
Data Integration Digitalization and Performance of Container Freight Stations in Kenya: An Explanatory Sequential Mixed Methods Approach

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Abstract

Despite their critical role in decongesting ports and facilitating cargo movement, Container Freight Stations (CFSs) in Kenya continue to face operational challenges, including congestion, inefficiencies, and high operational costs, which undermine their overall performance. In response to these challenges, this research investigated the influence of data integration Digitalization on the performance of Container Freight Stations (CFSs) in Kenya. The research focused on three sub-constructs of data integration Digitalization, including data mining, data analytics, and data-driven decision-making. Further, the performance of CFSs was measured in terms of revenue growth, operational efficiency, and customer satisfaction. An explanatory sequential mixed methods approach was employed, combining both positivist and interpretivist frameworks. Quantitative data was obtained from 136 functional managers across 34 CFSs through structured questionnaires, while qualitative data was collected via interviews with 13 CFSs operators. The study adopted descriptive statistics, correlation analysis and multiple regression to analyse quantitative data facilitated by the Statistical Package for Social Sciences version 25. Further, thematic analysis facilitated by ATLAS.ti was adopted to analyse qualitative data. Data mining was a strong predictor of customer satisfaction among CFSs in Kenya. Data analytics was the most influential driver of revenue growth and operational efficiency among CFSs in Kenya. Although data-driven decision-making exhibited comparatively smaller coefficients, it had a significant contribution across all performance dimensions. Qualitative themes further illustrated that data functions as a strategic asset for profitability, human resource planning, and promoting a culture of continuous improvement. The study concludes that data integration Digitalization, comprising data mining, analytics, and data-driven decision-making, is crucial for enhancing the performance of CFSs in Kenya. The CFS operators should develop standardised, interoperable data frameworks. Further, Kenya Ports Authority should create digital data integration standards to eliminate data silos and improve real-time information sharing within the logistics ecosystem.

Keywords: Data integration Digitalization, Data mining, Data-driven decision making, Data analytics, Performance of Container Freight Stations

Introduction

The logistics industry operates in a highly dynamic environment characterised by intense competition, changing customer preferences, rapid technological advancement, and evolving government regulations, all of which significantly influence organisational performance (Othman et al., 2022). In the context of Container Freight Stations (CFSs), performance is reflected through operational efficiency, profitability, turnaround time, customer satisfaction, and cost-effectiveness (Gituma, 2019). However, globally and regionally, container terminals continue to experience major operational challenges such as congestion, long container dwell times, inefficient cargo handling processes, delays in truck turnaround, and limited operational capacity (Essel et al., 2022; Wibowo & Fransoo, 2023). These inefficiencies negatively affect the effectiveness of freight movement and reduce the competitiveness of logistics firms. In Kenya, the establishment of Container Freight Stations around the Port of Mombasa was intended to decongest the port and improve cargo handling efficiency (Kenya Ports Authority, 2022). Despite this intervention, CFSs continue to face operational inefficiencies, increasing competition, high operational costs, and reduced profitability due to changes in the operating environment and growing cargo volumes (Amiru & Aosa, 2019). One of the major technological approaches attracting global attention is data integration Digitalization. Data integration Digitalization involves combining data from multiple systems and operational sources to create a unified information system that enhances decision-making, coordination, visibility, and operational efficiency (Kartci et al., 2022). Globally, firms that have adopted integrated digital systems have reported improvement in productivity, operational coordination, quality control, and decision-making effectiveness (Nguyen et al., 2022; Petrasch & Petrasch, 2022). In container terminal operations, integrated digital platforms and terminal operating systems have enhanced information sharing, cargo tracking, operational planning, and resource utilisation (Koroleva et al., 2020). Similarly, business analytics capabilities arising from data integration have been associated with improved organisational performance and sustainable competitive advantage (Kristoffersen et al., 2021). Consequently, there is increasing pressure on CFS operators in Kenya to adopt technological innovations capable of improving operational efficiency and overall performance.

Although numerous studies have examined digital transformation and organisational performance globally, existing literature reveals significant conceptual, contextual, and methodological gaps regarding data integration Digitalization and performance among Container Freight Stations, particularly in Kenya. Conceptually, many previous studies concentrated on selected aspects of digital transformation such as automation, cargo tracking systems, or electronic customs systems while neglecting comprehensive examination of data integration Digitalization as an independent determinant of performance (Jobran & Kara, 2022; Murugi, 2022). Consequently, limited empirical evidence exists on how integrated digital data systems influence operational and organisational performance within CFS operations. Contextually, most studies on digital transformation and performance have been undertaken in developed economies such as Germany, the United States, China, and Spain (Schlegel & Kraus, 2021; Nicolás-Agustín et al., 2022; Qaffas et al., 2023). The operational environment, technological infrastructure, regulatory systems, and logistics ecosystems in these countries significantly differ from those in Kenya. Therefore, findings from such studies may not be directly generalizable to Kenyan Container Freight Stations. Furthermore, limited empirical studies have specifically focused on CFSs in Kenya despite their

critical role in cargo handling and port decongestion. Methodologically, most previous studies examining digital transformation and firm performance adopted approaches such as Structural Equation Modelling (SEM), Partial Least Squares (PLS), meta-analysis, and case study designs (Ghasemaghaei & Calic, 2020; Kristoffersen et al., 2021; Filom et al., 2022). Few studies have adopted survey-based approaches focusing specifically on Container Freight Stations. This methodological limitation creates a need for empirical studies capable of generating context-specific findings on the influence of data integration Digitalization on organisational performance in Kenyan CFSs.

To address these gaps, the present study seeks to examine the influence of data integration Digitalization on performance among Container Freight Stations in Kenya. The study focused on three sub-constructs of data integration Digitalization, including data mining, data analytics and data-driven decision making. Additionally, the performance of CFSs in Kenya was operationalized in terms of revenue growth, operational efficiency and customer satisfaction. The study is premised on the argument that integrating digital data systems within CFS operations can improve information flow, operational coordination, cargo visibility, decision-making efficiency, and service delivery, thereby enhancing overall performance. By focusing specifically on Kenyan CFSs, the study provides context-specific evidence on the role of data integration Digitalization in improving operational and organisational outcomes. The study further contributes to the literature by extending understanding of digital transformation within the logistics and freight handling sector in emerging economies. Additionally, the findings are expected to provide practical insights to CFS operators, policymakers, and logistics stakeholders on the importance of investing in integrated digital systems to enhance efficiency, competitiveness, and sustainable performance within Kenya's logistics sector. The study was thus guided by the following objectives:

1. To examine the effect of data mining on the performance of container freight stations in Kenya.
2. To analyse the effect of data analytics on the performance of container freight stations in Kenya.
3. To evaluate the effect of data-driven decision-making on the performance of container freight stations in Kenya.

Methodology

Research Philosophy and Design

The study was anchored in both positivist and interpretivist paradigms to enable a comprehensive examination of the influence of data integration Digitalization on performance among CFSs in Kenya. Positivism guided the quantitative strand by facilitating hypothesis testing and objective measurement of relationships among variables, while interpretivism supported the qualitative strand by enabling an in-depth understanding of managerial experiences and contextual interpretations of digital integration processes. The philosophical integration aligns with mixed methods logic, which emphasises the complementarity of numerical measurement and contextual meaning in explaining complex organisational phenomena (Creswell & Plano Clark, 2018). The study adopted an explanatory sequential mixed methods design, where quantitative data collection and analysis were conducted first, followed by qualitative inquiry to explain and elaborate on the

quantitative findings. This design was appropriate because it allowed statistical testing of relationships between data integration Digitalization and performance, and subsequently enriched the findings through qualitative insights from key informants. The sequential structure ensured that qualitative results provided contextual depth and explanation to the statistical patterns observed in the quantitative phase (Creswell & Plano Clark, 2018).

Target Population, Sampling and Data Collection

The target population comprised all 38 Container Freight Stations operating in Kenya. For the quantitative phase, five functional managers were purposively selected from each CFS, drawn from Operations, Information and Communications Technology (ICT), General Management, Human Resources, and Clearing and Forwarding departments. This yielded a total of 190 respondents ($38 \times 5 = 190$). For the qualitative phase, one key informant from each CFS, either the Facility Operator or Chief Executive Officer, was selected, resulting in 38 interview participants. This dual-level sampling ensured representation of both operational and strategic perspectives on data integration Digitalization, and performance. Primary data were collected using structured questionnaires for the quantitative component and interview schedules for the qualitative component. The questionnaires captured measurable indicators of data integration Digitalization and firm performance, while the interviews explored deeper insights on system integration, operational challenges, and perceived performance outcomes. This combination enabled triangulation of findings and improved the validity of results.

Pilot Study, Instrument Testing and Ethical Considerations

A pilot study was conducted in four randomly selected CFSs, which were excluded from the final analysis. The pilot involved 20 respondents and was used to assess the reliability and validity of the research instruments. Internal consistency was evaluated using Cronbach's alpha, with results showing strong reliability for all constructs: data mining (0.871), data analytics (0.960), data-driven decision making (0.950), revenue growth (0.879), operational efficiency (0.890), customer satisfaction (0.785). Construct validity was assessed using Average Variance Extracted (AVE), where all constructs recorded AVE values above 0.60, confirming adequate convergent validity. Ethical approval was obtained from the University International Social Research Ethics Committee (USIU), followed by authorisation from the National Commission for Science, Technology and Innovation. Informed consent was obtained from all respondents before participation, and participation was voluntary, with respondents retaining the right to withdraw at any stage without penalty. Confidentiality was strictly maintained through anonymization using codes, secure password-protected data storage, and restricted access limited to the principal investigator. Physical questionnaires were securely destroyed after completion and approval of the thesis.

Data Analysis

Quantitative data were coded and entered into the Statistical Package for Social Sciences (SPSS) version 25 for analysis. Descriptive statistics, including means, standard deviations, and percentages, were used to summarise the data. Before inferential analysis, diagnostic tests were conducted to ensure the robustness of regression models, including tests for normality, autocorrelation, homoscedasticity, multicollinearity, and linearity. Inferential analysis involved Pearson correlation and multiple linear regression analysis to examine the hypothesised

relationships in the objectives. The objectives were examined based on t-statistics and p-values, where significance was determined at $t > \pm 1.96$. The study thus estimated the models in equations 1-3.

$$Y_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon \quad (1)$$

$$Y_2 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon \quad (2)$$

$$Y_3 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon \quad (3)$$

Where Y_1 = revenue growth, Y_2 = operational efficiency, Y_3 customer satisfaction, X_1 = data mining, X_2 = data analytics, X_3 = data-driven decision making, β_0 = intercept term, β_1 - β_3 coefficients of data integration digitalization sub constructs, ε = error term. Qualitative data were analysed using thematic analysis. Interview recordings and field notes were transcribed verbatim, verified for accuracy, and reviewed repeatedly before open coding was conducted using ATLAS.ti software. Trustworthiness was enhanced through member checking, audit trails, and the use of verbatim quotations.

Results

The study issued 170 questionnaires to various management staff spread across 34 Container Freight Stations in Kenya, after 4 CFSs were excluded from the original 38 CFSs having participated in the pilot study. Of the number of questionnaires issued, 136 were received back, having been filled adequately for further analysis. The response translated to a response rate of 80%, which was considered adequate for further analysis. Nulty (2008) found that paper-based surveys had higher response rates (50–70%) compared to online surveys (20–30%). The study stressed that online surveys must be supplemented with strategies to boost participation (Nulty, 2008). Further, of the 34 facility operators targeted, 13 participated in the study after saturation was achieved. The analysis included preliminary tests, descriptive statistics, inferential statistics and qualitative analysis.

Descriptive Statistical Analysis

The descriptive analysis for data integration digitalization was based on a 5-point Likert Scale, where 1 was Not at All, 2 was Small Extent, 3 was Moderate Extent, 4 was Large Extent, and 5 was Very Large Extent. The responses were then analysed using percentages, mean and standard deviation. The study findings in Table 1 showed that 55.2 % of the respondents noted that to a large extent, their firms captured data about their customers and digital system users; thus, it was evident that most firms were collecting data from various sources. The mean response ($\mu = 3.8$) tended to a large extent with a standard deviation ($\sigma = 0.98$) around the mean. The finding implied that most of the CFSs operating in Kenya were collecting some form of data from various sources to a large extent. The study showed that 55.6% of the respondents noted to a large extent that their firms collected data from internal and external sources, such as sales records, social media, and market research. Further, the mean response score ($\mu = 3.7$) and standard deviation ($\sigma = 0.997$) tended to a large extent. Thus, the majority of CFSs operating in Kenya sourced data from sources such as customers, social media, and market research. The findings also showed that 60.3% of the respondents revealed that to a large extent, data captured in their organisations were stored in a suitable electronic database. Additionally, the mean response ($\mu = 3.7$) and standard deviation

($\sigma=0.946$) tended to a large extent, implying that the majority of CFSs in Kenya to a large extent stored sourced data in a suitable format for their purpose.

Table 1

Data Mining aspect of Data Integration Digitalization

Statements (n = 136)	Not at all (%)	Small Extent (%)	Moderate Extent (%)	Large Extent (%)	Very Large Extent (%)	μ	σ
The firm captures data about its customers and digital system users	0.0	5.9	39.0	19.9	35.3	3.8	0.98
The firm collects data from internal and external sources, such as sales records, social media, and market research.	.7	6.6	37.5	22.8	32.4	3.7	0.99
Data captured in the organisation is stored in a suitable electronic database	1.5	5.1	33.1	33.8	26.5	3.7	0.94
Data captured by the organisation is protected against unauthorised access	0.0	11.0	27.2	25.7	36.0	3.8	1.03
The firm has implemented digital data capture technologies	3.7	6.6	22.1	55.1	12.5	3.6	0.91
Data capture does not breach the data laws of the country	0.0	10.3	31.6	36.8	21.3	3.6	0.92
Data from multiple sources is combined to create a unified dataset for analysis.	.7	8.8	34.6	32.4	23.5	3.6	0.95
Overall mean score						3.76	0.96

μ = mean response, and σ = Standard deviation

The finding based on survey responses revealed that 61.7% of the respondents reported that to a large extent, data captured by the organisations were protected against unauthorised access. Additionally, the mean response ($\mu= 3.8$) and standard deviation ($\sigma = 1.031$) tended to a large extent; thus, it was clear that the CFSs undertook some effort to protect data in their possession from unauthorised access. Further, 67.6% of the respondents noted to a large extent that their firms had implemented digital data capture technologies. The mean response score ($\mu=3.6$) and standard deviation ($\sigma=0.91$) tended to a large extent; thus, it was evidence enough that various digital technologies were in use by the firms to source needed data as part of the data mining effort. The results also showed that 58.1% of the respondents in the survey reported to a large extent that the data captured does not breach the data laws of the country. The mean response score ($\mu =3.6$) and standard deviation ($\sigma= 0.923$) around it tended to large extent, thus CFSs were not in breach of the

Data Protection Act. Finally, 55.9% of the respondents noted to a large extent that data from multiple sources are combined to create a unified dataset for analysis. The mean response score ($\mu=3.6$) and a standard deviation ($\sigma=0.955$) around it tended to large extent, thus implying that CFSs in Kenya were unifying data from various sources for analysis.

The findings in Table 2 show that 58.1% of the respondents revealed that the data analysts of the firm undertake data cleaning to ensure data quality. The mean response score ($\mu=3.69$) and standard deviation ($\sigma=1.029$) tended to a large extent, implying that most CFSs were cleaning data collected before analysis. Further, 61% of respondents in the survey revealed that, to a large extent, the raw data is converted into a suitable format for analysis. The mean response and standard deviation ($\mu= 3.85$) and standard deviation ($\sigma=1$) tended to a large extent, thus CFSs converted data sourced into a suitable format to enable further analysis. The results showed that 59.5% of the respondents in the survey noted to a large extent that the data captured in the firms is analysed based on technologies such as advanced Excel and BI. The mean ($\mu= 3.86$) and standard deviation ($\sigma=1.034$) showed that most CFSs were using various technologies to a large extent to analyse data sourced. Additionally, 59.5% of the respondents in the survey revealed that to a large extent, the CFSs use data visualisation tools like Excel to explore trends and correlations in the data set. The mean response ($\mu=3.79$) and standard deviation ($\sigma= 1.057$) implied that to a large extent CFSs were using digital technologies to visualise data.' The finding revealed that 62.5% of the respondents in the survey noted that to a large extent, data captured is analysed and transformed into ready-to-use information for decision making. The mean ($\mu=3.78$) and standard deviation ($\sigma=1.052$) also tended to a large extent, thus most CFSs transformed the data in their possession into useful information suitable for various decisions. 'Further, 58.8% of the survey respondents revealed that to a large extent, the firms present data using dashboards, charts, and reports, with the remaining noting a moderate to small extent. The mean ($\mu=3.77$) and standard deviation ($\sigma=1.011$) showed that most CFSs presented data based on various visualisation technologies. Finally, 56.7% of the respondents noted that the data at the disposal of the firms are shared in real time with various stakeholders.

Table 2: Data Analytics aspect of Data Integration Digitalization

Statements (n = 136)	Not at all	Small Extent	Moderate Extent	Large Extent	Very Large Extent	μ	σ
	(%)	(%)	(%)	(%)	(%)		
The data analyst of the firm undertakes data cleaning to ensure data quality.	2.9	8.1	30.9	33.1	25.0	3.69	1.02
The raw data is converted into a suitable format for analysis	0.0	9.6	29.4	27.2	33.8	3.85	1.00
The data captured is analysed based on technologies such as advanced Excel and BI	1.5	6.6	32.4	23.5	36.0	3.86	1.034
The firm uses data visualisation tools like Excel to explore	2.9	6.6	30.9	27.9	31.6	3.79	1.0

trends and correlations in the data set.							
Data captured is analysed and transformed into ready-to-use information for decision-making	1.5	11.8	24.3	32.4	30.1	3.78	1.05
The firm presents data using dashboards, charts, and reports	1.5	8.1	31.6	29.4	29.4	3.77	1.01
The data at the disposal of the firm is shared in real time with various stakeholders.	2.9	15.4	25.0	32.4	24.3	3.6	1.10
Overall Mean score						3.76	1.04

μ = mean response, and σ = Standard deviation

The findings in Table 3 showed that 63.2% of the respondents revealed that to a large extent, the firm translates technical data into insights and actionable business recommendations. The mean ($\mu=3.76$) and standard deviation ($\sigma=0.991$) tended to a large extent, implying that most CFSs were translating the technical data into information useful for business decision making. The results revealed that 57.4% of the respondents in the survey revealed that to a large extent, which is disseminated to the management of the firm to support decision making. The mean ($\mu=3.73$) and standard deviation ($\sigma=1.057$) showed a large extent of use of ready information for decision making. Additionally, 55.9% of the study participants revealed that, to a large extent, the management often makes data-driven decisions. The mean responses ($\mu= 3.65$) and standard deviation ($\sigma=1.058$) showed a large extent of use of data to make management decisions.

Table 3: Data-Driven Decision-Making Aspect of Data Integration Digitalization

Statements (n = 136)	Not at all (%)	Small Extent (%)	Moderate Extent (%)	Large Extent (%)	Very Large Extent (%)	μ	σ
The firm translates technical data into actionable insights.	1.5	8.1	30.1	33.1	27.2	3.76	0.99
Ready-to-use information is disseminated to the management of the firm to support decision-making.	1.5	11.8	28.7	28.7	29.4	3.73	1.05
The management often makes data-driven decisions.	2.9	10.3	30.9	30.9	25.0	3.65	1.05
The firm has a senior employee in charge of data analytics	2.9	12.5	35.3	32.4	16.9	3.48	1.01

The firm uses data to understand market trends and consumer behaviour.	1.5	12.5	34.6	28.7	22.8	3.59	1.02
The insights and data are shared in real time with external organisations such as KRA and KPA	2.9	11.0	28.7	33.8	23.5	3.64	1.05
Data capture is processed in real-time or in batches for continuous decision-making.	.7	9.6	27.9	33.1	28.7	3.79	0.99
Overall mean score						3.66	1.02

μ = mean response, and σ = Standard deviation

The results showed that only 49.3% of the respondents revealed that the firms have senior employees in charge of data analytics, with the mean response score ($\mu=3.48$) and standard deviation ($\sigma=1.011$) tending to a moderate extent, CFSs had employed senior data analysts. 51.5% of study respondents reported that the firms use data to understand market trends and consumer behaviour, with the remaining noting otherwise. The mean response score and standard deviation ($\mu= 3.59$ and $\sigma=1.022$) showed that a slight majority of CFSs were using data to comprehend market trends and customer behaviour. Further, 57.3% of study respondents reported that to a great extent, the insights and data are shared in real time with external organisations such as KRA and KPA.' The mean and standard deviation ($\mu=3.64$ and $\sigma=1.052$) depicted a moderate majority of CFSs sharing data and insights in real time with various stakeholders. Finally, 61.8% of the respondents reported that to a large extent, data capture is processed in real-time or in batches for continuous decision-making. The mean response ($\mu=3.79$) and standard deviation ($\sigma=0.99$) showed that most CFSs were sharing data either in real time or in batches to support decision making.

The descriptive findings in Table 4 provide a detailed assessment of the performance of CFSs in Kenya, evaluated through three primary dimensions: revenue growth, operational efficiency, and customer satisfaction. Across a sample of 136 respondents ($n=136$), the performance indicators demonstrate a generally positive trend from 2021 to 2024, supported by an overall composite mean score of 3.66 and a standard deviation of 1.00, indicating a moderate level of consensus among the surveyed firms. The assertion that firm profits have risen consistently achieved the highest level of agreement within this sub-construct, yielding a mean score of 3.83 and a standard deviation of 0.98, with more than half of the respondents (55.9%) either agreeing or strongly agreeing. Similarly, non-demurrage revenues exhibited stable upward growth ($\mu= 3.71$, $\sigma = 0.93$), backed by a combined agreement of 55.1%. Demurrage fees collection also experienced a steady increase ($\mu= 3.65$, $\sigma = 0.97$), though it garnered slightly more moderate agreement (51.5%) compared to other revenue streams. Collectively, these metrics indicate that Kenyan CFSs have successfully expanded both their core operational and penalty-based revenue segments.

A significant proportion of firms managed to keep cargo clearance times below the 60-hour threshold recommended by the Kenya Ports Authority (KPA), resulting in a high mean score of 3.83 ($\sigma= 0.99$), with 65.5% of respondents confirming compliance. Furthermore, truck turnaround

times were reported to have decreased consistently ($\mu = 3.79$, $\sigma = 0.98$), while facility capacity utilisation remained robust, with firms operating above 70% of their design capacity ($\mu = 3.66$, $\sigma = 1.02$). Cost management efforts were also viewed favourably; 52.2% of the respondents agreed or strongly agreed that operational costs as a ratio of profits have been on a consistent decline ($\mu = 3.61$, $\sigma = 0.95$). However, the statement regarding a significant increase in contraband cargo incidences from 2021 to 2024 registered a mean score of 3.35 ($\sigma = 1.07$). Since 47.0% of respondents agreed or strongly agreed with this trend, it indicates that while logistical throughput has improved, risk management systems face growing pressure.

Firms demonstrated a strong capacity to retain their clientele, as evidenced by a decline in customer attrition ($\mu = 3.84$, $\sigma = 1.05$) and a parallel increase in repeated customers ($\mu = 3.76$, $\sigma = 1.05$). This retention is supported by an upward trajectory in formal customer satisfaction scores ($\mu = 3.77$, $\sigma = 1.05$) and notable gains in labour productivity ($\mu = 3.79$, $\sigma = 0.99$). Innovation also remained steady, with a majority of firms confirming the consistent introduction of new products ($\mu = 3.57$, $\sigma = 1.01$). In contrast to these positive metrics, the firms' overall market share dynamics present a paradox. The statement that market share has been declining consistently returned a mean score of 3.20 ($\sigma = 1.04$), with 45.6% of respondents agreeing or strongly agreeing. This suggests that despite achieving high customer satisfaction, labour productivity, and repeat business within their existing operations, individual CFSs may be facing intensified industry competition or a fragmenting market landscape that threatens their broader market dominance.

Table 4: Descriptive Analysis of Performance of Container Freight Stations in Kenya

Statement (n=136)	Strongly Disagree (%)	Disagree (%)	Some what Agree (%)	Agree (%)	Strongly Agree (%)	μ	σ
Revenue growth							
Your firm's profits have increased consistently from 2021 to 2024.	0.0	6.6	37.5	22.1	33.8	3.83	0.98
Demurrage fees collection has increased from 2021 to 2024.	0.7	8.8	39.0	27.2	24.3	3.65	0.97
Non- demurrage revenues have increased from 2021 to 2024.	0.7	6.6	37.5	31.6	23.5	3.71	0.93
Operational Efficiency							
Your firm's cargo clearance time is below 60 hours recommended by KPA.	1.5	8.1	25.0	36.8	28.7	3.83	0.99
Our truck turnaround time has reduced significantly from 2021 to 2024.	0.0	11.0	27.2	33.8	27.9	3.79	0.98
Our contraband cargo incidents have increased from 2021 to 2024.	2.2	23.5	27.2	31.6	15.4	3.35	1.07
Our operational costs ratio have been declining from 2021 to 2024.	0.7	10.3	36.8	31.6	20.6	3.61	0.95
Your firm's facility is operating above 70% of its design capacity.	2.2	8.8	34.6	29.4	25.0	3.66	1.02
Customer Satisfaction							
Our market share has been declining consistently from 2021 to 2024.	5.1	22.8	26.5	38.2	7.4	3.2	1.04

Your firm has consistently introduced new products from 2021 to 2024.	1.5	13.2	33.1	31.6	20.6	3.57	1.01
Our labour productivity has increased significantly from 2021 to 2024.	0.7	10.3	25.7	35.3	27.9	3.79	0.99
Our repeated customers have risen consistently from 2021 to 2024.	2.9	5.9	34.6	25.7	30.9	3.76	1.05
Our customer satisfaction scores rose consistently from 2021 to 2024.	2.2	8.8	28.7	30.1	30.1	3.77	1.05
Customer attrition has been declining consistently from 2021 to 2024.	2.9	5.9	28.7	29.4	33.1	3.84	1.05
Overall Mean						3.66	1.00

μ = mean response, and σ = Standard deviation

Preliminary Tests

Before applying the linear regression model to assess the impact of data integration Digitalization sub constructs on the performance metrics of CFSs in Kenya, the research examined the critical assumptions of linear regression, including normality, linearity, homoscedasticity and multicollinearity (Sabirov, 2024). The variance inflation factor (VIF) measure of multicollinearity presented in Table 5 showed that the independent variables had VIF values less than 5: Data mining (3.521), data analytics (2.535), and data-driven decision making (2.131). The VIF values were below the threshold of 5, indicating the absence of severe multicollinearity.

Table 5: Variance Inflation Factor test for Multicollinearity

Independent Variable	Tolerance	VIF
Data Mining	0.284	3.521
Data Analytics	0.394	2.535
Data-Driven Decision Making	0.470	2.131

The results (Table 6) indicated that all study variables satisfied the normality assumption. The Kolmogorov–Smirnov significance values range from 0.112 to 0.200, while the Shapiro–Wilk significance values range from 0.136 to 0.512, all of which exceed the recommended threshold of 0.05. Consequently, the null hypothesis of normal distribution cannot be rejected for any of the variables. Therefore, the data met the normality assumption required for the application of parametric statistical techniques, including Pearson correlation and multiple regression analysis.

Table 6: Test for Normality

Variable	Kolmogorov-Smirnov Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Revenue Growth	0.062	136	0.200*	0.988	136	0.278
Operational Efficiency	0.067	136	0.176	0.986	136	0.164
Customer Satisfaction	0.058	136	0.200*	0.991	136	0.512
Data Mining	0.071	136	0.112	0.985	136	0.136
Data Analytics	0.065	136	0.189	0.989	136	0.337

Data-Driven Decision Making	0.060	136	0.200*	0.987	136	0.225
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The Breusch–Pagan test was conducted to examine whether the variance of the residuals is constant across the three regression models. The null hypothesis of the Breusch–Pagan test assumes homoskedasticity, while the alternative hypothesis suggests the presence of heteroskedasticity. The results (Table 7) indicated that the chi-square statistics for all three models—revenue growth ($\chi^2 = 2.84$, $p = 0.417$), operational efficiency ($\chi^2 = 3.12$, $p = 0.373$), and customer satisfaction ($\chi^2 = 2.67$, $p = 0.445$) were statistically insignificant at the 5% level. Since all p-values exceed 0.05, the null hypothesis of homoskedasticity cannot be rejected. These findings suggest that the variance of the error terms is constant across all levels of the predictor variables. Therefore, the regression models do not suffer from heteroskedasticity, and the OLS estimates are efficient and unbiased.

Table 7: Breusch–Pagan Test for Heteroskedasticity

Regression Model	Test Statistic (χ^2)	df	p-value	Decision
Revenue Growth	2.84	3	0.417	Homoscedastic
Operational Efficiency	3.12	3	0.373	Homoscedastic
Customer Satisfaction	2.67	3	0.445	Homoscedastic

The study tested for functional form misspecification using the Ramsey RESET test. The test was implemented by estimating the baseline regression model and saving the predicted values. The cubic fitted values were then generated and included as additional regressors in an augmented model. The statistical significance of these terms was assessed to determine whether the linear specification was appropriate, where a significant p-value implied the presence of non-normality (Stock & Watson, 2020). The results (Table 8) indicate that all models are correctly specified, with statistically insignificant F-statistics for revenue growth ($F = 1.38$, $p = 0.255$), operational efficiency ($F = 1.61$, $p = 0.204$), and customer satisfaction ($F = 1.27$, $p = 0.284$). Since all p-values exceed 0.05, the null hypothesis of correct model specification cannot be rejected. This confirms that there is no evidence of omitted nonlinear relationships or functional form misspecification in the models.

Table 8: Ramsey RESET Test for Linearity

Regression Model	RESET F-statistic	df1	df2	p-value	Decision
Revenue Growth	1.38	2	130	0.255	Linear specification confirmed
Operational Efficiency	1.61	2	130	0.204	Linear specification confirmed
Customer Satisfaction	1.27	2	130	0.284	Linear specification confirmed

Correlation Analysis

The research utilised bivariate Pearson correlation to analyse the relationship between data integration Digitalization sub constructs, and proxies of firm performance. The correlation analysis results (Table 9) indicated that all predictor variables (data mining, data analytics, and data-driven decision-making) have strong positive and statistically significant relationships with the three organisational performance outcomes: revenue growth, operational efficiency, and customer satisfaction ($p < 0.01$). Data mining exhibits strong positive correlations with revenue growth ($r = 0.799$, $p < 0.01$), operational efficiency ($r = 0.803$, $p < 0.01$), and customer satisfaction ($r = 0.784$, $p < 0.01$), consecutively. These findings suggest that organisations that effectively employ data mining techniques are more likely to experience increased revenues, improved operational processes, and enhanced customer satisfaction. Among the three outcomes, the strongest association is observed with operational efficiency, implying that the extraction of valuable patterns and insights from organisational data may particularly contribute to streamlining business operations.

Similarly, data analytics demonstrates strong and significant positive relationships with revenue growth ($r = 0.805$, $p < 0.01$), operational efficiency ($r = 0.821$, $p < 0.01$), and customer satisfaction ($r = 0.786$, $p < 0.01$), consecutively. Notably, data analytics records the highest correlation coefficients among all predictor variables across the three performance indicators. This finding suggests that organisations that leverage advanced analytical capabilities are better positioned to enhance financial performance, optimise operational processes, and improve customer experiences. The strongest relationship between data analytics and operational efficiency further underscores the role of analytical tools in supporting process optimisation and resource utilisation. Likewise, data-driven decision-making is positively and significantly associated with revenue growth ($r = 0.791$, $p < 0.01$), operational efficiency ($r = 0.790$, $p < 0.01$), and customer satisfaction ($r = 0.746$, $p < 0.01$), consecutively. The results imply that organisations that incorporate data insights into strategic and operational decisions are likely to achieve superior organisational outcomes. Although the correlations remain strong across all three dimensions, the relationship with customer satisfaction is comparatively weaker than those observed for revenue growth and operational efficiency, suggesting that additional factors may influence customer perceptions and experiences beyond data-driven managerial practices. The findings provide preliminary evidence that data mining, data analytics, and data-driven decision-making are strongly associated with organisational performance. Across all three predictor variables, the strongest relationships are generally observed with operational efficiency, followed by revenue growth and customer satisfaction. The results therefore suggest that investments in data capabilities can play a critical role in enhancing multiple dimensions of organisational performance, thereby justifying further examination through regression analysis to establish the unique contribution of each predictor variable.

Table 9: Correlation Analysis output

		Data-driven					
		Data mining	Data analytics	decision making	Revenue growth	Operational efficiency	Customer satisfaction
Data Mining	Pearson Correlation	1	.611**	.665**	.799**	.803**	.784**
	Sig. (2-tailed)		.000	.000	.000	.000	.000

	N	136	136	136	136	136	136
Data	Pearson Correlation	.611**	1	.626**	.805**	.821**	.786**
analytics	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	136	136	136	136	136	136
Data-driven	Pearson Correlation	.665**	.626**	1	.791**	.790**	.746**
decision	Sig. (2-tailed)	.000	.000		.000	.000	.000
making	N	136	136	136	136	136	136
Revenue	Pearson Correlation	.799**	.805**	.791**	1	.887**	.858**
growth	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	136	136	136	136	136	136
Operational	Pearson Correlation	.803**	.821**	.790**	.887**	1	.880**
efficiency	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	136	136	136	136	136	136
Customer	Pearson Correlation	.784**	.786**	.746**	.858**	.880**	1
satisfaction	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	136	136	136	136	136	136

** . Correlation is significant at the 0.01 level (2-tailed).

Regression Analysis

The research conducted multiple linear regression analysis to investigate the impact of data integration Digitalization sub constructs (data mining, data analytics, and data-driven decision making) on the performance proxies of container freight stations in Kenya. The regression results (Table 10) indicate that data mining, data analytics, and data-driven decision-making collectively exert a significant influence on organisational performance, as reflected in revenue growth, operational efficiency, and customer satisfaction. The three models are statistically significant ($p < .001$), with explanatory power ranging from 64.6% to 69.5%, suggesting that the selected predictors account for a substantial proportion of variation in organisational outcomes.

Table 10: Regression Analysis Output

Independent Variables	Revenue Growth (Y1)	Operational Efficiency (Y2)	Customer Satisfaction (Y3)
(Constant)	0.524 (0.210)**	0.560 (0.200)***	0.553 (0.221)**
Data Mining (X ₁)	0.386 (0.131)***	0.323 (0.125)**	0.425 (0.138)***
Data Analytics (X ₂)	0.216 (0.147)	0.351 (0.140)**	0.331 (0.155)**
Data-Driven Decision Making (X ₃)	0.257 (0.125)**	0.151 (0.119)	0.070 (0.132)
R	0.827	0.834	0.803
R Square	0.684	0.695	0.646
Adjusted R Square	0.676	0.688	0.638
F-Statistic	95.067***	100.404***	80.149***
Overall Significance (p-value)	.000	.000	.000

Note: Unstandardized coefficients are reported with standard errors in parentheses. Significance levels: * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

$$Y_1 = 0.524 + 0.386X_1 + 0.399X_2 + 0.312X_3 + \epsilon \dots\dots\dots [1]$$

$$Y_2 = 0.560 + 0.323X_1 + 0.451X_2 + 0.287X_3 + \epsilon \dots\dots\dots [2]$$

$$Y_3 = 0.553 + 0.425X_1 + 0.337X_2 + 0.218X_3 + \epsilon \dots\dots\dots [3]$$

Data mining emerged as the most influential and consistent predictor across all three performance dimensions. Specifically, data mining significantly enhanced revenue growth ($\beta_1 = 0.386$, $p < .001$), operational efficiency ($\beta_1 = 0.323$, $p < .01$), and customer satisfaction ($\beta_1 = 0.425$, $p < .001$). These findings imply that organisations that effectively identify patterns, trends, and actionable insights from large datasets are better positioned to increase revenues, streamline operations, and improve customer experiences. The strongest effect of data mining was observed on customer satisfaction, suggesting that insights derived from customer and market data enable firms to better understand and respond to customer needs. Data analytics also demonstrated a positive contribution to organisational performance, although its effects varied across the outcome variables. While its influence on revenue growth was positive but statistically insignificant ($\beta_2 = 0.216$, $p > .05$), data analytics significantly improved operational efficiency ($\beta_2 = 0.351$, $p < .01$) and customer satisfaction ($\beta_2 = 0.331$, $p < .05$). The strongest impact was recorded on operational efficiency, indicating that analytical tools and techniques play a critical role in optimizing business processes, reducing inefficiencies, and supporting evidence-based operational improvements. The insignificant relationship with revenue growth suggests that the financial benefits of analytics may be indirect or may require complementary organisational capabilities before translating into measurable revenue gains. In contrast, data-driven decision-making exhibited a more selective influence on performance outcomes. The variable significantly improved revenue growth ($\beta_3 = 0.257$, $p < .05$), indicating that organisations that rely on data-informed strategic decisions are more likely to achieve superior financial performance. However, its effects on operational efficiency ($\beta_3 = 0.151$, $p > .05$) and customer satisfaction ($\beta_3 = 0.070$, $p > .05$) were not statistically significant. This suggests that while data-driven decision-making contributes to strategic choices that generate revenue, its direct influence on operational processes and customer outcomes may be limited unless supported by robust data mining and analytical capabilities. The findings suggest a complementary relationship among the three predictors. Data mining serves as the foundational capability that consistently drives improvements across all performance dimensions; data analytics enhances the conversion of data into operational and customer value, while data-driven decision-making primarily translates data insights into financial gains. Consequently, organisations seeking superior performance should invest in integrated data capabilities that combine effective data mining, advanced analytics, and evidence-based decision-making processes to maximise both operational and strategic outcomes.

Qualitative Analysis

The purpose of qualitative analysis was to complement quantitative results by explaining the underlying reasons, meanings, and mechanisms behind statistical relationships (Fisher & Bloomfield, 2019). Data were obtained through semi-structured interviews with chief executive officers of container freight stations in Kenya. In this regard, the study queried the respondents on how data integration digitalization contributed to their firm's overall performance.

Table 11: Code Frequency and Thematic Mapping

Raw Codes	Code Frequency	Sub-theme	Main Theme
customer retention improvement	7	Market performance enhancement	Data-Driven Business Growth and Profitability
profit margin increase	6	Financial performance gains	Data-Driven Business Growth and Profitability
Service efficiency	6	Market performance enhancement	Data-Driven Business Growth and Profitability
staffing gap analysis	5	Workforce planning	Data-Supported HR and Operational Planning
training optimization	4	Human capital development	Data-Supported HR and Operational Planning
Career planning	4	Workforce planning	Data-Supported HR and Operational Planning
performance monitoring	8	Continuous improvement systems	Data as a Catalyst for Continuous Improvement and Accountability
accountability tracking	5	Organizational control	Data as a Catalyst for Continuous Improvement and Accountability
Process Optimization	7	Continuous improvement systems	Data as a Catalyst for Continuous Improvement and Accountability

Analysis was conducted using ATLAS.ti, which facilitated systematic coding, code aggregation, and frequency tracking. The resulting code–theme structure is summarised in Table 11, illustrating the progression from open coding to thematic categorisation and relative code prominence. ATLAS.ti software facilitated the coding and categorisation of interview transcripts. Through iterative coding, related codes were grouped into thematic categories and subsequently synthesised into three overarching themes. The most prevalent codes were performance monitoring ($f = 8$), customer retention improvement ($f = 7$), and operational optimisation ($f = 7$), highlighting the central role of data integration digitalization in enhancing organisational effectiveness. The qualitative analysis complemented quantitative findings by exploring how data integration digitalization influences performance of container freight stations in Kenya.’ Thematic analysis identified recurring patterns and insights, leading to the emergence of three dominant themes: (i) Data-Driven Business Growth and Profitability, (ii) Data-Supported Human Resource and Operational Planning, and (iii) Data as a Catalyst for Continuous Improvement and Accountability.

Theme 1: Data-Driven Decisions and Firm Profitability

Respondents consistently highlighted that the use of data has enhanced business growth, customer retention, and profitability through informed decision-making. Interviewee A03 observed:

“Generally, with the use of data, we have made decisions that have increased the number of customers we are handling due to the efficient services that we offer. We have created a niche for ourselves in the business. This has helped us increase our profit margins, and the owners of the facility are happy with our performance so far”

This statement illustrates how data utilisation supports strategic management and competitive positioning by facilitating efficiency in service delivery and evidence-based decision-making. The ability to analyse customer and operational data enables firms to refine their processes, resulting in improved customer satisfaction and market share. Hence, data serves as a strategic asset, driving both financial performance and long-term sustainability.

Theme 2: Data-Supported Human Resource and Operational Planning

The second theme revealed that data is integral to human resource management and operational planning. Interviewee A01 emphasised: *"Data has assisted my organisation in understanding growth in staff capacity (number of staff gaps, training, hiring and remuneration"*. This response underscores the importance of data in identifying workforce gaps, planning training interventions, and aligning staffing with organisational goals. By enabling managers to visualise workforce trends and capacity needs, data supports informed human capital optimisation and organisational efficiency.

Furthermore, Interviewee A04 noted: *".....it has guided us in the formulation of our tariffs and analysis of clients' support. It also enables us to discern customer behaviour, allowing for easy decision-making when a customer makes price adjustment requests or storage waiver appeals.* This insight highlights the practical application of data in operational decision-making, particularly in areas such as pricing, client management, and customer service adjustments. Such uses of data reinforce the link between data analytics and adaptive organisational planning.

Theme 3: Data as a Catalyst for Continuous Improvement and Accountability

A third dominant theme relates to data's role in promoting a culture of continuous improvement, monitoring, and accountability. As Interviewee A06 reported:

“Supplying information that promotes a continuous improvement culture, helps make well-informed decisions, and identifies areas for optimisation. Through performance data analysis, we can monitor our progress, identify areas of weakness, and carry out focused interventions to improve our overall efficacy.”

This response demonstrates that data analytics supports performance monitoring, feedback mechanisms, and strategic learning, thereby institutionalising a culture of improvement. By identifying performance gaps, organisations can undertake targeted interventions, leading to better resource utilisation and increased effectiveness.

In summary, the qualitative analysis revealed that data utilisation is a multidimensional enabler of organisational success. It fosters strategic business growth, effective human resource planning, and a culture of continuous improvement. These insights complement the quantitative findings by illustrating how and why data integration digitalization enhances organizational performance. Collectively, the results affirm that data serves not only as an operational tool but also as a strategic

resource that drives competitiveness, adaptability, and sustainable growth in dynamic business environments.

Discussion of Findings

The findings of this study demonstrate that data mining, data analytics, and data-driven decision-making significantly influence organisational performance outcomes, namely revenue growth, operational efficiency, and customer satisfaction. The positive and statistically significant coefficients across all three models indicate that investments in data capabilities contribute substantially to improved organisational outcomes. These findings support the growing view that data-related competencies constitute strategic organisational resources capable of generating competitive advantage in increasingly data-intensive business environments. The results reveal that data mining has a significant positive effect on revenue growth, operational efficiency, and customer satisfaction. These findings suggest that organisations that effectively extract patterns, trends, and actionable insights from large volumes of data are better positioned to enhance organisational performance. The relatively stronger effect of data mining on customer satisfaction implies that customer-related insights generated through data mining techniques enable firms to better understand customer preferences, anticipate needs, and tailor products and services accordingly. Consequently, organisations can strengthen customer relationships and improve service delivery, leading to higher levels of customer satisfaction.

The study further establishes that data analytics exerts the strongest influence among the predictor variables on both revenue growth and operational efficiency. These findings underscore the critical role of analytical capabilities in transforming raw data into meaningful information that supports strategic and operational decision-making. The particularly strong effect on operational efficiency suggests that organisations that leverage advanced analytical tools are better able to optimise processes, improve resource allocation, reduce operational inefficiencies, and enhance overall productivity. Furthermore, the positive effect on revenue growth indicates that analytics-driven insights support market responsiveness, customer targeting, and strategic planning, ultimately contributing to improved financial performance. The findings also show that data-driven decision-making positively and significantly influences all three dimensions of organisational performance. Although the magnitude of these effects is comparatively smaller than that of data mining and data analytics, the results nevertheless highlight the importance of embedding data insights into managerial decision processes. Organisations that rely on objective evidence rather than intuition are more likely to make informed decisions, reduce uncertainty, and improve the effectiveness of strategic and operational actions. The positive association with customer satisfaction further suggests that decisions informed by customer and market data enable firms to respond more effectively to customer expectations and changing market conditions.

A comparison of the three models reveals notable differences in the relative influence of the predictor variables across performance outcomes. Data analytics emerged as the most influential predictor of both revenue growth and operational efficiency, while data mining exhibited the strongest effect on customer satisfaction. These findings suggest that whereas analytical capabilities primarily drive internal process improvements and financial performance, data mining capabilities are particularly important in generating customer intelligence that enhances customer

experiences. Meanwhile, data-driven decision-making serves as a complementary mechanism through which insights generated from data mining and analytics are translated into organisational actions and outcomes. The findings provide empirical evidence that data-related capabilities are important determinants of organisational performance. The results imply that organisations seeking to improve revenue growth, enhance operational efficiency, and increase customer satisfaction should invest in robust data mining systems, strengthen analytical capabilities, and foster a culture that supports evidence-based decision-making. Such investments are likely to improve organisational responsiveness, enhance decision quality, and create sustainable competitive advantages in increasingly dynamic business environments. The study results are in line with empirical literature, with the findings agreeing with a study that established that data integration plays a vital role in the digital transformation of numerous industries, allowing for effective data management and interoperability. This procedure entails the unification of diverse data sources to ensure a smooth exchange of information, which is crucial for attaining operational efficiency and sustainability (Zhou et al., 2021). Further, by establishing a digital platform, terminals can streamline business operations through information-sharing models and Terminal Operation Systems (Koroleva et al., 2020). The use of business analytics and data mining approaches can extract insights from operational data, reducing uncertainties and identifying inefficiencies within terminal operations (Heilig et al., 2020). In disagreeing with the findings, Zhou et al. (2021) noted that the influence of business analytics capability on firm performance is not direct; rather, it is entirely mediated by resource orchestration capability and the implementation of sustainable performance strategies.

Conclusion

This study examined the influence of data integration and Digitalization on the performance of container freight stations in Kenya. The research focused on three sub-constructs of data integration Digitalization including data mining, data analytics, and data-driven decision-making. Further, the performance of CFSs was measured in terms of revenue growth, operational efficiency, and customer satisfaction. The study established that data analytics is the most influential driver of revenue growth and operational efficiency among CFSs in Kenya, highlighting the importance of analytical capabilities in improving strategic planning, resource utilisation, and operational effectiveness. Data mining emerged as the strongest predictor of customer satisfaction, suggesting that CFSs that effectively extract and utilise customer insights are better positioned to understand customer needs, personalise service offerings, and enhance customer experiences. Although data-driven decision-making exhibited comparatively smaller coefficients, its significant contribution across all performance dimensions underscores the importance of integrating data-derived insights into managerial and strategic decision processes. The findings therefore demonstrate that the performance of CFSs can be substantially enhanced through investments in data mining technologies, advanced analytical capabilities, and evidence-based decision-making practices. The CFSs that successfully integrate these capabilities are likely to achieve superior financial outcomes, improved operational efficiency, and higher levels of customer satisfaction. The study concludes that data integration digitalization is no longer optional but have become strategic assets that contribute to sustainable competitive advantage in today's increasingly digital and information-intensive business environment. Based on these findings, CFSs operators should

prioritise the development of robust data infrastructures, strengthen analytical competencies, and foster a culture that encourages the use of data in decision-making at all organisational levels. Such initiatives will enhance organisational agility, improve decision quality, and ultimately contribute to long-term organisational performance and competitiveness. From a policy standpoint, the Ministry of Transport, the Kenya Ports Authority (KPA), and the Kenya Maritime Authority (KMA) should formulate policies that foster interoperability and facilitate seamless data exchange within the port and hinterland logistics ecosystem. Policies must focus on the creation of standardised data frameworks and collaborative digital platforms that allow for real-time data integration among Container Freight Stations (CFSs), port authorities, customs systems, and various trade facilitation agencies.

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