved in the decision problem. Decision-making in transport corridor is often performed with single-objective of achieving cost effective and efficient corridor. According to research by Josias Zietsman (2006), the type of decision-making methodology applied when all objectives are factored in the decision making will have a major impact on the final decision. The decision-maker, therefore, can use the results from the different decision-making analysis methodologies as a basis for selecting on the most appropriate alternatives. The theory provides a framework in which data can be used to make an informed decision towards achieving specific objectives. It proofs a need to have evidence based decision making. This validates the use of data in identifying bottlenecks in the transport corridor by use of factual data.

Contingency Theory is an organizational theory which states that there is no specific way which can be regarded as the best of all the ways in solving a problem or to guide in decision making. It states that any decision making or problem solving is guided by situations available

and there is need to apply several options of trial and error until one option is selected. This theory is based on two major findings: First, There exist one way which is the best in managing an organization or organizing a firm. Second, each of the specific method chosen by the firm is not necessarily the most effective of all the available options (Galbraith, 1973). The basic argument of contingency theory argues that the best way for solving a problem or making decision is guided by the environment in which an organization operates. According to Peter Weill et al (April 1987), Contingency theorists attempted to look and identify specific variables which are considered as key and have great impact in the performance of an organization. The theorists then attempted to analyse and evaluate identified various variables and be able to determine how they affect the performance of an organization. Application of the theory in measuring corridor performance is in evaluation of the use of Inter-organizations systems' data in measuring efficiency. As the theory states that there is no best way in making a decision, it helps in evaluating the effectiveness of the adopted use of technology and identifies areas of improvement. Since the theory states that there is no best way in making decisions, it implies that the adopted technology by the northern corridor is not necessary the best and there exist areas of improvement in improving the way of monitoring corridor efficiency. The theory does not propose specific and way of identifying the best way of doing something, but it gives a platform for continuous improvement. In the case of Northern corridor monitoring, the theory implies that the current way of monitoring efficiency may be the most efficient but there exist areas of improvement that needs to be addressed.

Complexity theory states that critically interacting components self-organize to form evolving structures showing a hierarchy of emergent system properties. It attempts to demonstrate why the whole universe is greater than the sum of the parts and how all its components come together to produce order as the system learns, evolves and adapts (Barclay & Dann, 2001). According to James Courtney (2008), it is believed that a better understanding of complexity

will give a better ability to function more effectively and achieve our goals, both personal and professional. A study by the University of West of England (2012) applied complexity theory in transport monitoring by showing that transport systems are comprised of many elements which are been taken as a whole and the characteristics and performances of these transport systems and their components are usually defined on the basis of quantitative evaluation of their effects, considering the objectives and the constraints of the transport system. From the study, they concluded that transport corridors are in a constant process of evolution therefore understanding the relationship between various elements of the systems. In summary complexity theory has led to adoption of different methodologies of measuring corridor performance shifting from an ordered, rational, analytical and evolving dynamic approach of use of the technological innovation.

With the decision theory, the study will looks at the use of data analytics for decision making towards enhancing corridor performance. This research will therefore build on the decision theory by looking at how data analytics can facilitate decision making. Contingency theory will guide in looking at how best is the transport observatory tool and factors that can enhance its usage in the transport corridor performance monitoring. Complexity will facilitate looking into various components that constitute the performance of the transport corridor.

2.3 Inter-organization systems' data and integration

With the adoption of Information systems by different organizations along transport corridor, operational systems data collected provided an opportunity for a new concept of accessing corridor efficiency. Operational systems' data extracted from the systems of different organizations in the same transport corridor can be integrated to provide an insight view of how the corridor activities are carried out. All activities in the corridor are inter-connected and

overall contribute to the performance of the corridor. This has made Information systems data a basic tool used for monitoring of corridor performance. Information systems establishes formalised procedures to provide decision makers at various levels with appropriate information and data from all relevant sources to enable them to take timely and effective decisions for planning, controlling, directing and subsequently upgrading the corridor efficiency.

A research paper by Gael Raballand et al (2008) which focused on presenting several corridor performance methodologies adopted in Africa and the lessons learned concluded that the core of monitoring corridor activities should mostly rely on existing consolidated data (customs and port data) and limited surveys from different stakeholders to benchmark corridor performance. The research has contributed majorly in establishing monitoring tools using systems data available. However, the study run short of guiding on how to measure specific indicators using the data available and how to link to the corridor performance. A research by International Transport Forum on analysis of Logistics Observatory for Chile concluded that transport observatory is a useful performance measurement tool which facilitates advance collection and processing of inter-organizations data which can be used in preparing and developing strategies on freight transport and logistics geared towards enhancing transport corridor trade. It also concluded that the logistics observatory would promote decision making and evidence-based policy support. The study however could not elaborate on challenges which can be encountered as well as mitigation measures.

The need for introducing management information systems data in day-to-day operations and management of corridor operations has been reported by many authors (Kunaka et al 2014). Nijman (1993) identifies and recommends Information systems data as one of the management conditions essential to improve the system performance based on his research study on the

managerial perspective of performance of the corridor performance. He argues that Information systems' data generates information and provokes thinking that will help to improve the working of transport corridor. It involves sustained analysis of information and keeping watch on the changes that take place in the components of the corridor. However, in his recommendation, the author focused on establishing an integrated system which can be used to measure efficiency. This is different considering it involved establishing a new system in place. Also, the author just proposes but no much insight has been provided on the effectiveness of the same.

2.4 Data integration and Performance monitoring

Data is necessary for planning, improving, and managing intermodal corridors. Data tells the story of a corridor's performance, to support managing the corridor on a daily basis, to justify additional investments, and to sustain support for on-going operations and maintenance costs (NCHRP, 2016). Data requires efficient collection, analysis, storage, and maintenance, and effective reporting. Real-time data collection and use supports managing and adjusting corridor throughput as necessary. The owners and operators of the modal networks within a corridor must coordinate their efforts so that data can be shared, integrated, and, most importantly, used. Data should support different levels of modelling appropriate for improving decisions at different stages of corridor development and management.

Peter Drucker (1999) provides that two activities keep businesses successful – innovation and marketing. In line of Monitoring corridor performance, it brings up the need of being more innovative in coming up with the new ways of measuring corridor performance. This informed the use of information technology data to measure performance. However, the theory got a gap

where it run short of elaborating the elements of sustainability of existing technology to measure corridor efficiency.

The Federal Highway Administration (FHWA) through a project conducted by American Transportation Research Institute (ATRI) in 2003 addressed the lack of national consensus on Freight Performance Measures (FPM). The research evaluated number of adopted technologies for tracking freight movements in the U.S. with objective of developing freight performance measures and finally settled on using data from global positioning system (GPS) units already installed in many transport fleets. According to Review of Corridor Coordination and Management Models by the African Union, The concept of corridors in Africa started with transit corridors linking landlocked countries to sea ports as an economic lifeline through which imports and exports were channelled.

A project Titled "Real-Time Arterial Performance Monitoring Using Traffic Data from Existing Signal Systems" (October 2009) by Minnesota Department of Transportation Research Services & Library was carried out with a goal of developing and testing a real-time performance measurement system to automatically collect traffic signal data on arterial road networks. The outcome of the project demonstrated improvements in performance measures such as travel time, delay, number of stops, and level of service with the use of technological data for informed decisions making. However, the project focused on the use of a newly established real-time information collection. It lacks short on elaborating the use of existing information systems already available under operational automations by different stakeholders.

South Asia Sub-regional Economic Cooperation (SASEC) carried out a study which focused on performance and monitoring of two corridors (Dhaka- Rangpur- Burimari and Banglabandha- Rangpur- Dhaka) using a Time–Cost–Distance (TCD) methodology to assist decision makers in understanding the pattern and magnitude of time and cost of transportation

process and identifying, isolating and addressing physical and non-physical obstacles. The study analyses the average speed along the corridor and identifies key bottlenecks. The study presented both the challenges and enormous opportunities for enhancing transport efficiency along the corridors which the Policy makers and other stakeholders should treat as encouraging as it informs of the measures to be put in place to improve efficiencies along the corridors.

2.5 Challenges of Corridor performance monitoring

Time it takes to transport along the transport corridor is perceived to be due to long distance as well as due to a number of adopted rules and regulations and laid down procedures. Other contributing factors are some regulations which may sometimes are conflicting, inefficiencies of the service providers, multiple road blocks as well as other cumbersome stakeholders' procedures. Major challenges experienced by stakeholders are associated with delays and unnecessary bottlenecks along the corridor (World Bank, 2011). All the challenges in the corridor make the corridor to be costly and inefficient in the long run. Studies on delays have pointed out to conflicting rules and regulations, unnecessary procedures and laxity of staff/employees from different players responsible for facilitating the operational processes (SSATP, 2008). A lot of information systems have been established by different stakeholders carrying out various operational activities along the corridor. These systems generate various forms of data. The data are located in different locations, and in different format. Activities of Collecting and assembling these systems data is very expensive, and rolling out an initiative on data collection for the purposes of monitoring performance will require substantial amount of resources hence reducing the available resources meant for actual program activities on transport corridor. Building on existing data systems for purposes of performance measurement would still require a substantial commitment of resources. Elements of stakeholders' resistance to share data are also a challenge in establishing corridor monitoring tool.

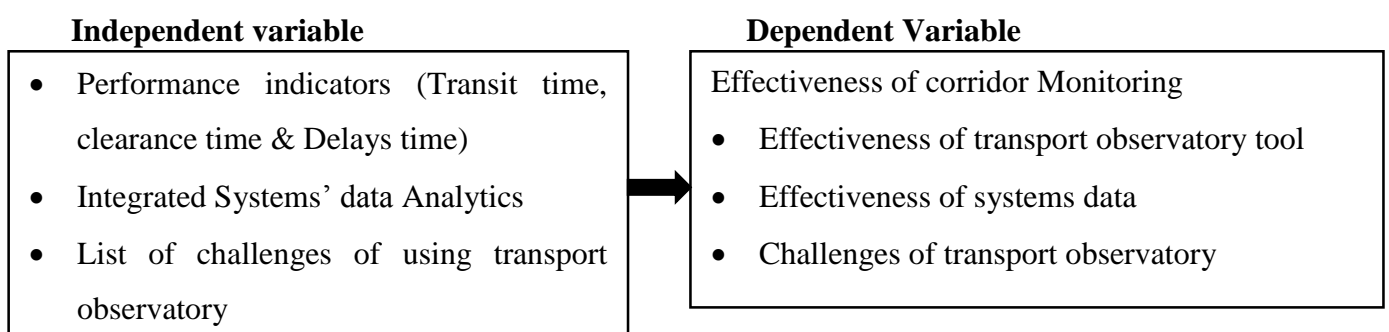## 2.6 Summary of literature review and Research gap

Most of the researches carried out focuses on the use of information systems data to coordinate activities along the corridor. Also, from most of the studies, it outline that most of them focused on developed countries where a lot of innovations have been put in place towards measuring transport corridor efficiencies. None of the research has focused on the use of integrated operational systems data in measuring efficiencies along the Northern corridor. Also, it's attributed to the fact that the selected case study of the northern corridor, is the new feature in the use of technology data to measure corridor efficiency in Kenya. Not much interventions and critics has been carried out in evaluating the initiative. With this identified gaps, there is a need to carry out research to determine how effective is the approach as well as bring out the challenges experienced and proposed the best innovative ways to improve.

None of the research carried out in Kenya focused on the use of information systems data to measure corridor efficiency. Research by Sirali (2014) focused on the use of GPS data to measure and monitor corridor efficiencies. Little attention has been given to the use of Operational systems data in measuring corridor efficiencies.

2.7 Conceptual framework

A conceptual framework elaborates a research problem and summarizes the variables and their indicators in relation to the study objectives and reviewed literature.

Figure 2.1: Conceptual Framework

Independent variable   **Dependent Variable**

Independent variable	Dependent Variable
• Performance indicators (Transit time, clearance time & Delays time) • Integrated Systems' data Analytics • List of challenges of using transport observatory	Effectiveness of corridor Monitoring • Effectiveness of transport observatory tool • Effectiveness of systems data • Challenges of transport observatory

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

In this Chapter, the focus will be on the design and methodology which outlines how the research was carried out. Also to be covered includes Methods of collecting data, sampling methods, analysis of data as well as presentation.

3.2 Research Design

A research design is an approach that explains how research will be carried out to unearth a problem. In this study, descriptive and longitudinal Case Study Research approach was used. A case study is an in-depth study of a particular research problem rather than a sweeping statistical survey or comprehensive comparative inquiry. The selected approach was selected because it allow to carryout in-depth research to know how effective is the use of systems data analytics in measuring corridor performance as applied in the Northern corridor Transport Observatory and allowed to unearth and bring out the challenges associated with the use of technology.

The case study critically looked at how information systems data analytics are used to measure performance of the Northern corridor as well as bring out the challenges encountered during the use of the technology data. The research study provided an in-depth understanding of the challenges as well as provided practical innovation measures which can be applied to address the challenges.

3.3 Case study selection

Having Northern Corridor Transport Observatory as a case study was informed by the fact that Northern corridor transport Observatory is the only transport Corridor monitoring tool that have been adopted in Kenya which uses integrated systems' data analytics. Since Transport Observatory uses systems' data analytics to measure northern corridor performance, it gives a clear understanding and basis on evaluating the use of Information systems data analytics. Also, the case study is in line with the geographical scope of this study as it intends to cover the Kenya section of the Northern Corridor.

3.4 Data Collection

The method of data collection was semi-structured questionnaires consisting of both open and closed-ended questions as well as guided interviews. This method was preferable because all the respondents are able to read and write independently and sitting with them for one-on-one interviews will be able to provide much more information for the qualitative analysis. The questionnaire was structured in the following parts: Demographic information on respondents, Systems data usage in monitoring corridor performance, Performance of northern corridor, Challenges of technology usage and recommended approaches to data collections. Also, secondary data from the transport observatory database were used to measure efficiency of the tool. In this case, data in the observatory were used to see the trend on specific indicators and see if the adopted transport observatory translates to improvement in the northern corridor performance.

The target population in this study were stakeholders involved in the transport observatory. This includes; Staff working under transport Observatory at NCTTCA (Executive secretary,

Director of Transport policy, deputy directors, ICT specialists, statisticians, and Customs experts), data providers from Kenya Ports Authority and Kenya Revenue Authority, Transporters from Kenya Transporters association as well as policy makes along the corridor. For this case, the researcher used reasonable sample of the entire target population for the research.

This case study was also to examine existing data and reports as well as conduct Interviews from different stakeholders and players involved in the project. Just like any other case study the findings here might not be generalized to wider scenario outside the scope of the study.

3.5 Data Analysis

The analyses have both quantitative and qualitative aspects. Qualitative data from administered questionnaires were analysed thematically using content analysis and presented together with quantitative data. Content analysis and descriptive analysis were used to establish how effective is the use of information systems and inter-organizations data analytics in measuring corridor performance. Descriptive statistics were used in establishing the challenges associated with adoption of the use of systems in measuring corridor performance.

Longitudinal analysis looked into how effective is the adopted transport observatory in measuring corridor performance. The analysis used data from transport observatory to show the trend of the corridor performance before and after the adoption of the corridor monitoring tool. The independent variable to be studied in this research is the use of systems' data while dependent variable will be level of effectiveness of corridor Monitoring using systems data.

The focus of the study was; the perceived effectiveness of information systems data in measuring corridor performance; the effectiveness of the adopted Transport Observatory tool in measuring corridor performance; the challenges associated with the use of technology data

within NCTTCA Transport Observatory and possible are of improvement in the use of technology to monitor performance.

Table 3.1. Objectives and mode of data analysis

No	Objective	Mode of data analysis
1.	To establish perceived effectiveness of information systems data analytics in measuring corridor performance.	Descriptive and Content analysis
2.	To establish effectiveness of the adopted Transport Observatory tool in measuring corridor performance.	Longitudinal descriptive analysis
3.	To establish the challenges associated with the use of technology data within NCTTCA Transport Observatory	Descriptive statistics

For objective 2 (To establish effectiveness of the adopted Transport Observatory tool in measuring corridor performance.), measure of the effectiveness of transport observatory as a tool is the ratio of the current performance efficiency to previous performance efficiency where the performance efficiency consist of three (3) measure variables (Transit times, Delay times, and Clearance time)

The formula is;

Tool effectiveness = Performance Efficiency 2017

Performance Efficiency 2013

Where**;**

Performance Efficiency 2017 =Average performance of corridor efficiency in 2017 based on three indicators (Transit time, clearance time and delay time). To obtain the performance

efficiency for 2017, we picked the average annual figure of each of the indicators and calculate the mean as follows.

Performance Efficiency 2017 = (Transit Time + Delay Time + Clearance Time)/3

Performance Efficiency 2013 =Average performance of corridor efficiency in 2013 based on three (3) indicators (Transit time, clearance time and delay time). To obtain the performance efficiency for 2017, we picked the average annual figure for each of the indicators and calculate the mean as follows.

Performance Efficiency 2013 = (Transit Time + Delay Time + Clearance Time)/3

To evaluate the effectiveness, we compare the performance efficiency of the corridor from the time of inception of the transport observatory in 2013 up to the 2017. If the performance of the corridor has been improving since inception of the tool, then it means the tool effective in measuring performance

Tool Effectiveness gives the level of effectiveness with interpretation that; if it is greater than one (1) means the tool is not effective whereas if the figure is less than one (1) means the tool is effective.

CHAPTER FOUR: DATA ANALYSIS, FINDINGS AND INTERPRETATION

4.1 Introduction

This chapter presents the analysis and findings of the study as set out in the research methodology. The findings have been presented in two main sections; background information of the respondents and discussion and findings of each of the objectives of the study.

4.2 Response Rate

A total of 56 respondents were targeted but the researcher managed to obtain 34 completed questionnaires representing 60.7% response rate. According to Mugenda (2003), a response rate of 60% is good enough for analysis; hence the response for this study was considered enough to do the analysis.

4.3 General Information of the respondents

4.3.1 Distribution of Respondents by Category

The targeted respondents for this study were classified into three categories; staff of NCTTCA who runs the transport observatory, the data providers who share data analytics for use in the corridor performance monitoring and policy makers who are mainly informed by the transport observatory data analytics in decision making geared towards improving corridor performance to achieve efficiency of the corridor.

Table 4.1 Distribution of Respondents by Category

Category	Frequency	Percentage (%)
NCTTCA Staff	18	52.9%
Policy makers	4	12.5%
Data providers	12	35.3%
TOTAL	**34**	**100%**

Source: (Research data, 2018)

Majority of the respondents were NCTTCA staff at 52.9%   followed by data providers at 35.3% while the policy makers were at 11.8%.

4.3.2 Distribution of respondents by level of understanding

Respondents who are not staff of NCTTCA were required to indicate their level of understanding of transport observatory as a monitoring tool and the use of data analytics in measuring corridor performance. The findings are contained in Table 4.2.

Table 4.2 Respondents' level of understanding

Level Of Understanding	Frequency	Percentage (%)
High	13	81.2%
Moderate	2	12.5%
Low	1	6.3%
Total	**16**	**100%**

Source: (Research data, 2018)

This was meant to evaluate their ratings on the measure of effectiveness of systems' data analytics in measuring corridor performance. NCTTCA staffs were exempted from this question as it was assumed that they have an in-depth understanding of using data analytics to measure corridor performance.

The findings show that majority of the respondents at 81.2% have got high level of understanding on the use of data analytics in measuring corridor performance as well as how transport observatory works. 12.5% have moderate understanding. Only one respondent (6%) indicated to be having low understanding of the transport observatory. This means their perceived opinion on the effectiveness of using data analytics to measure corridor performance is well informed and valuable in evaluating the effectiveness of using data analytics to measure corridor performance.

4.4 Effectiveness of data analytics in corridor performance (Objective 1)

Respondents were asked to give their opinion on the effectiveness of information systems data analytics in measuring corridor performance. The responses were classified into three levels;

'Yes' which indicated that the responded was considering the use of the data analytics to be most effective, 'Somehow' indicated that the respondent considered use of data analytics for measuring corridor performance to be somehow effective and there might be other areas of improvement or ways for measuring corridor performance, and lastly 'No' response indicated that respondent was not agreeing with the use of data analytics for measuring corridor performance to be the effective. The results are contained in Table 4.3

Table 4.3 Effectiveness of data analytics in corridor performance

Effectiveness of systems data analytics	Frequency	Percentage (%)
Yes	27	79.4%
Somehow	5	14.7%
No	2	5.9%
Total	**34**	**100**

Source: (Research data, 2018)

From the findings, 79.4% of the total respondents agree that use of systems' data analytics is the most effective way of measuring corridor performance. 14.7% agree with the use of systems' data but with some reservations. Only 2 respondents (5.9%) disagree with the effectiveness of the systems' data analytics in measuring corridor effectiveness.

Breaking down the findings per the category of the respondents is as shown in the table 4.4.

Table 4.4 Effectiveness of systems data analytics per respondents' category

Effectiveness of systems data analytics	NCTTCA staff	Policy makers	Data providers	Total %
	%	%	%	%
Yes	44	12	24	79
Somehow	6	-	9	15
No	3	-	3	6
Total	**53**	**12**	**36**	**100**

Source: (Research data, 2018)

From the table above, it shows that majority of respondents who agree that systems' data analytics are effective in measuring corridor performance are respondents who are staff of NCTTCA at 44% followed by data providers at 24% of the total respondents. Of the total respondents, 6% NCTTCA staff and 9% data providers indicated that they somehow believe data analytics are effective in measuring corridor performance. This means they have some reservations or believe there could be better alternative ways of measuring corridor performance. 3% of total respondents who are NCTTCA staff as well as 3% of the total respondents who are data providers consider use of data analytics for measuring corridor performance not to be effective.

4.5 Effectiveness of the transport Observatory tool (Objective 2)

The measure of the effectiveness of transport observatory as a tool for measuring corridor performance was derived from the ratio of the most recent annual performance efficiency to previous performance efficiency where the performance efficiency is the mean average of three (3) measure variables namely; Transit times, Delay times, and Clearance time. The formula used is;

Tool effectiveness= (Performance Efficiency 2017)/ (Performance efficiency 2013)

Where;

Performance Efficiency 2017 =Average performance of corridor efficiency in 2017 based on three performance indicators (Transit time, clearance time and delay time) as recorded during that year of 2017. To obtain the performance efficiency for 2017, we pick the average annual figure of each of the indicators as recorded in 2017 and calculate the mean as follows.

Performance Efficiency 2017= (Transit Time + Delay Time + Clearance Time)/3

Performance Efficiency 2013 =Average performance of corridor efficiency in 2013 based on three (3) indicators (Transit time, clearance time and delay time) as recorded in 2013. To obtain the performance efficiency for 2013, we pick the average annual figure for each of the indicators as recorded in 2013 and calculate the mean as follows.

Performance Efficiency 2013= (Transit Time + Delay Time in + Clearance Time)/3

The table 4.5 below gives breakdown of all the components of performance from the year 2013 to year 2017 which is considered as the current year under consideration.

Table 4.5 Effectiveness of systems data analytics per respondents' category

Year	Performance indicator Annual values			
	Clearance time (Hours)	Transit time (Hours)	Delay Time (Hours)	Performance efficiency (mean)
2013	2.07	256.38	61.82	106.8
2014	2.04	230.42	45.44	92.6
2015	2.34	179.00	43.66	75
2016	2.77	138.01	44.25	61.7
2017	2.21	104.51	41.69	49.5

 Source: top.ttcanc.org (Northern corridor performance indicators)

From the figures above, we can calculate the following parameters;

Performance Efficiency 2013 = (256.38+61.82+2.07)/3 = 106.76

Performance Efficiency 2017 = (104.51+41.69+2.21)/3 = 49.47

Tool effectiveness = (Performance Efficiency 2017)/ (Performance efficiency 2013)

Tool effectiveness=49.47/106.76 = 0.46

Tool Effectiveness gives the level of effectiveness of transport observatory with interpretation that; if it is greater than one (1) means the tool is not effective whereas if the figure is less than one (1) means the tool is effective.

Comparing the performance efficiency of the corridor from the time of inception of the transport observatory in 2013 up to the 2017, the findings indicate that there has been improvement in corridor performance since inception of the corridor. This is because the time it takes to complete a process has been reducing from 2013 up to 2017. In 2013, Clearance time

was taking 2.07 hours, Transit time was taking 256 hours and delay time was 61 hours. All the three indicators gives the performance efficiency of the corridor in 2013 to be 106.8 hours. Comparing with 2017, Clearance time was taking 2.21 hours, Transit time was taking 104 hours and delay time was 41 hours, hence giving performance efficiency of 49.5.

The findings above give a figure of 0.46 which is less than one. If the performance of the corridor has been improving since inception of the tool, then it means the tool effective in measuring performance

This means that the transport observatory is effective as a monitoring tool to measure performance of the northern corridor.

The results revealed that there is significant improvement of the corridor performance since the adoption of the transport observatory. Even though there might be other factors which might have contributed towards improvement of the corridor performance, the transport observatory tool played a major role by analysing and informing policy makers of various areas of intervention needed to improve corridor performance. The figures indicates that there have been consistent improvement of the corridor performance every year from 2013 to 2017.

4.6 Challenges of using data analytics for Transport Observatory (Objective 3)

One of the research objectives was to establish the challenges associated with the use of data analytics for measuring corridor performance and the transport observatory as a monitoring tool. To gather enough information for this objective, the researcher administered open ended questions to data providers and policy makers to provide what they consider as the challenges with the use of data analytics for measuring corridor performance as well as the use of the transport observatory as a corridor performance measuring tool.

The researcher also administered closed ended questions to the NCTTCA staff to evaluate known challenges to do with the use of data analytics in measuring corridor performance. The closed ended questions required the respondent to give their ratings on some of the identified challenges. This was meant to help the researcher to evaluate the known challenges. The rating of the challenges was in a scale of 1 to 4 where; 1=Strongly Disagree, 2=Moderately Agree, 3=Agree and 4=Highly Agree. Findings from closed ended questions administered to NCTCA staff resulted in the findings as indicated in table 4.6 below

Table 4.6 Rating of challenges

Rank	Challenge	Number of respondents				Total rating	Mean score
		1	2	3	4		
1.	Unreliability of data providers in sharing data	0	1	0	17	70	2.1
2.	Complexity of consolidating different data formats	1	0	3	14	66	1.9
3.	Availability of data gaps in the shared data	1	1	3	13	64	1.8
4.	Complexity of processes of data analysis	5	2	5	6	48	1.4
5	Complexity and unreliability of data collection tools	12	2	3	1	29	0.9

Source: (Research data, 2018)

From table 4.6 above, the findings shows that unreliability of data providers in sharing data is the leading challenge with a mean score of 2.1 This challenge gives a total rating of 70 and a mean score of 2.1 which is the highest compared to other listed challenges. Complexity of consolidating different data formats got a total rating of 66 and a mean score of 1.9 becoming the second rated challenge when using data analytics for measuring corridor performance. Availability of data gaps got a total rating of 64 (mean score=1.8) indicating it is ranked as the third challenge experienced. Complexity and unreliability of data collection tools and complexity of data analysis got total score ratings of 29 (mean of 0.9) and 48 (mean of 1.4) respectively making them to be the least challenges in the use of data analytics in measuring corridor performance.

4.7 Discussions of Findings

The discussions were guided by the study objectives as follows:

4.7.1 Effectiveness of systems data analytics in corridor performance (Objective 1)

In evaluating the effectiveness of using systems data analytics to measure corridor performance, findings indicate that most of the respondents at 79% endorsed the use of systems' data analytics in measuring corridor performance. As the findings indicate that most of the respondents in the study understand well the use of data analytics in measuring corridor performance, it implies that their opinion on the effectiveness of using data analytics is valid for consideration.

The findings therefore indicate that use of data analytics is the preferred and most effective way of measuring corridor performance. The findings conform with the findings of

Harrison et al (2006) which their findings indicated that data has a wide range of uses applicable to identifying the failures, successes, and needs of the logistics monitoring as it relates to performance.

As the decision theory provides a framework in which data can be used to make an informed decision, the research findings contribute to the theory in bringing out the areas of data analytics usage in transport corridor monitoring and decision making. As data scientist once stated that 'without data, you are just another person with an opinion', it proofs the need to have evidence based decision making. This validates the use of data in identifying bottlenecks in the transport corridor by use of factual data. The findings affirm the need for stakeholders in transport corridor to invest more in systems integration to facilitate data sharing for use in measuring corridor performance.

4.7.2 Effectiveness of the Transport Observatory tool

The findings revealed that there is significant improvement of the corridor performance since the adoption of the transport observatory. The findings reported that corridor performance efficiency in 2013 was 106.76 which is the mean of the three performance indicators whereas the corridor performance efficiency in 2017 was 49.47. The two mean averages indicate that there have been great improvement in the corridor performance efficiency since the inception of transport observatory as a corridor performance monitoring tool in the year 2013. Even though there might be other factors which might have contributed towards improvement of the corridor performance, the transport observatory tool played a major role by analysing and informing policy makers of various areas of intervention needed to improve corridor efficiency. Effectiveness of every invention is based on the results experienced (Kunaka et al 2014).

These findings on the effectiveness of transport observatory in measuring corridor performance support the findings (Sirali, 2014) on the use of GPS data to measure corridor performance where the researcher reported that there is a need of investing in various technologies and tools that help to reveal bottlenecks along transport corridor for intervention by policy makers.

However, the findings indicates that there still some areas of improvement which can make the transport observatory tool more efficient. This conforms to the Contingency Theory which states that there is no specific way which can be regarded as the best of all the ways in solving a problem or to guide in decision making. Each of the specific method chosen by the firm is not necessarily the most effective of all the available options (Galbraith, 1973). This means that even though the transport observatory is effective as per the findings, there is still always other ways of improving the tool to be more efficient. With these findings, it provide a platform towards enhancing the transport observatory as the most effective and reliable tool for measuring corridor performance. The findings can guide in further evaluation of the transport observatory and invest more towards enhancing on its performance and make it more effective.

4.7.3 Challenges of using data analytics for measuring performance

The findings show that there are challenges to do with the data structure and the reliability of data providers in availing the data. Inconsistency of data provided by different services providers and data gaps makes it challenging when linking the data to monitor processes across the corridor. Data gaps in the use of data analytics for performance measurement are not a new phenomenon and always expected (Little et al (2002)). Any gap in connecting data makes it impossible to link and in some cases calls for integration of various systems.

The lack of an integration of the different data sources contributes a lot to the data gaps and complexities in transformation of the data.

On the open ended questions, most of the respondents indicated that major challenge is associated with the dissemination of findings to relevant policy makers and stakeholders who are responsible for implementations of the recommendations. Inefficiency on dissemination tools and lack of awareness are the most mentioned challenges by the respondents. In today's Information age, increasing importance is placed on information dissemination (Corbin, 2002). These calls for a need to invest more on information dissemination to ensure efficient tools are put in place for dissemination. Most of the stakeholders have no access to reports and findings from the transport observatory and there is a need for awareness and sensitization. Also, outstanding challenges emanating from other users of the transport observatory relates to usability of the online tools. All these challenges were generally viewed as major setbacks towards enhancing and making the transport observatory to be more efficient tool.

CHAPTER FIVE: SUMMARY, CONCLUSION & RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the research study, the discussions of the findings and conclusions. Also to be presented are the limitations encountered in the study and the recommendations.

5.2 Summary of Findings

The main purpose of undertaking this study was to establish the effectiveness of using inter-organizations data analytics in measuring corridor performance as well as evaluating the perceived effectiveness of the transport observatory tool adopted by northern corridor in measuring corridor performance. The researcher administered questionnaires targeting 56 respondents but managed to obtain 34 completed questionnaires representing 60.7% response rate. The questionnaire contained questions that addressed the objectives of the study. The researcher sought the opinion of the stakeholders of the northern corridor on the effectiveness of the transport observatory adopted by NCTTCA as well as effectiveness of systems' data analytics obtained from different data providers. The study focused on the adopted transport observatory of the northern corridor as the case study. The research was guided by the following specific objectives; to establish perceived effectiveness of information systems data in measuring corridor performance; the effectiveness of the adopted Transport Observatory tool in measuring corridor performance; the challenges associated with the use of technology data within NCTTCA Transport Observatory and possible are of improvement in the use of technology to monitor performance.

The findings indicate that most of the respondents consider the use of data analytics to be among the effective ways of measuring corridor performance. From the findings, most of the respondents understood well how transport observatory works as well as how data analytics are utilized in measuring corridor performance. This means their perceived effectiveness of using data analytics to measure corridor performance is well informed and worth considering. However, the respondents informed of the challenges to do with gathering and processing of data analytics. The findings indicated that as far as use of data analytics is effective, there are challenges to do with data sharing, processing of data and data gaps from the data collected. This implies that there still exist areas of improvement in addressing the challenges of handling data to make the use of data analytics more effective.

The use of transport observatory adopted by NCTTCA for measuring corridor performance was evaluated to be quite effective. From the findings from the data obtained from the transport observatory, it is evident that there has been great improvement on the corridor performance since the inception of the transport observatory for measuring corridor performance. It is worth noting that the use of transport observatory is not the only factor which contributed to improved corridor performance. There exist other factors which contribute to the performance of the transport corridor. However, transport observatory played a major as it enables policy makers to identify bottle-necks and areas of intervention towards making corridor to be more efficient.

Effectiveness of the transport observatory and the use of data analytics in measuring corridor performance also got challenges. From the findings, various challenges and setbacks were identified which needs to be addressed in order to enhanced the effectiveness in measuring corridor performance. Most of the challenges from the findings include inefficiency of developed dissemination tools, lack of awareness by corridor stakeholders as well as technical challenges on handling of data analytics.

5.3 Conclusion

According to objective one which aimed to establish perceived effectiveness of information systems data analytics in measuring corridor performance, it is safe to conclude that operational systems' data analytics forms the best component needed to measure corridor performance. Operational systems used to automate processes generate a lot of data which can be utilized to measure corridor performance by generating information for decision makers and policy makers. Use of data analytics for informed decision making is growing drastically and has proofed to be the best way for decision makers to get informed of what is happening. It is evident from the findings that most of the respondents believe that the use of systems' data is the best way to measure performance. However, with the use of systems' data from different organization's systems, there exist a lot of challenges which makes it uphill tasks to access the crucial data. Different organizations use different technologies in automating their processes. This leads to difficulties in merging different data obtained from these different technologies for common purpose. Also, with the varied technologies adopted by different stakeholders, it brings in challenges of transforming data and sharing.   Other challenges identified are more of unfounded resistance by the data owners in sharing the data. Most of the data providers are hesitant in sharing the data with the fear that it will expose the inefficiencies within their organization as well as can leak more crucial information. These challenges call for more stakeholder engagement and sensitization as well the need to integrate systems to facilitate data sharing processes.

In terms of effectiveness of the transport observatory as a monitoring tool, the findings indicate that the tool is most effective in measuring corridor performance. However, challenges have been noted from the way online tools are designed to disseminate the findings for use by policy makers, stakeholders and other people with interest with the performance of the corridor.

Most of the respondents indicated that level of dissemination of the findings is very low and a lot need to be done. Information and findings can be useless if not disseminated well to relevant people for use.

5.4 Recommendations of the study

In an effort to improve on the effectiveness of using systems data analytics for measuring performance, it requires adoption of new technologies that allows integration of data. Integrating systems from different organization will make it easy to get consolidated data that covers all operations along the corridor as well as will address the issues of data gaps and inconsistencies of data collected.

Also, to enhance the usefulness of the tool, there is a need to design user friendly, highly optimized online tools that assist in disseminating findings and information from the transport observatory. With an effective means of dissemination, all relevant stakeholders will be informed and get updated with all the bottlenecks along the corridor and be able to take necessary actions. Making use of seminars, workshops, social media and other means can ensure information is disseminated widely.

5.5 Limitations of the Study

The researcher encountered a number of limitations that posed challenges towards accessing information sought by the study. The respondents were reluctant in giving Information as they didn't see the importance of the research. The researcher handled the problem by talking on one on one with the respondents to clarify the need for the questions asked.

Geographical location of respondents was another major challenge. Most of the respondents are located in different places and was quite difficult in accessing them. The researcher used

online technological tools to send questionnaires and receive answers from the respondents. This was followed by phone calls for those respondents who could not be reached physically.

5.6 Suggestions for further research

The research aimed at establishing the effectiveness of using systems' data analytics from different organizations in measuring corridor performance as well as evaluating the effectiveness of the adopted transport observatory of northern corridor. The research also looked into the challenges of using inter-organization systems' data analytics and ways of addressing. From the findings of the research, raw data from the automated processes are resourceful in measuring performance. There is need to undertake more research in the usage of integrating systems and using single source of data for monitoring performance. There is also need to do research on the level of automation of processes along transport corridors. The findings of research on level of automation of processes can help in enhancing performance measurement by looking into integration of systems and addressing the data gaps which come as a result of lack of automation of some processes.

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APPENDICES

Appendix 1: Introduction Letter

Dear Respondent,

I am a postgraduate student pursuing my Master's Degree in Business Administration, University of Nairobi. I am currently doing research titled, **Use of Inter-organizations systems' data analytics in measuring corridor performance: A case study of Northern Corridor Transport Observatory.**

In this regard, you have been selected to take part in this study as a respondent. Please answer all the questions freely. The data collected will be used for this research only.

Your cooperation in completing this exercise will be highly appreciated.

Yours Sincerely,

Noah Kipyegon

Appendix 2: Questionnaire

<u>Answer all questions appropriately</u>

Name: ………………….. Organization: ………………………..

Part I: <u>GENERAL QUESTIONS (FOR ALL RESPONDENTS)</u>

1. How many years have you worked with your organization?

    Less than 1 year

    1-2 years

    3-5 years

    Over 5 years

2. How often do you interact with Operational information systems?

    Daily

    Weekly

    Rarely

    Never

3. What is your level of understanding of the transport Observatory as a Monitoring tool?

    HIGH [ ]   MODERATE [ ]   LOW [ ]

4. In your Opinion, do you think the use of inter-organizations systems' data in measuring corridor performance is effective?

    YES [ ]   MODERATE [ ]   NO [ ]

Comments: _____

_____

5. Do you participate in the process of extracting data for use in measuring corridor efficiency?

ALWAYS [ ]   SOMETIMES [ ]   NEVER [ ]

6. What are the challenges faced when using transport Observatory?

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. What are the recommended approaches towards addressing the challenges?

1. _____

2. _____

3. _____

4. _____

5. _____

Part 2: For NCTTCA officers ONLY.

1. Does the data provided by data providers usually match the requirements?

   ALWAYS [ ]   SOMETIMES [ ]   NEVER [ ]

   Comments: _____

   _____

   _____

2. Does the systems data from different stakeholders adequate enough for measuring corridor efficiency?

   ALWAYS [ ]   SOMETIMES [ ] NEVER [ ]

   Comments: _____

   _____

   _____

3. In your Opinion, do you think the use of inter-organizations systems' data analytics in measuring corridor performance is effective?

   YES [ ]   MODERATE [ ] NO [ ]

4. Do the data gaps exist in the collected data from stakeholders for measuring corridor efficiency?

   ALWAYS [ ]   SOMETIMES [ ]   NEVER [ ]

   Comments: _____

   _____

   _____

5. <u>Feedback on the effectiveness of the transport observatory as a tool</u>

Based on your experience in the use of transport observatory, Please use a tick (✓) to share your opinion on the effectiveness of the following components which defines the transport observatory.

Use a 5-point rating scale that ranges from: (1-5) Where the higher the number, the higher the level of approval of the specific component that defines the effectiveness of the tool

	component	Scale (1=low 5=high)				
		1	2	3	4	5
1.	defined data requirements for use in the transport Observatory are clearly defined					
2	The data sources are reliable in accessing data					
3	Data collection tools are reliable					
4	Defined processes of analysis are accurate					
5	Online tools of data dissemination are efficient					
6	Generated information for decision making are easily accessible					
7	Findings of the data in measuring efficiency are realistic					

6. <u>Challenges in the transport observatory tool and the data</u>

Please use a tick (✓) to establish the challenges of Transport Observatory and the use of systems data in measuring corridor efficiency.

	challenge	Strongly Disagree	Moderately Agree	Agree	Highly Agree
1.	Complexity of consolidating different data formats				
2	Unreliability of data providers in sharing data				
3	Complexity and unreliability of data collection tools				
5	Availability of data gaps in the shared data				
6	Complexity of processes of data analysis				

7. What are the recommended approaches towards addressing the challenges?

   1. _____

   2. _____

   3. _____

   4. _____

   5. _____

Part 4: Secondary data collection sheet

Kindly share the data as per the sheet below

Month/Year	Performance indicator Annual values		
	Clearance time (Hours)	**Transit time (Hours)**	**Delay Time (Hours)**
2013			
2014			
2015			
2016			
2017			