International Journal of Business and Management Invention (IJBMI)
ISSN (Online): 2319 – 8028, ISSN (Print): 2319 – 801X
www.ijbmi.org || Volume 14 Issue 9 || September, 2025 || PP—12-17

The Digital Edge in Sugar Supply: Examining Electronic Inventory Management at Kibos Sugar

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ABSTRACT: *Western Kenya is the largest producer of sugar in Kenya, supporting about 170,000 smallholders farming households and contributing about 80 percent of the total sugar produced in Kenya. This contribution is however threatened given that the sugar firms in that region are producing sub optimally. In recent years, sugar production has declined from about 635,700 tonnes in 2018 to 491,100 tonnes in 2023 of milled sugar. Meanwhile, sugar imports have been increasing. The annual domestic demand is over 900,000 tonnes, meaning the country is a net importer of sugar. Empirical evidence on Inventory Management Practices focused on other sectors of the economy and ignored important elements such as Electronic Inventory Management System. Some reviewed studies show weak relationship between Inventory Management Practices and Supply Chain Performance. The current study sought to investigate the role of Electronic Inventory Management Practices on Supply Chain Performance of Kibos Sugar Company Limited. Data were analyzed through thematic analysis and computer assisted qualitative data analysis software, NVivo 10, was used to aid in the data management and analysis process. Findings revealed that Electronic Inventory Management System have positive influence on Supply Chain Performance. It is hoped that the study will be useful to the academia, SDMFs and inform policies by the government.*

KEY WORD*: Electronic Inventory, Kenya, Kibos Sugar*

Date of Submission: 08-09-2025 Date of acceptance: 19-09-2025

I. INTRODUCTION AND LITERATURE REVIEW

The sugar industry in Kenya plays a significant role in the national economy by creating jobs and income opportunities in rural areas (Were *et al.,* 2015). However, fluctuations in global sugar prices and volatile domestic demand have put pressure on local firms' profitability in recent years (KNBS, 2018). Statistics indicated that average inventory holding periods across Kenyan sugar processing companies exceed internationally recommended levels by over 30%, translating to unnecessary capital tied up and higher overall inventory carrying costs (KNBS, 2021). Inefficiencies in inventory management negatively impact social welfare and economic livelihoods. Prolonged stockouts can disrupt rural farmers' cashflows when unable to deliver cane on time, creating financial distress (Muriithi, 2017). Rising inventory levels increase production overhead costs passed on to consumers through higher sugar prices, reducing affordability. This constrains household spending power at a time of rising living expenses. Furthermore, limited competitiveness frustrates government goals to attract private sector investment in agriculture and boost farming communities' standards of living through higher cane yields and purchasing prices .

Electronic Inventory Management Systems (EIMS**)** directly impacts supply chain performance by improving inventory visibility, accuracy, and decision-making. It utilizes advanced technology (e.g., barcoding, RFID to monitor stock levels, forecast demand, and automate replenishment processes.

The role of Electronic Inventory Management System on Supply Chain Performance has not been overlooked globally. Kurdia, Alzoubib, Akourc and Alshuridehd (2022) carried out a study on the effect of block chain and smart inventory system on supply chain performance: Empirical evidence from retail industry in the United Arab Emirates (UAE). Supply chain performance was assessed based on factors such as inventory turnover rate, shipping schedules, and transactional duration. These indicators helped companies design and operate cost-effective supply chain management systems and keep an eye on every activity. Regionally, Michael, Adekunle and Adeboye (2019) carried out an Assessment of Electronic Inventory Management Systems and Utilization in the Healthcare System in Abuja, FCT Nigeria. Three hypotheses were formulated and guided the analysis of the assessment. A cross-sectional questionnaire-based study design was adopted and the study was focused on a population of about 122 hospitals in Abuja FCT Nigeria. Data collected was analyzed by Sigma XL software and

statistical significance at $P < 0.05$. A total of 98 hospitals were surveyed and 84 responded (91% response rate). Majority were private hospitals 68 (81%). The implementation and utilization of partially electronic inventory system in which some manual register/card exist (39, 46%). Chi-square test revealed that factors such as age, variety of services and type of hospital did not influence the implementation of EIMS, but indicate that a significant ($P < 0.00$), proportion (37, 78%) of the hospital implementing EIMS are using software developed and managed by Nigerians.

Studies on Electronic Inventory Management and Supply Chain Management have also been carried out in Kenya in different contexts. Mukoya and Achuora (2019) established the influence of E-inventory Management Systems on the Performance of Supermarkets in Nairobi County, Kenya. Specifically, the study sought to examine the effect of electronic data interchange, electronic point of sale, bar coding and radio frequency identification on performance of supermarkets in Nairobi County. The study was grounded on the Resource Based View theory. A descriptive cross-sectional survey research design was employed and stratify random sampling approach was used to ensure representativeness of the population of the study. The target population was 158 supermarkets in Nairobi County and the study sample size was 113 supermarkets. A structured questionnaire was used to collect primary data and was administered to the heads of supply chain management in the respective firms through the drop-and-pick later method. Descriptive statistics and multiple regression equation were applied to analyze quantitative data with the help of Statistical package for social science (version 21.0). The study established a positive significant relationship between E-inventory Management Systems and Performance of Supermarkets. The study therefore concluded that E-inventory Systems significantly improve performance of supermarkets. Consequently, the study recommended that supermarkets in Kenya should implement E-inventory Management Systems in order to improve their performance through reduction of operation costs and improved inventory control.

Further, the government should give tax rebate on IT infrastructure related to E-inventory Management Systems to encourage up take of the systems by firms as a way of boosting their performance and growth. Major gap of the study was that it relied on quantitative data collection and analysis techniques hence respondents' opinions and views were restricted to what was in the questionnaire. Current study overcame this gap by using interviews to collect data thus in-depth rich information was obtained as respondents had the opportunity to express their views and opinions just as how they experienced in their work environment.

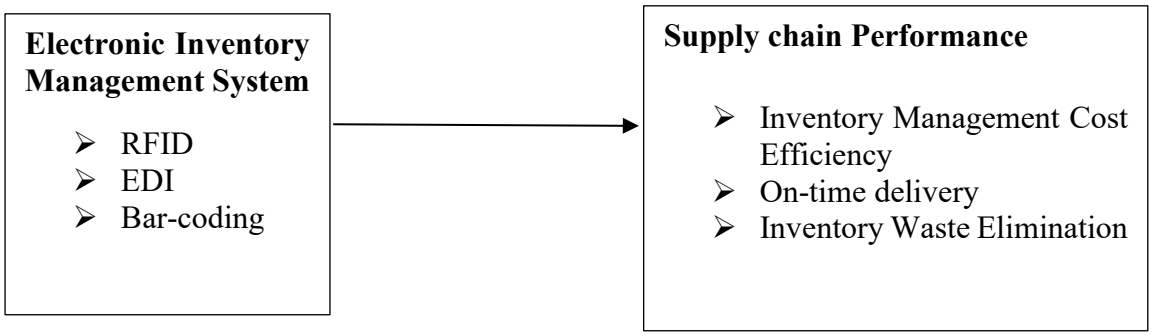

Figure 1: Conceptual Framework on the role of Inventory management Practices on Supply
Source: (Adapted from Mekonnen & Mulugeta, 2019)

1.2 Research Objectives

The objective of the research is to establish how Electronic Inventory Management System shapes supply chain performance at Kibos Sugar Company Limited and Allied Industries in Kisumu County?

1.3 Research Methodology and Data Analysis

In order to observe the factors that affect the inflow of FDI of the country, the researcher employed a qualitative descriptive research design to gather data on the habits, opinions, and attitudes of individuals within a population sharing similar characteristics. The study was conducted within Kisumu County in Western Kenya, which serves as the contextual boundary for the research.

Target Population & Sample: The target populations of the study were senior managers and employees from five key departments in Kibos Sugar Company Limited that were directly involved, responsible and affected by inventory management practices of the company. These key departments were Supply Chain, Quality, Production, Finance and Marketing departments. The sample frame for this study was the entire list of staff as listed in the Kibos Sugar Company Limited Human Resource List (2023). 20 participants formed the sample size as

determined by saturation and as supported by Morgan et al. (2016) who conducted a pioneer methodological study using data collected on environmental risks.

Data collection: An interview schedule, (see Appendix II) was used to collect data from senior managers and three officers from each of the 5 departments: Supply Chain, Safety and Environment, Production, Finance and Marketing within Kibos Sugar Company Limited. Once approval was given from NACOSTI, the researcher obtained telephone numbers of all the sampled employees of Kibos Sugar Company Limited as listed in the Kibos Sugar Company Limited Human Resource List (2023) directly by visiting the company and requested for contact details as well as made the first contact. Thereafter, the researcher sought for the email addresses and telephone numbers of the target Participants to request permission to post an introduction letter to potential participants' e-mail addresses. An invitation letter to take part in the interview was sent via e-mail to each potential participant. An informed consent form was required for each participant prior to participating. Once the consent form was received from the participants, approximately one week before the scheduled interview the researcher sent an interview schedule/guide to each individual participants' e-mail address to allow the participants familiarize themselves with the questions.

Face-to-face interviews were carried out with the senior managers and three officers from each of the 5 departments (i.e. Supply Chain, Safety and Environment, Production, Finance and Marketing) within Kibos Sugar Company Limited. Busseto et al. (2020) shows that interview the best form of data collection when one desires to minimize non-response. First, each participant was asked to tell his/her understanding of Inventory Management Practices. In the preceding part of the interview protocol, the participants were asked to describe how Electronic Inventory Management Systems, Lean Inventory Management System and Strategic Supplier Partnership impact Supply Chain Performance. Finally, participants were asked to describe how Inventory Management Practices impact Supply Chain Performance. The use of narrative interview approach was particularly adopted to evoke new and much exhaustive insights from the participants.

Data Analysis: Thematic analysis approach was employed. Thematic analysis allows for exploration and discovery of patterns within qualitative data through coding techniques aided by computer software (Dawadi, 2020). An inductive analysis process was followed to ensure themes strongly linked to the actual data emerged without preconceived expectations.

Analysis occurred in three phases. First, interview transcripts were reviewed several times, searching for "recurring regularities" . The researcher highlighted quotes and phrases from the interviews that were significant to the study.

The process of analyzing, reanalyzing, and comparing new data to existing data is known as constant comparison As each phase of coding begun, it was important to continue reviewing the data in previous phases so that connections were constantly made until saturation occurred. Using the constant comparative method (Pathan, 2020), the researcher went back and forth among transcripts until categories emerged that were consistent, yet distinct. The researcher named these categories, coded the transcripts and placed sections in labeled folders representing each category.

Coding of transcripts was completed in the order of the interviews conducted, in batches of four at a time, allowing the researcher to reflect and edit the interview questions as themes begun to emerge from the data. Coding was used to aid the researcher in understanding the perspectives of the participants and in analyzing their combined experiences. Codes were created during the research process, based on the data, for the purposes of analyzing the data (Pathan, 2020). Coding was conducted both manually and using computer assisted qualitative data analysis software (NVivo). Coding the transcriptions, or breaking them down into meaningful and manageable chunks of data, is a critical part of the data analysis. Coding was instrumental in focusing the interview analysis on the experience of the participants in a structured way. Coding helped to prevent the interviewer from overemphasizing the importance of any one aspect early in the study and it helped in ensuring a thorough analysis of the entire interview (Charmaz, 2020). Coding terminology used for this dissertation was adopted from Pathan (2020) who termed the three phases of coding as open, selective, and theoretical.

Open coding is the phase when each line of transcribed interview text is coded line by line (Pathan, 2020). Line-by-line coding is a critical part of grounded theory methods (Charmaz, 2020; Makri & Neely, 2021). It is what its name reflects, where coding each line of the transcribed interviews by using a few words to describe the data, as suggested by Charmaz (2020), Makri & Neely, (2021) and Pathan (2020). This method of coding helped the researcher to focus in-depth on every interview. This method also helped to instill the discipline of grounded theory where the theory emerges from the data itself. Coding line by line in open coding typically results in many codes (Charmaz, 2020; Makri & Neely, 2021).

Selective coding begins to occur when there are no new open codes, or when codes relate only to the core categories that begin to emerge (Pathan, 2020). In general, the terms categories and constructs are interchangeable across the grounded theory methods (Makri & Neely, 2021; Pathan, 2020). Some selective codes may emerge more often than others. Sometimes a single selective code becomes a prominent theme, or a theoretical code

(Makri & Neely, 2021; Pathan, 2020). In selective coding, the researcher strives to find categories emerging, but will hopefully not have as many selective codes as open codes. Pathan (2020) suggested revisiting the selective code categories if too many selective codes emerged from the original coding. Reinforcing that coding is an iterative process, Pathan (2020) suggested that the researcher review selective codes to see if selective code names best represent the open codes or selective codes identified. Pathan (2020) also suggested that looking at the selective code attributes and potential relationships can help the researcher distinguish between open, selective, and theoretical codes.

Division among grounded theorists exists regarding when exactly thematic sampling begins. Charmaz (2020) asserted that thematic sampling begins after categories emerge. Makri & Neely, (2021) argued that thematic sampling can begin during open coding, as the initial data starts to reveal concepts that begin to signal potential themes. Thematic coding occurs when the codes and categories that will emerge during open coding and selective coding are compared, and relationships are found between the codes or categories (Pathan, 2020). The themes emerge from these relationships. All of the coding is iterative. New codes should be constantly compared to existing data to determine if new categories emerge and whether or not these new categories are densifying. Memos are important to the thematic coding process and were included in constant comparative analysis.

Second, the researcher brought together the coded interviews and field notes and looked for relationships within and across the data sources. A table was developed to compare various coded interviews. As tentative categories emerged, the researcher tested them against the data. Finally, the researcher integrated and refined the categories until themes solidified.

A computer assisted qualitative data analysis software, NVivo 10, was used to aid in the data management and analysis process. The software was also used to query key words for comparison with manually coded categories and themes. NVivo 10 was not used as a primary coding source and was only used in the context of solidifying data analysis. The research process was led by the researcher, not by supporting software (Charmaz, 2020). Software was useful as a repository and for sorting through data (Charmaz, 2020).

The Inventory Management Practices and Supply Chain Performance model in Figure 4.1 shows how Electronic Inventory Management, improves Supply Chain Performance of Kibos Sugar Company Limited. The data structure in figure 4.1 was generated from the NVivo 10 software. It is divided into first-order categories (raw data themes), second order themes (higher order themes) and aggregate dimensions. First order categories (or in-vivo codes) were derived from the interview transcripts. The second order themes were generated by looking for patterns and explanations in the codes from the twenty different transcripts. Finally, based on all the second order themes generated, a third order category (aggregate dimensions) was developed. During this process, the influence of Electronic Inventory Management was generated from the data as presented in Figure 4.1.

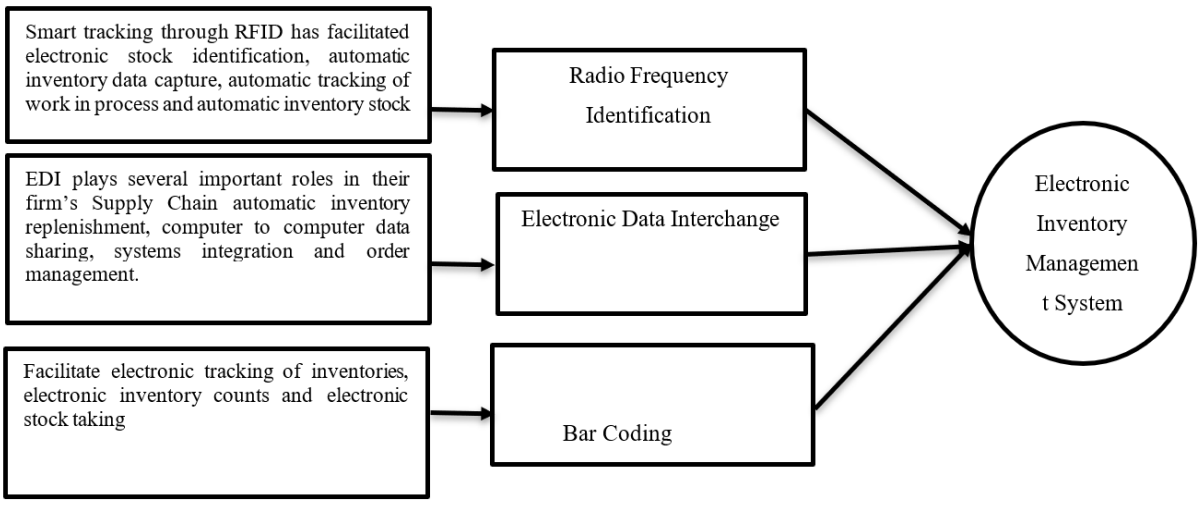

Figure 2: Data Structure

1.4 Findings and Interpretation

Electronic Inventory Management

The first objective of the study was to investigate the role of Electronic Inventory Management on Supply Chain Performance of Kibos Sugar Company Limited. To do this, Electronic Inventory Management practices generated from the data structure in figure 4.1 was used to explain the role of Electronic Inventory Management on Supply Chain Performance of Kibos Sugar Company Limited as explained below. This analysis suggests that Kibos Sugar Company Limited implemented Radio Frequency Identification, Electronic Data Interchange and Bar Coding as the Electronic Inventory Management practices.

When responding to the question on how has your firm implemented Radio Frequency Identification (RFID), all the participants expressed the same view that their firm has implemented passive RFID tags and the RFID tags are read via radio frequencies and therefore it is not mandatory to place the items in a particular position to read it, and this can overcome the problems in manual sorting and picking. Participants also confirmed that smart tracking through RFID has facilitated electronic stock identification, automatic inventory data capture, automatic tracking of work in process and automatic inventory stock and this has been paramount in ensuring maintenance of optimal levels of inventory as noted by P13, P17 and P19.

"*The speed and ease of RFID scanning has enabled us to check inventory levels more frequently, which supports more accurate inventory counts and has provided us continuous location information about our products in the supply chain*". P13

"*With the RFID system, it eases the sorting and picking operations, as it capture real time, accurate information about the items availability in host computer database without physical movement*". P17

"*Due to tracking limitations of conventional systems our firm was not able to get accurate information on actual sales of items; this amplified the magnitude of the bullwhip narrative shift. With the implementation of RFID technology, accurate and real time information on product sale are always captured and used for decision making thus, our firm has been able to reduce the Bullwhip narrative shift*". P19

Participants confirmed that Electronic Data Interchange helped their firm to reduce lead time, save documentation processing costs, eliminate procurement errors, clarify inventory status information and enhance strategic alliances throughout the supply chain. In a broader perspective, EDI plays several important roles in their firm's supply chain management which include: automatic inventory replenishment, computer to computer data sharing, systems integration and order management. Participants had this to say

"*EDI has helped our firm to save time and money by reducing transaction processing and data entry costs while gaining faster access to information*". P2

"*EDI has significantly reduced the human element in my department's communication while improving both speed and accuracy of data flow*". P15

"*As a department responsible for inventory management, EDI has help us lower inventory costs by reducing the time raw materials spend in inventory and reduced both lead times and inventory levels*". P20

Participants also confirmed that Bar Coding facilitated electronic tracking of inventories, electronic inventory counts and electronic stock taking. Participants gave their streams of thought on how Bar Coding helped their firm to reduce losses due to theft or errors by providing a means of tracking inventory as well as an audit trail for identifying stolen items. One participant specifically pointed out that Bar Coding at the point of sale has been a good experience for their department as it provides an accurate record of what has been sold and when. The participant further explained how such information is used to reconcile inventory levels, help prevent stock-outs and revenue loss. In addition Bar Coding helped their firm to track individual items as they move through the supply chain, making it easier to identify where errors or losses occur. The participant also mentioned that as a result of this visibility into these areas, their firm was able to take steps to correct problems and improve efficiency oy heir supply chain operations. Participants had these to say regarding Bar Coding

"*To start off, we deal with big retailers in this region and I can attest our firm has gone beyond their expectations in order fulfillment as a result of error-free deliveries since Bar Coding has made it possible to assign items to orders*". P11

"*It's interesting to note how Bar Coding enables our firm to improve customer satisfaction by tracking inventory levels better and identify opportunities for improving efficiency and reducing costs. Take this case in point, our Bar Code system can detect an item is out of stock at location A, but plenty of units are still available at location*

B. as a result, we can transfer these extra units to location A so that we can use to fulfill customer orders, thereby reducing the chances of delays or disruptions in service". P1
"*I can't remember when my department last experienced stock outs or any disruptions that can negatively impact customer satisfaction as we use the data collected in our barcode systems to track customer behaviour trends to adjust our operations accordingly*". P10

Going by the Participants sentiments, it is clear that Electronic Inventory Management is an integral Inventory Management practice. A number of studies (Michael & Achuora, 2019; Michael, Adekunle & Adeboye, 2019 and Kurdia et al., 2022) have argued that Electronic Inventory Management leads to improvement of Supply Chain Performance of firms. This study postulation was grounded on such studies within the resource-based view theory. The study findings indicate that Kibos Sugar Company Limited embraced Radio Frequency Identification, Electronic Data Interchange and Bar Coding as Electronic Inventory Management Practices within its operations and as a result experienced improvement in its Supply Chain Performance. The findings of this study strongly agree with resource-based view theorists (Peteraf, 2015; Wade & Hulland, 2010; Fahy, 2002) which theorized a positive and significant relationship between Electronic Inventory Management Practices and Supply Chain Performance and advance Electronic Inventory Management Practices as unique resources capable of giving a firm competitive advantage and Supply Chain Performance.

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