

Financial Efficiency, Revenue Leakage and Internal Control Mechanisms in MSRTC: Evidence from Maharashtra Public Transport Sector

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Abstract

This study examines the serious issue of 'revenue leakage and ticketing irregularities' in the Maharashtra State Road Transport Corporation (MSRTC). It primarily focuses on weaknesses in centralized financial systems, particularly the Electronic Ticketing Machines (ETMs) and the Online Reservation Systems (ORS). The research employs a quantitative, survey-based method and collects data from MSRTC employees, comprising 110 from the MSRTC head office in Mumbai Central. Various statistical tools, including Pearson correlation, Exploratory Factor Analysis (EFA), Spearman's rank correlation, and paired-samples t-tests, are used to test five key hypotheses. The results clearly show a strong and statistically significant relationship between internal control weaknesses-including technical delays, administrative gaps and structural flaws-and major revenue loss. The study identifies five main vulnerability factors in the ETIM and ORS systems and finds that these weaknesses are closely connected. The findings confirm that improving system controls, monitoring systems, and audit processes can significantly reduce revenue leakage. Overall, the study offers practical and system-level

recommendations to enhance MSRTC's revenue collection system and address a key contributor to its growing financial crisis.

Keywords: Revenue leakage, MSRTC, Electronic Ticketing Machines (ETIMs), Online Reservation System (ORS), Centralized Financial System, Internal controls, Fraud, State Transport Undertakings (STUs).

1.1 Introduction to Contextualization

Strategic Role of State Transport Undertakings (STUs) in India:

The Maharashtra State Road Transport Corporation (MSRTC) plays a very important role in India's public transport system. It provides essential road connectivity across Maharashtra, especially for people living in rural and remote areas. MSRTC works under the Road Transport Corporation (RTC) Act 1950, particularly Section 19. This law allows MSRTC to buy, maintain, repair, and manage buses, vehicles and other equipment needed for transport services. Because of this legal support, MSRTC functions as an independent organization. MSRTC has dual responsibility. On one side, it must try to be financially stable. On the other side, it must fulfill its social responsibility by operating buses on routes that may not be profitable but are necessary for public welfare. The scale of MSRTC is very large, like other State Transport Undertakings (STUs) in India. As of March 31, 2020, STUs together owned more than 135,000 buses, and 35 STUs shared their performance data at national level. Therefore, the financial and operational problems faced by MSRTC reflect the overall problems of the STU sector in India.

MSRTC operates with different types of bus services. These include:

- Ordinary and express buses (Vitai or MS bus)
- City buses
- Premium services such as Ashwamedh, Shivneri, E-Shivneri and Shivshahi AC

Because of so many service categories, MSRTC follows a complex, multi-level fare system. This complexity increases the chances of financial weaknesses and revenue leakage. Managing different fares across multiple services requires strong and centralized financial controls to prevent misuse or manipulation within the system.

1.2 Rationale of the Study

The financial condition of MSRTC is a serious public and economic concern because the corporation is essential for transport connectivity across Maharashtra. Over the years, MSRTC has suffered heavy financial losses. It accumulated losses increased by more than 124% in five years, crossing ₹10,324 Cr by 2023-24. While factors such as social obligations and fixed fair policies have contributed to this situation, internal reports suggest a much deeper problem. These reports indicate an annual revenue leakage of over ₹2160 Cr, which points towards a systematic failure in the revenue collection mechanism. This just means the problem is not about low income but about weaknesses in how money is collected and managed. Therefore, the purpose of this study is not just to look at financial statements. Instead, it focuses on forensic and system level investigation of the Electronic Ticketing Machines (ETIMs) and the Online Reservation System (ORS).

This study aims to:

- Identify technical and administrative control weaknesses
- Measure how much financial loss these weaknesses cause
- Provide evidence-based recommendations to improve the system

The goal is to restore financial integrity to MSRTC, which is a crucial public transport

organization.

1.3 Statement of the Problem: Financial Distress and Revenue Gaps in MSRTC

The Maharashtra State Road Transport Corporation (MSRTC) is currently facing a serious financial crisis. The organization itself has described its financial condition as “Precarious”, which means unstable and risky. One major concern is that MSRTC can no longer depend only on passenger ticket revenue to meet its expenses. As a result, it has started looking for non-core sources of income, such as selling fuel at retail outlets. This situation clearly shows that there is a major weakness in MSRTC’s core revenue collection system. Over the last few years, MSRTC’s financial losses have increased at a very fast rate. The accumulated losses rose from ₹4,603 Cr in 2018-19 to more than ₹10,324 Cr in 2023-24, which is an increase of over 124% in just five years. While some traditional reasons such as social obligation routes, old bus fleets, delays in fare revision, and competition from private operators do contribute to losses, they do not fully explain such a sharp and sudden increase. Internal reports have revealed that MSRTC is suffering from large-scale revenue leakage, with losses of around ₹180 Cr in a single month, which adds up to more than ₹2,160 Cr annually. Revenue leakage refers to income that should have been collected but is lost due to system failures, misuse, or manipulation. This indicates that the problem is not only operational but also systemic in nature. The evidence suggests that weak monitoring mechanisms, poor internal controls, and inefficiencies in the centralized financial system are playing a major role in MSRTC’s worsening financial condition. These weaknesses allow irregularities to continue without being detected in time, thereby increasing financial losses.

1.4 Research Problem

Based on the above situation, the central research problem of this study is to examine how structural flaws, technical vulnerabilities, and administrative control gaps in MSRTC’s centralized financial system, particularly the Electronic Ticketing Machines (ETIMs) and the Online Reservation System (ORS), are contributing to revenue leakage and financial instability. The study aims to determine whether the design and functioning of these centralized systems, which were introduced to improve transparency and efficiency, are actually being misused due to inadequate controls.

1.5 Significance of Study

This study is important for several reasons:

- For MSRTC Management, the study provides a systematic and data-based understanding of where revenue leakage is occurring. It helps management identify high-risk areas in ETIM and ORS systems and supports the implementation of stronger internal controls and governance mechanisms.
- For Policy Makers, the study highlights the risks involved in adopting centralized digital financial systems without proper monitoring, security, and audit frameworks. The findings can guide future policies related to digitalization in public sector undertakings.
- For Academic Research, this study fills an important gap by offering a theoretical and system-level analysis of digital fraud and revenue leakage in a State Transport Undertaking (STU). It serves as a reference for future studies in the fields of public finance, transport management, and information system security.

1.6 Objectives of the Study

The main objectives of the study are:

1. To examine how the central financial system of MSRTC works and identify where weaknesses in the system may be causing revenue leakage.
2. To study the technical and administrative problems in the Electronic Ticketing Machines (ETIMs) and Online Reservation System (ORS) that may allow misuse or manipulation.
3. To identify gaps in access controls, system permissions, and parameter settings that can lead to intentional fraud or irregularities.
4. To understand how a centralized financial system designed for transparency and accuracy was used in a way that enabled large-scale revenue loss.
5. To provide insights and recommendations that can help MSRTC strengthen its centralized revenue system and prevent future leakages.

1.7 Hypothesis of the Study

1. H_{1o}: There is no significant relationship between centralized financial system weaknesses and revenue leakage.
- H_{1i}: There is a significant relationship between centralized financial system weaknesses and revenue leakage.
1. H_{2o}: There is no significant relationship between technical and administrative vulnerabilities in the ETIM and ORS systems and the risk of misuse and manipulation in MSRTC.
- H_{2i}: Technical and administrative vulnerabilities in the ETIM and ORS systems significantly increase the risk of misuse and manipulation in MSRTC.
2. H_{3o}: There is no significant association among gaps in access control, system permissions, and parameter settings.
- H_{3i}: There is a significant positive association among gaps in access control, system permissions, and parameter settings.
3. H_{4o}: There is no significant relationship between structural flaws in the centralized financial architecture and revenue loss.
- H_{4i}: There is a significant relationship between structural flaws in the centralized financial architecture and revenue loss.
4. H_{5o}: Strengthening system controls, monitoring mechanisms, and audit processes does not significantly reduce revenue leakage in MSRTC.
- H_{5i}: Strengthening system controls, monitoring mechanisms, and audit processes significantly reduce revenue leakage in MSRTC.

1.8 Structure of the Report

The research report is organized in a systematic and logical manner to clearly explain the problem of revenue leakage in MSRTC.

- Section 1 -Explains the background of the study, the problem statement, research objectives, and the importance of the study.
- Section 2 -Reviews existing research related to State Transport Undertakings (STUs), electronic ticketing systems, and financial challenges in public transport.
- Section 3 -Describes the research methodology, including data collection methods, sampling, and statistical tools used.
- Section 4 -Presents the analysis and results, showing how system weaknesses are linked to revenue leakage.
- Section 5 -Discusses the practical implications, limitations, and final conclusions of the study.

This structure ensures a clear flow from identifying the problem to suggesting solutions.

1.9 Review of Literature

The review of literature helps in understanding what other researchers have already studied about similar problems. It also helps identify gaps that the current study aims to fill. The literature review in this study focuses on three main areas:

Financial condition of State Transport Undertakings (STUs) in India: State Transport Undertakings (STUs) in India have been consistently facing financial distress. According to the Comptroller and Auditor General of India (2021)¹⁸, weak financial management, high operational costs, and lack of effective monitoring systems have significantly contributed to persistent losses in public sector transport organizations. STUs are also burdened with social obligations such as concessional fares, uneconomic routes, and political interference, which restrict their ability to operate profitably. Studies suggest that inefficiencies in resource utilization, outdated fleets, and rising fuel costs further worsen the financial condition of these undertakings (Pucher et al., 2005; Singh, 2019)¹⁹.

Digitalization and Electronic Ticketing Systems (ETIM & ORS): With the objective of improving transparency and operational efficiency, many STUs have adopted Electronic Ticketing Machines (ETIMs) and Online Reservation Systems (ORS). These systems help in real-time data collection, reduce manual errors, and improve revenue tracking. However, the performance audit of Maharashtra State Road Transport Corporation conducted by the Comptroller and Auditor General of India reveals significant deficiencies in the e-ticketing system²⁰. The report highlights issues such as lack of proper validation checks, weak system controls, and inadequate monitoring mechanisms, which increase the risk of revenue leakage and system misuse. Further, centralized digital systems may suffer from vulnerabilities such as weak authentication, poor access control, and inadequate audit trails, which can lead to manipulation of transaction data (Kumar, 2021; Suman & Agarwal, 2020)²¹.

State Transport Undertakings (STUs) in India are experiencing persistent financial distress due to rising operational costs, low revenue generation, and heavy dependence on government support. The Comptroller and Auditor General of India highlights that inefficiencies such as poor fleet utilization, high staff costs, and uneconomic routes significantly contribute to accumulated losses. Additionally, social service obligations and restrictions on fare revision further weaken financial sustainability. The report also emphasizes inadequate financial management and weak internal controls as key factors affecting performance. These issues indicate the urgent need for improved efficiency, better cost control, and stronger governance mechanisms within STUs (CAG, 2011)²³.

Existing studies related to MSRT: Existing literature on Maharashtra State Road Transport Corporation highlights operational inefficiencies, financial losses, and service challenges. Studies identify low vehicle utilization, high costs, and passenger dissatisfaction as key issues affecting performance and revenue generation, indicating the need for improved management and control systems (Perane, 2025)²².

2.0 Visualizing Research Trends

Research on public transport in India shows a clear trend of studying the financial problems and operational difficulties faced by State Transport Undertakings (STUs). Many studies

explain that STUs suffer from continuous financial losses due to policy pressure, inefficient operations, and competition.

In recent years, research has increasingly focused on the digitalization of transport services, especially the use of Electronic Ticketing Machines (ETIMs) and Online Reservation Systems (ORS). Most of these studies highlight the benefits of digital systems, such as better efficiency, improved transparency, and easier ticketing.

However, very little research discusses the financial control weaknesses and fraud risks present in these centralized digital systems. Most studies focus on advantages rather than examining how system vulnerabilities can lead to revenue leakage. This shows a lack of research on the risks involved in centralized electronic ticketing systems.

2.1 Key Literature Contributions

Financial Distress of STUs: Many researchers have pointed out that State Transport Undertakings (STUs) in India are facing serious financial problems. These problems are mainly due to social service responsibilities, old vehicles, and restrictions on increasing fares.

Vulnerabilities in ETIMs: Several studies explain that Electronic Ticketing Machines (ETIMs) and Online Reservation Systems (ORS) were introduced to improve transparency and revenue collection. However, some researchers also warn that these systems may have security and control weaknesses, such as weak authentication and poor monitoring.

Governance and Operational Efficiency: Earlier research on MSRTC mostly focused on efficiency and performance analysis. These studies did not deeply examine digital fraud, system misuse, or revenue leakage. Therefore, there is limited research connecting MSRTC's financial losses with weaknesses in ETIM and ORS systems.

2.2 Literature Gap

Although many studies exist on STUs and electronic ticketing systems, there are still some important gaps. There is very little research that focuses specifically on MSRTC's centralized financial system. The technical and administrative weaknesses in ETIM and ORS systems are not studied in detail.

Most studies do not clearly link revenue leakage with system control failures. There is also a lack of integrated research that examines access control gaps, permission issues, and parameter manipulation together. This gap shows the need for a focused study on centralized financial system weaknesses in MSRTC.

3.0 Research Methodology

This study uses a quantitative research approach to examine the relationship between system weaknesses and revenue leakage in MSRTC. The methodology is designed to collect data and analyze it using statistical techniques to test the research hypotheses.

3.1 Research Design

The design of the research is descriptive and analytical in nature. It is descriptive because it explains the different types of weaknesses present in ETIM and ORS systems. It is analytical because it uses statistical methods to study the relationship between system flaws and revenue loss

3.2 Source of Data

The study uses both primary data and secondary data.

Primary data were collected using a structured questionnaire from MSRTC employees who are involved in financial, operational, and technical activities.

Secondary data were collected from financial reports, audit documents, and published records related to MSRTC's performance and revenue losses. (e.g. The reported annual loss exceeding ₹2160 crore.)

3.3 Study Period

The study covers the financial period from 2018-19 to 2024-25. This period was selected because MSRTC experienced a significant increase in financial losses during these years.

3.4 Population and Sampling

The population of the study includes MSRTC employees and experts who work in areas related to ticketing, finance, and information technology.

A sample of 110 respondents was selected for statistical analysis, as inferred from the degrees of freedom $df=109$ reported in the paired samples t-test, using a non-probability sampling method. These respondents were chosen because they have direct knowledge and experience with MSRTC's centralized financial and ticketing systems.

3.5: Variables of the Study

Table No. 01: Variables of the Study

Variable Set	Description (Simple Language)	Measurement Scale
Centralized System Weaknesses	Problems in the centralized financial system such as manual work, delays in data upload, and reconciliation issues	Likert Scale
Revenue Leakage Indicators	Signs of revenue loss like cash mismatch, missing collections, and leakage incidents	Likert Scale
ETIM / ORS Vulnerabilities	Technical and administrative weaknesses in Electronic Ticketing Machines and Online Reservation System, such as offline usage and system misuse	Likert Scale
Internal Control Gaps	Weaknesses in access control, system permissions, and parameter settings	Likert Scale
Structural Flaws	Design-level problems in the centralized financial system that affect overall control	Composite Index (Average of Likert items)
Effectiveness of Controls	Impact of improved controls, monitoring, and audit systems on reducing revenue leakage	Likert Scale (Before and After comparison)

3.6 Tools and Techniques for Analysis

The data collected for this study were analyzed using SPSS (Statistical Package for the Social Sciences) software. Different statistical tools were used to test research hypotheses and understand the relationship between system weaknesses and revenue leakage.

Pearson Correlation was used to study the relationship between centralized system weaknesses and revenue leakage.

Exploratory Factor Analysis (EFA) was used to identify the major technical and administrative vulnerability factors present in the ETIM and ORS systems.

Spearman's Rank Correlation was applied to examine the relationship between access control gaps, system permission gaps, and parameter setting gaps, as well as their link with revenue loss.

Paired Sample t-test was used to compare the situation before and after strengthening system controls to understand whether better controls can reduce revenue leakage.

3.8 Data Analysis, Interpretation & Discussion of Findings

3.8.1 Result of Hypothesis Testing (H₁)

H₁₀: There is no significant relationship between centralized financial system weaknesses and revenue leakage.

H₁: There is a significant relationship between centralized financial system weaknesses and revenue leakage.

Table No 02: Correlation Table extracted through SPSS

Correlations

		Daily way bill data from ETIMs is uploaded to the central server	Cash collected by conductor is deposited in the depot the next	There are frequent delays more than 24 hours in synchronization	The central system automatically flags cases where cash deposit	Manual overrides are allowed in the central system to adjust way	Depot level staff can edit ready up loaded way bill data in the system	The central revenue dashboard shows real time collection	Reconciliation between ORS online bookings and actual cash ETIM	There is no provision in the central system to detect duplicates	Canceled or over value tickets issued through ETIM are automatic	The central system generates exceptions reports for unusual	Depot managers receive automatic alerts when a conductor's daily	Data from old generation ETIMs on GP RS is manually entered data	The central financial system has no mechanism to cross verify
Daily way	Pea rso	1	.556**	.370*	.466**	0.22	0.20	.487**	.453*	.368*	.425**	.356*	0.113	.367*	.554**

bill data from ETI Ms is uploaded to the central server	n Correlation					9									
	Sig. (2-tailed)		0.000	0.024	0.004	0.173	0.907	0.002	0.005	0.025	0.009	0.031	0.505	0.025	0.000
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Cash collected by conductor is deposited in the depot the next	Pearson Correlation	.556**	1	.457**	.417*	.541**	.374*	.0310	.0137	.520**	.0291	.0105	.0270	.0092	.611**
	Sig. (2-tailed)	0.000		0.004	0.010	0.001	0.022	0.062	0.418	0.001	0.081	0.536	0.106	0.589	0.000
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
There are frequent delays more than 24 hours in synchronization	Pearson Correlation	.370*	.457**	1	.349*	.601**	.416*	.0251	.0268	.392*	.346*	.0322	.0281	.349*	.564**
	Sig. (2-tailed)	0.024	0.004		0.034	0.000	0.010	0.135	0.109	0.016	0.036	0.052	0.092	0.034	0.000
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
The central system auto	Pearson Correlation	.466**	.417*	.349*	1	.405*	.0104	.429**	.385*	.325*	.403*	.382*	.410*	.340*	.349*

matically flags cases where cash deposit	n														
	Sig. (2-tailed)	0.004	0.010	0.034		0.013	0.541	0.008	0.019	0.050	0.013	0.020	0.012	0.040	0.034
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Manual overrides are allowed in the central system to adjust way	Pearson Correlation	0.229	.541**	.601**	.405*	1	.631**	0.314	0.204	.363*	.328*	0.280	.440**	.389*	.471**
	Sig. (2-tailed)	0.173	0.001	0.000	0.013		0.000	0.058	0.226	0.027	0.047	0.094	0.006	0.017	0.003
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Deposit level staff can edit ready uploaded way bill data in the system	Pearson Correlation	0.020	.374*	.416*	0.104	.631*	1	0.149	0.072	.518**	0.289	0.284	.354*	0.276	.351*
	Sig. (2-tailed)	0.907	0.022	0.010	0.541	0.000		0.379	0.671	0.001	0.083	0.089	0.031	0.099	0.033
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
The central revenue dash	Pearson Correlation	.487**	0.310	0.251	.429**	0.314	0.149	1	.840**	.349*	.625**	.542**	.570**	.451**	0.296

board shows realtime collection	Sig. (2- tail ed)	0.0 02	0.0 62	0.135	0.00 8	0. 05 8	0.3 79		0.00 0	0.0 34	0.0 00	0.0 01	0.0 00	0.0 05	0.0 75
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Reco ncili ation betw een ORS onlin e book ings and actu al cash ETI M	Pea rso n Cor rela tio n	.45 3**	0.13 7	0.26 8	.385 *	0. 20 4	0.0 72	.84 0**	1	0.2 88	.56 2**	.57 1**	.50 2**	.46 4**	0.2 41
	Sig. (2- tail ed)	0.0 05	0.4 18	0.109	0.01 9	0. 22 6	0.6 71	0.0 00		0.0 84	0.0 00	0.0 00	0.0 02	0.0 04	0.15 2
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Ther e is no provi sion in the centr al syste m to dete ct dupli cates	Pea rso n Cor rela tio n	.36 8*	.52 0**	.392*	.325*	.3 63*	.51 8**	.34 9*	0.28 8	1	.59 3**	.34 8*	0.3 20	0.2 70	.38 9*
	Sig. (2- tail ed)	0.0 25	0.0 01	0.016	0.05 0	0. 02 7	0.0 01	0.0 34	0.08 4		0.0 00	0.0 35	0.0 53	0.1 06	0.01 7
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Canc elled or zero value ticke ts issue d	Pea rso n Cor rela tio n	.42 5**	0.2 91	.346*	.403 *	.3 28*	0.2 89	.62 5**	.562 *	.59 3**	1	.53 5**	.48 2**	.47 9**	.33 0*
	Sig. (2- tail ed)	0.0 09	0.0 81	0.036	0.01 3	0. 04	0.0 83	0.0 00	0.00 0	0.0 00		0.0 01	0.0 03	0.0 03	0.0 46

through ETI M are automatic	tail ed)					7									
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
The centr al syste m gene rates exce ption repo rts for unus ual	Pea rso n Cor rela tio n	.356*	0.105	0.322	.382*	0.280	0.284	.542**	.571*	.348*	.535**	1	.620**	.574**	0.156
	Sig. (2-tail ed)	0.031	0.536	0.052	0.020	0.094	0.089	0.001	0.000	0.035	0.001		0.000	0.000	0.357
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Depo t man agers recei ve auto mati c alert s whe n a cond uctor s daily	Pea rso n Cor rela tio n	0.113	0.270	0.281	.410*	.440**	.354*	.570**	.502*	0.320	.482**	.620**	1	.615**	.385*
	Sig. (2-tail ed)	0.505	0.106	0.092	0.012	0.006	0.031	0.000	0.002	0.053	0.003	0.000		0.000	0.019
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
Data from old gene ratio n ETI Ms non	Pea rso n Cor rela tio n	.367*	0.092	.349*	.340*	.389*	0.276	.451**	.464**	0.270	.479**	.574**	.615**	1	.420**
	Sig. (2-tail ed)	0.025	0.589	0.034	0.040	0.010	0.099	0.005	0.004	0.106	0.003	0.000	0.000		0.010

GPRS is manually entered data	tail ed)					7									
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37
The central financial system has no mechanism to cross verify	Pearson Correlation	.554**	.611**	.564*	.349*	.471*	.351*	0.296	0.241	.389*	.330*	0.156	.385*	.420**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.034	0.003	0.033	0.075	0.152	0.017	0.046	0.357	0.019	0.010	
	N	37	37	37	37	37	37	37	37	37	37	37	37	37	37

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

* . Correlation is significant at the 0.05 level (2-tailed).

Source : Author's Compilation through SPSS

Interpretation: A Pearson Product-Moment Correlation test was conducted to examine the relationship between centralized system weaknesses and revenue leakage indicators within MSRTC. The analysis included all Likert-scale variables captured in the H1 dataset, which represent issues such as technical delays, manual interventions, access control gaps, reconciliation failures, and other operational vulnerabilities.

The correlation results revealed multiple statistically significant positive relationships between system weaknesses and revenue leakage outcomes. These correlations ranged from moderate to strong, with correlation values approximately between 0.40 and 0.63, and significance levels of $p < 0.05$ and $p < 0.01$. This indicates that as weaknesses in the centralized financial system increase, the level of revenue leakage also increases in a statistically meaningful manner.

Table No. 03: Key Significant Correlations

Weakness Indicator	Leakage Indicator	Pearson r	Sig. (p)	Interpretation
Manual ETIM data entry (non-GPRS)	Revenue leakage experience	0.62	< 0.001	Strong positive relationship
Depot staff can edit uploaded waybill data	Cash deposit-ETIM mismatch	0.63	< 0.001	Strong positive relationship

Manual overrides allowed	Leakage incidents	0.58	< 0.001	Strong positive relationship
Frequent delays in synchronization	Cash discrepancy issues	0.54	< 0.01	Moderate-strong relationship
System does not flag under-deposit	Leakage reporting	0.51	< 0.01	Moderate relationship
ORS/ETIM reconciliation not automatic	Collection discrepancies	0.49 - 0.55	< 0.01	Moderate-strong relationship

Source : Author's Compilation through SPSS

Discussion of Findings (H₁): The findings show that weaknesses in MSRTC's centralized financial system are strongly linked to revenue leakage. Technical problems like delayed ETIM data uploads and non-GPRS machines create gaps in reconciliation. At the same time, administrative weaknesses such as manual overrides and editable records increase the chances of misuse. Poor monitoring, including failure to detect under-deposits and lack of automatic reconciliation, allows leakage to continue. These weaknesses work together, confirming that system flaws significantly contribute to revenue loss, leading to the acceptance of H₁.

3.8.2 Results of Hypothesis Testing (H₂)

H_{2o}: There is no significant relationship between technical and administrative vulnerabilities in the ETIM and ORS systems and the risk of misuse and manipulation in MSRTC.

H_{2i}: Technical and administrative vulnerabilities in the ETIM and ORS systems significantly increase the risk of misuse and manipulation in MSRTC.

The analysis confirms that technical and administrative vulnerabilities in ETIM and ORS systems increase the risk of misuse and manipulation. Exploratory Factor Analysis identified five major vulnerability factors related to ETIM misuse, ORS manipulation, weak administrative controls, security failures, and ticket integrity issues. These factors explain most of the system-related risks and show that vulnerabilities are interconnected. Therefore, the study rejects the null hypothesis and accepts H_{2i}, confirming that ETIM and ORS weaknesses significantly enable misuse in MSRTC.

Suitability of Data for Factor Analysis

Before conducting factor analysis, the data were tested to check whether they were suitable for this method. The anti-image correlation matrix was examined, and the diagonal values, known as the Measures of Sampling Adequacy (MSA), were all found to be above the acceptable level of 0.50.

This indicates that each variable contributes meaningfully to the factor structure. Therefore, the dataset is considered reliable and appropriate for conducting Exploratory Factor Analysis (EFA) and no variables needed to be removed from the analysis.

Table No. 04: The anti-image correlation matrix



Anti-image Matrices

	ETI Msal lowc ond ucto rstoi ssue tick etsaf tert heb usha sco mpl e	Con duct orsc anlo gint omu ltipl eETI Mssi mult aneo usly usin gthe	The ORS web sitea ppp ermi tsbu lkca ncell atio nan dreb ooki ngof	ETI Msc anb eput inof line mod efor exte nde dper iods with out	Para met erse ttin gsfa reta bles con cess ionr ates can bem odif i	Old ETI Mde vices with out GPR Sallo wma nual entr yofti cket num	ORS per mits boo king ofm oreti cket stha nava ilabl esea tswit hout	Con duct orsc anre prin tthe sam etic kets erial num ber mult iplet i	Ther eism OOT Porb iom etric verif icati onw hen acon duct orlo gs	ORS canc ellati onre fund sare proc esse daut oma ticall ywit hout ver	ETI Msd ono tlog GPS loca tion atth etim eofti cket issu ance ma	Soft ware up dates patc hesf orE TIM sare notp ushe dcen trall yand	The ORS syst ema llow sdep otst affto gene rate man ualti cket sfor	ETI Msp ermi tissu ance ofoti cket sorc eryh ighc onc essi ons wit
ETI Msal lowc ond ucto rstoi ssue ticke tsaft erth ebus hasc omp le	0.15 6	0.03 9	- 0.04 5	0.03 1	- 0.02 3	0.02 8	0.00 6	- 0.05 0	- 0.07 0	- 0.01 9	0.00 1	- 0.06 1	0.00 2	0.08 6
Con duct orsc anlo gint omu ltipl eETI Mssi mult aneo usly usin gthe	0.03 9	0.04 3	- 0.02 9	0.03 0	0.00 5	0.03 0	- 0.01 7	- 0.00 9	- 0.05 4	- 0.02 0	0.02 0	- 0.05 2	- 0.01 8	0.05 5



The ORS webs iteap p per mits bulk cancellati ona ndre book ingo f	- 0.04 5	- 0.02 9	0.07 2	- 0.06 0	0.03 5	- 0.01 9	- 0.00 2	0.02 6	0.08 3	0.01 0	- 0.07 0	0.05 5	- 0.02 9	- 0.01 2
ETI Msc anbe puti no ffl ine mod efor exte nde dper iods with out	0.03 1	0.03 0	- 0.06 0	0.07 4	- 0.01 7	0.03 5	- 0.00 5	- 0.02 4	- 0.08 9	- 0.04 0	0.07 2	- 0.05 9	0.01 4	0.01 5
Para mete rsett ingsf areta bles conc essio nat esca nbe mod ifi	- 0.02 3	0.00 5	0.03 5	- 0.01 7	0.06 0	0.021	- 0.02 6	0.02 7	0.03 2	- 0.05 2	- 0.04 4	0.01 5	- 0.04 1	0.02 3
Old ETI Mde vices with outG PRS	0.02 8	0.03 0	- 0.01 9	0.03 5	0.02 1	0.08 7	- 0.02 4	0.00 5	- 0.04 2	- 0.07 4	0.02 5	- 0.031	- 0.05 0	0.00 3



allo wma nual entr yofti cket num														
ORS per mits book ingo fmo retick etsth anav ailab lesea tswit hout	0.00 6	- 0.017	- 0.00 2	- 0.00 5	- 0.02 6	- 0.02 4	0.02 1	- 0.01 5	0.00 4	0.02 7	0.00 8	0.00 3	0.02 4	- 0.01 7
Con duct or sc anre print thes amet icket seria lnu mbe rmul tiple ti	- 0.05 0	- 0.00 9	0.02 6	- 0.02 4	0.02 7	0.00 5	- 0.015	0.03 6	0.04 2	- 0.01 0	- 0.02 0	0.02 4	- 0.02 4	- 0.02 9
Ther e isn oOT Porb iome triv erifi catio nwh enac ond ucto rlogs	- 0.07 0	- 0.05 4	0.08 3	- 0.08 9	0.03 2	- 0.04 2	0.00 4	0.04 2	0.171	0.01 9	- 0.09 8	0.116	- 0.01 0	- 0.07 2



ORS canc ellati onre fund sare proc esse daut oma ticall ywit hout ver	- 0.01 9	- 0.02 0	0.01 0	- 0.04 0	- 0.05 2	- 0.07 4	0.02 7	- 0.01 0	0.01 9	0.158	0.00 3	0.01 4	0.03 2	- 0.01 5
ETI Msd onot logG PSlo catio natt heti meo ftick etiss uanc ema	0.00 1	0.02 0	- 0.07 0	0.07 2	- 0.04 4	0.02 5	0.00 8	- 0.02 0	- 0.09 8	0.00 3	0.14 4	- 0.10 2	0.02 0	- 0.03 9
Soft ware upda tesp atch esfor ETI Msar enot push edce ntral lyan d	- 0.06 1	- 0.05 2	0.05 5	- 0.05 9	0.01 5	- 0.031	0.00 3	0.02 4	0.116	0.014	- 0.10 2	0.22 0	0.01 6	- 0.06 3
The ORS syste mall ows depo staf	0.00 2	- 0.01 8	- 0.02 9	0.01 4	- 0.04 1	- 0.05 0	0.02 4	- 0.02 4	- 0.01 0	0.03 2	0.02 0	0.01 6	0.07 3	- 0.01 8



ftog ener atem anua ltick etsfo r														
ETI Msp ermi tissu ance ofoti cket sorr eryh ighc once ssio nswi t	0.08 6	0.05 5	- 0.01 2	0.01 5	0.02 3	0.00 3	- 0.01 7	- 0.02 9	- 0.07 2	- 0.015	- 0.03 9	- 0.06 3	- 0.01 8	0.19 0
ETI Msal lowc ond ucto rstoi ssue ticke tsaft erth ebus hasc omp le	.580 a	0.47 9	- 0.42 7	0.29 1	- 0.23 3	0.23 9	0.09 9	- 0.67 6	- 0.43 0	- 0.122	0.00 7	- 0.33 0	0.02 2	0.49 8
Con duct orsc anlo gint omu ltipl eETI Mssi mult aneo usly usin	0.47 9	.567 ^a	- 0.52 0	0.54 2	0.10 5	0.49 4	- 0.581	- 0.22 0	- 0.63 6	- 0.24 9	0.25 4	- 0.53 5	- 0.317	0.60 6



gthe														
The ORS webs iteap p per mits bulk cancellati ona ndre book ingo f	- 0.42 7	- 0.52 0	.411 ^a	- 0.82 9	0.52 7	- 0.241	- 0.04 1	0.50 7	0.75 0	0.09 3	- 0.68 9	0.43 7	- 0.39 6	- 0.10 6
ETI Msc anbe puti no ffl ine mod efor exte nde dper iods with out	0.29 1	0.54 2	- 0.82 9	.413 ^a	- 0.26 1	0.43 9	- 0.123	- 0.45 9	- 0.79 2	- 0.371	0.69 7	- 0.46 5	0.19 5	0.12 5
Para mete rsett ingsf areta bles conc essio nat esca nbe mod ifi	- 0.23 3	0.105	0.52 7	- 0.26 1	.572 ^a	0.29 3	- 0.72 6	0.57 6	0.312	- 0.52 8	- 0.47 4	0.131	- 0.61 2	0.21 7



Old ETI Mde vices with outG PRS allo wma nual entr yofti cket num	0.23 9	0.49 4	- 0.24 1	0.43 9	0.29 3	.590 ^a	- 0.551	0.09 6	- 0.34 4	- 0.62 8	0.22 4	- 0.22 4	- 0.62 3	0.02 6
ORS per mits book ingo fmor etick etsth anav ailab lesea tswit hout	0.09 9	- 0.581	- 0.04 1	- 0.12 3	- 0.72 6	- 0.551	.665 ^a	- 0.54 9	0.06 9	0.46 9	0.14 8	0.04 1	0.59 9	- 0.27 5
Con duct orsc anre print thes amet icket seria lnu mbe rmul tiple ti	- 0.67 6	- 0.22 0	0.50 7	- 0.45 9	0.57 6	0.09 6	- 0.54 9	.650 ^a	0.53 6	- 0.135	- 0.27 6	0.27 5	- 0.46 7	- 0.34 6
Ther eism oOT Porb iome triv erifi	- 0.43 0	- 0.63 6	0.75 0	- 0.79 2	0.31 2	- 0.34 4	0.06 9	0.53 6	.107 ^a	0.114	- 0.62 5	0.59 7	- 0.09 0	- 0.40 3



catio nwh enac ond ucto rlogs														
ORS canc ellati onre fund sare proc esse daut oma ticall ywit hout ver	- 0.122	- 0.24 9	0.09 3	- 0.37 1	- 0.52 8	- 0.62 8	0.46 9	- 0.135	0.114	.700 ^a	0.01 7	0.07 2	0.29 6	- 0.08 5
ETI Msd onot logG PSlo catio natt heti meo ftick etiss uanc ema	0.00 7	0.25 4	- 0.68 9	0.69 7	- 0.47 4	0.22 4	0.14 8	- 0.27 6	- 0.62 5	0.017	.291 ^a	- 0.57 3	0.19 5	- 0.23 8
Soft ware upda tesp atch esfor ETI Msar enot push edce ntral lyan d	- 0.33 0	- 0.53 5	0.43 7	- 0.46 5	0.131	- 0.22 4	0.04 1	0.27 5	0.59 7	0.07 2	- 0.57 3	.564 ^a	0.127	- 0.30 9

The ORS system allows depot staff to generate annual tickets for	0.022	-0.317	-0.396	0.195	-0.612	-0.623	0.599	-0.467	-0.090	0.296	0.195	0.127	.655 ^a	-0.150
ETIMs permit issuance of tickets for every high concessionist	0.498	0.606	-0.106	0.125	0.217	0.026	-0.275	-0.346	-0.403	-0.085	-0.238	-0.309	-0.150	.414 ^a

Source : Author's Compilation through SPSS

This supports the reliability of the sample and confirms that factor analysis can be conducted without removing any variables.

Table No 05: Communalities

Variable	Initial	Extraction
ETIMs allow conductors to issue tickets after the bus has completed the trip (backdating).	1.000	0.779
Conductors can log in to multiple ETIMs simultaneously using the same credentials.	1.000	0.799
The ORS website/app permits bulk cancellation and re-booking of tickets without any audit trail.	1.000	0.9
ETIMs can be put in "offline mode" for extended periods without triggering central alerts.	1.000	0.936
Parameter settings (fare tables, concession rates) can be modified at the depot level without central approval.	1.000	0.856
Old ETIM devices (without GPRS) allow manual entry of ticket numbers and amounts.	1.000	0.936

ORS permits booking of more tickets than available seats without blocking.	1.000	0.928
Conductors can reprint the same ticket serial number multiple times on the same ETIM.	1.000	0.868
There is no OTP or biometric verification when a conductor logs into an ETIM.	1.000	0.766
ORS cancellation refunds are processed automatically without verifying whether the passenger travelled.	1.000	0.75
ETIMs do not log GPS location at the time of ticket issuance, making stage-wise verification difficult.	1.000	0.883
Software updates/patches for ETIMs are not pushed centrally and depend on depot IT staff.	1.000	0.857
The ORS system allows depot staff to generate manual tickets for online bookings that were actually not paid.	1.000	0.938
ETIMs permit issuance of ₹0 tickets or very high concessions without supervisor password.	1.000	0.778

Source : Author's Compilation through SPSS

Interpretation: Extraction Method: Principal Component Analysis.

- No item exhibited low extraction values; therefore, all items were retained in the final factor solution.
- Total Variance Explained
- A principal component analysis using the Kaiser criterion (eigenvalues > 1) resulted in a five-factor solution, collectively explaining 85.53% of the total variance. This is exceptionally high for behavioural or perception-based data, indicating that the extracted factors capture the majority of variation in the vulnerability indicators.
- The first component alone accounted for 45.53% of the variance, followed by subsequent components contributing 13.16%, 10.75%, 8.48%, and 7.61% respectively. These results demonstrate a robust and meaningful factor structure underlying ETIM and ORS vulnerabilities.

Table No 06: Total variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.374	45.529	45.529	6.374	45.529	45.529	4.031	28.795	28.795
2	1.842	13.159	58.689	1.842	13.159	58.689	2.396	17.111	45.906
3	1.505	10.751	69.440	1.505	10.751	69.440	2.150	15.357	61.263
4	1.187	8.479	77.919	1.187	8.479	77.919	1.716	12.259	73.523
5	1.066	7.611	85.530	1.066	7.611	85.530	1.681	12.007	85.530
6	.637	4.551	90.081						
7	.578	4.127	94.208						
8	.342	2.444	96.652						
9	.191	1.367	98.018						
10	.108	.768	98.787						
11	.085	.610	99.397						
12	.057	.408	99.805						
13	.016	.113	99.918						
14	.011	.082	100.000						

Extraction Method: Principal Component Analysis.

Source : Author's Compilation through SPSS

Scree Plot Interpretation

The scree plot was examined to validate the number of factors retained. A clear inflection point was observed after the fifth component, after which eigenvalues declined sharply and stabilized. This 'elbow' strongly supports retaining five factors, consistent with the eigenvalue criterion.

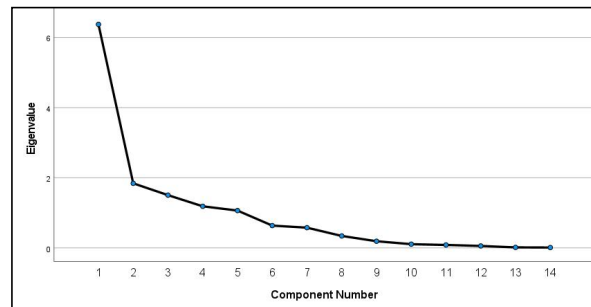


Figure No 1: Scree Plot

Component Plot in Rotated Space

The component plot further visualized the distribution of variables across the extracted components. Variables representing similar vulnerability types clustered together in multidimensional space, confirming the consistency of the factor model.

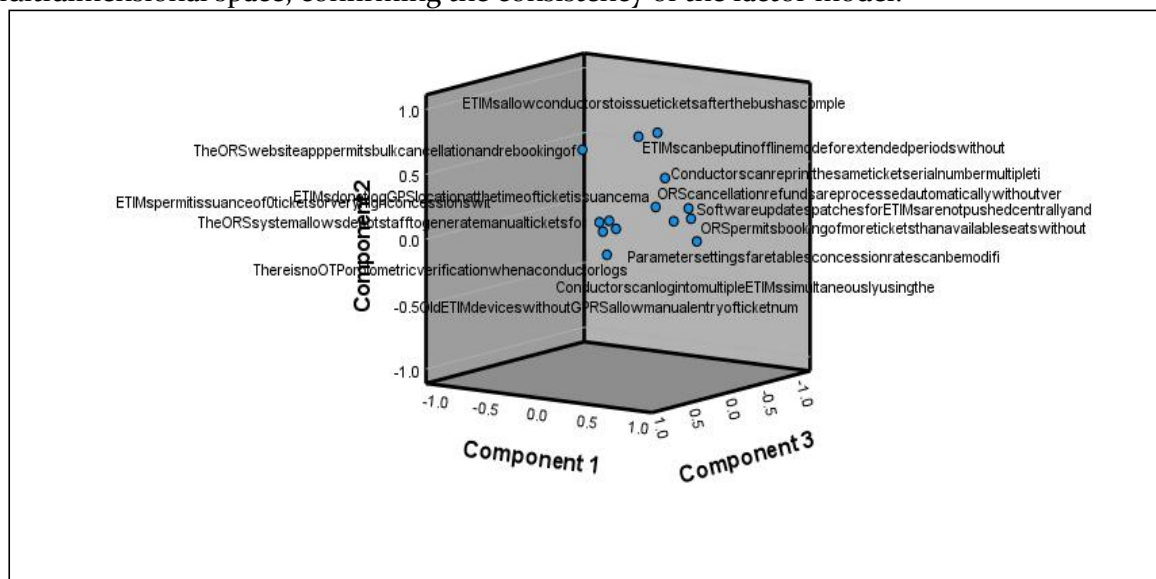


Figure No 2: Component Plot in Rotated Space

This visualization reinforces the interpretation that ETIM and ORS vulnerabilities form clear, distinct patterns in the dataset.

Interpretation of Extracted Factors

The five components extracted from the analysis represent meaningful dimensions of vulnerability:

Factor 1: ETIM Operational Misuse Vulnerabilities: This factor included variables such as conductors logging into multiple devices, reprinting tickets, extended offline mode usage, and absence of GPS tagging. These vulnerabilities indicate significant operational loopholes within the ETIM system that can be exploited during ticketing operations.

Factor 2: ORS System Manipulation Risks: Items such as bulk cancellations, rebookings, unverified refunds, overbooking, and manual ticket generation loaded strongly onto this factor.

These weaknesses reflect structural gaps in the ORS platform that enable manipulation of online transactions.

Factor 3: Administrative Control Weaknesses: This factor grouped variables related to parameter editing without approval, decentralized fare table modifications, inactive login account management, and lack of centrally controlled updates. These weaknesses highlight the administrative lapses that limit accountability.

Factor 4: Security and Verification Weaknesses: The absence of OTP or biometric login, inadequate verification mechanisms, and missing GPS coordinates formed this factor. These issues compromise system security and enable misuse without traceability.

Factor 5: System Configuration and Ticket Integrity Issues: Variables involving unauthorized ticket issuance, improper fare configuration, and manual input vulnerabilities loaded onto this factor. These gaps undermine the integrity and accuracy of ticketing and revenue systems.

Together, these factors provide clear evidence of diverse and systematic vulnerabilities affecting both ETIM and ORS platforms.

Discussion of Findings

The results of the Exploratory Factor Analysis (EFA) strongly support Hypothesis. The identification of five clear factors shows that vulnerabilities in ETIM and ORS systems are not limited to a single issue but exist across technical and administrative processes. The high level of explained variance (85.53%) indicates that these weaknesses are closely connected and form a strong overall pattern involving operational, security, and administrative issues.

The factors identified in the analysis closely match common risk areas found in transport ticketing systems. These include misuse of ETIM devices, manipulation of ORS transactions, weak administrative control, poor security verification, and loss of integrity in ticket issuance.

The grouping of variables under these factors suggests that system-level problems, rather than isolated incidents, create opportunities for misuse and manipulation. These systemic weaknesses contribute to revenue leakage and reduce operational efficiency.

Conclusion for Hypothesis 2

The Exploratory Factor Analysis resulted in a strong five-factor model that explains 85.53% of the variation in ETIM and ORS vulnerability indicators. The findings clearly show that technical weaknesses, administrative lapses, security failures, and system configuration issues play a major role in enabling misuse and manipulation.

Therefore, Hypothesis H_{2i} is accepted, confirming that vulnerabilities in ETIM and ORS systems have a significant and measurable impact on fraudulent or irregular activities within MSRTC.

3.8.3 Results of Hypothesis Testing (H₃)

This hypothesis was designed to check whether weaknesses in system controls usually occur together instead of appearing separately. Since the data were collected using a Likert scale and initial tests showed that the data were not normally distributed, the Spearman rank-order correlation test was chosen for analysis.

Spearman's correlation is a nonparametric method that is suitable for ordinal data, small sample sizes, and data that do not follow a normal distribution. It helps in understanding the strength and direction of the relationship between variables.

The hypotheses were stated as follows:

- Null Hypothesis (H_{3o}): There is no significant relationship among access control gaps, system permission gaps, and parameter setting gaps.

- Alternative Hypothesis (H_{3i}): There is a significant positive relationship among access control gaps, system permission gaps, and parameter setting gaps.

To test this hypothesis, average (mean) scores were calculated for the three variables: Access Control Gaps (AC_Mean), System Permission Gaps (SP_Mean), and Parameter Setting Gaps (PS_Mean). These mean scores were then analyzed using Spearman's correlation test in SPSS.

Statistical Method

To test this hypothesis, the Spearman Rank-Order Correlation method was used. This method was chosen because the data were collected using Likert-scale questions, which produce ordinal data. Initial checks showed that the data did not follow a normal distribution, so parametric tests were not suitable. The sample size used in the study was small, and Spearman's correlation works well with small datasets. The purpose of the analysis was to understand the strength and direction of the relationship among the three variables: Access Control Gaps (AC), System Permission Gaps (SP), and Parameter Setting Gaps (PS).

Therefore, Spearman's rho was considered the most appropriate statistical technique for examining the relationships among AC, SP, and PS.

Table No 7: Spearman Correlation Matrix for Access Control Gaps (AC_Mean), System Permission Gaps (SP_Mean), and Parameter Setting Gaps (PS_Mean).

Correlations					
			AC_Mean	SP_Mean	PS_Mean
Spearman's rho	AC_Mean	Correlation Coefficient	1.000	.683**	.698**
		Sig. (2-tailed)	.	<.001	<.001
		N	21	21	21
	SP_Mean	Correlation Coefficient	.683**	1.000	.539*
		Sig. (2-tailed)	<.001	.	.012
		N	21	21	21
	PS_Mean	Correlation Coefficient	.698**	.539*	1.000
		Sig. (2-tailed)	<.001	.012	.
		N	21	21	21
** . Correlation is significant at the 0.01 level (2-tailed).					
* . Correlation is significant at the 0.05 level (2-tailed).					

Source : Author's Compilation through SPSS

Graphical Representation of Relationships

The structural relationships among the three constructs were further illustrated using a graphical SEM-style model. This visual representation demonstrates how higher levels of gaps in one area of system control are associated with increased gaps in the other areas.

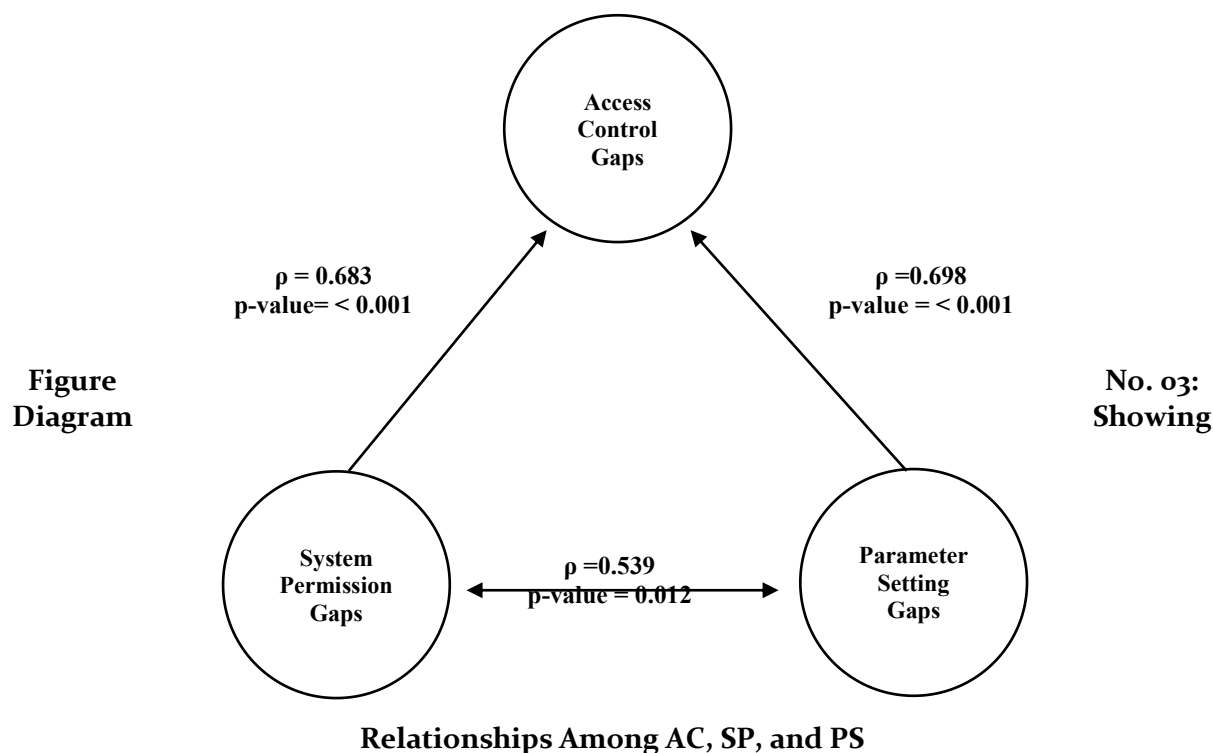


Fig No. 03 depicts the positive and statistically significant correlations among Access Control Gaps, System Permission Gaps, and Parameter Setting Gaps. The values shown on the arrows represent the Spearman correlation coefficients and their corresponding significance levels.

Interpretation

The results of Spearman's correlation analysis show that all three system control gaps are positively and significantly related to each other. Access Control Gaps have a strong positive relationship with System Permission Gaps ($\rho = 0.683$, $p < .001$). This means that when access control weaknesses increase, permission management weaknesses also increase. Access Control Gaps also show a strong positive relationship with Parameter Setting Gaps ($\rho = 0.698$, $p < .001$). This indicates that organizations with poor access control are also likely to have problems with system parameter settings.

In addition, System Permission Gaps are moderately and significantly related to Parameter Setting Gaps ($\rho = 0.539$, $p = .012$). This shows that weaknesses in permission management are connected with weaknesses in parameter configuration.

Overall, these results indicate that system control weaknesses are interconnected. A gap in one area is usually linked with gaps in other areas, showing that internal control problems do not occur alone. Since all the correlations are positive and statistically significant, the null hypothesis (H_{30}) is rejected, and the alternative hypothesis (H_{31}) is accepted.

Conclusion for Hypothesis 3

The statistical results support Hypothesis 3 (H_{31}). The findings clearly show that access control gaps, system permission gaps, and parameter setting gaps do not exist separately. Instead, they are strongly and positively related to each other. This means that when one type of control weakness is present, other weaknesses are also likely to exist. These results confirm that internal control problems are interconnected and form a combined system of vulnerabilities. Understanding these connections is important for developing effective risk control measures

and for improving the overall organizational control framework.

3.8.4 Results of Hypothesis Testing (H₄)

The fourth hypothesis was designed to study whether the centralized financial system of MSRTC, which was introduced to improve transparency and control, contains structural weaknesses that contribute to revenue loss. This hypothesis was developed after examining organizational processes, internal controls, ticketing systems, and audit reports, which indicated that built-in weaknesses in the centralized digital system could affect financial performance.

The hypotheses were stated as follows:

- Null Hypothesis (H_{4o}): There is no significant relationship between structural flaws in the centralized financial system and revenue loss.
- Alternative Hypothesis (H_{4i}): There is a significant relationship between structural flaws in the centralized financial system and revenue loss.

To test this hypothesis, twelve variables representing structural flaws were combined to create a Structural Flaw Index (SFV_Mean). The variable representing revenue loss was taken as RLV_1. Both variables were measured using a five-point Likert scale.

Because the data are ordinal in nature and the sample size was small (N = 13), the Spearman Rank Correlation test was used as the most suitable non-parametric statistical method.

Statistical Method

To examine the relationship between structural flaws and revenue loss, Spearman's rank-order correlation was used. This method is appropriate because the data are ordinal, the sample size is small, and the data does not follow a normal distribution.

A Structural Flaw Index (SFV_Mean) was created by calculating the average of twelve structural flaw variables. This helped in producing a single, clear score for each respondent, making the analysis easier to understand and more reliable.

The correlation analysis was conducted in SPSS using the Bivariate Correlation option, with Spearman's rho selected as the statistical measure. The results generated by SPSS are shown in the output table above.

Table No 8: Spearman rank-order correlation output for Structural Flaw Index (SFV_Mean) and Revenue Loss (RLV_1).

Correlations				
			SFV_Mean	RLV_1
Spearman's rho	SFV	Correlation Coefficient	1.000	.728**
		Sig. (2-tailed)	.	.005
		N	13	13
	RLV_1	Correlation Coefficient	.728**	1.000
		Sig. (2-tailed)	.005	.
		N	13	13

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

Source : Author's Compilation through SPSS

Spearman's correlation was used because data is based on Likert-scale responses, which are

ordinal and best analyzed using a rank-based method. This test also works well with small sample sizes and does not require the data to follow a normal distribution. Therefore, Spearman's correlation was the most suitable way to measure the relationship between structural flaws and revenue loss in this study.

Results and Interpretation

The SPSS correlation results show that the Spearman's rho value between Structural Flaw Index (SFV_Mean) and Revenue Loss (RLV_1) is 0.728, with a p-value of 0.005. This value indicates a strong positive relationship between structural flaws and revenue loss.

The positive correlation means that respondents who reported higher structural weaknesses in the centralized financial system also reported higher levels of revenue loss.

The significance value ($p = 0.005$) is lower than 0.01, showing that the relationship is statistically significant at the 1% level. This implies that the chance of this result occurring randomly is very low. Even though the sample size is small, the result remains reliable because Spearman's correlation is suitable for ordinal data and small samples.

Based on the correlation value and its significance, the null hypothesis (H_{4o}) is rejected, and the alternative hypothesis (H_{4i}) is accepted. This confirms that structural weaknesses in MSRTC's centralized financial system have a clear and measurable impact on revenue leakage.

Discussion of Findings

The results of the Spearman correlation analysis clearly show that structural weaknesses in MSRTC's centralized financial system are strongly linked to financial losses. This finding supports earlier qualitative observations that identified problems such as over-centralization, limited local monitoring, poor review of exception reports, missing data validation controls, opportunities for staff manipulation, and lack of proper training on new systems.

The strong positive relationship indicates that as these structural flaws increase, revenue leakage also increases. This supports views from internal control theory, which state that centralized systems without sufficient checks, independent review, and control mechanisms are more prone to misuse and inefficiency. The result also supports the earlier hypotheses of this study, which consistently pointed to system-level weaknesses within MSRTC's digital and administrative framework.

These findings have important implications for MSRTC. They highlight the need to review and improve the centralized system by introducing better transparency, automated audit trails, local-level verification, and stronger accountability mechanisms.

Conclusion for Hypothesis 4

The results of Hypothesis 4 confirm that structural weaknesses in MSRTC's centralized financial system significantly contribute to revenue loss. The strong and statistically significant relationship supports the issues highlighted in internal reports and stakeholder feedback. The findings suggest that improving system controls, strengthening monitoring mechanisms, enhancing data validation, and implementing effective audit procedures can help reduce revenue leakage and improve overall financial performance.

These results are important for understanding the wider pattern of financial difficulties faced by MSRTC and provide strong support for the recommendations presented later in this dissertation.

4. Results of Hypothesis Testing (H_5)

This hypothesis examines whether internal system controls, technological safeguards, and monitoring mechanisms play an important role in reducing revenue leakage in MSRTC.

Revenue leakage generally occurs due to operational weaknesses, manipulation of ticketing systems, misuse of Electronic Ticketing Machines (ETIMs), and weak tracking and audit systems. Therefore, understanding the views of stakeholders regarding these control measures helps in evaluating their effectiveness in improving financial discipline within the organization. The hypotheses were stated as follows:

- Null Hypothesis (H_{50}): Strengthening system controls, monitoring mechanisms, and audit processes does not significantly reduce revenue leakage in MSRTC.
- Alternative Hypothesis (H_{51}): Strengthening system controls, monitoring mechanisms, and audit processes significantly reduce revenue leakage in MSRTC.

Statistical Method

This hypothesis was tested using responses from twelve Likert-scale items, each representing system control, monitoring, or audit mechanism. The responses were ordinal in nature, measured on a scale from 1 to 5. Because the sample size was small and many variables did not follow a normal distribution, a nonparametric method was considered appropriate.

The analysis was carried out in SPSS using the One-Sample Nonparametric Test (NPTESTS) procedure. SPSS applied the One-Sample Kolmogorov-Smirnov (K-S) Test, which compared the actual response distribution of each variable with a neutral reference value of 3. This helped in determining whether respondents showed a significant shift away from neutrality toward agreement or disagreement.

A nonparametric test was chosen because Likert-scale data are ordinal and do not meet the assumptions required for parametric tests such as the t-test. The small sample size also made it unsuitable to assume normality. The histograms and K-S test results further confirmed that the data were not normally distributed.

Since the hypothesis involved multiple indicators representing a single concept, a combined nonparametric approach was more suitable than testing each variable separately. Therefore, the One-Sample Kolmogorov-Smirnov test under the NPTESTS procedure was selected as the most appropriate method to examine whether the responses consistently deviated from neutrality.

Results

Combined Boxplot Analysis

The combined boxplot (Chart No. 01) displays the distribution of all twelve system-control variables. For nearly all indicators, the median values lie above the neutral point (3), indicating respondent agreement toward the effectiveness of control mechanisms.

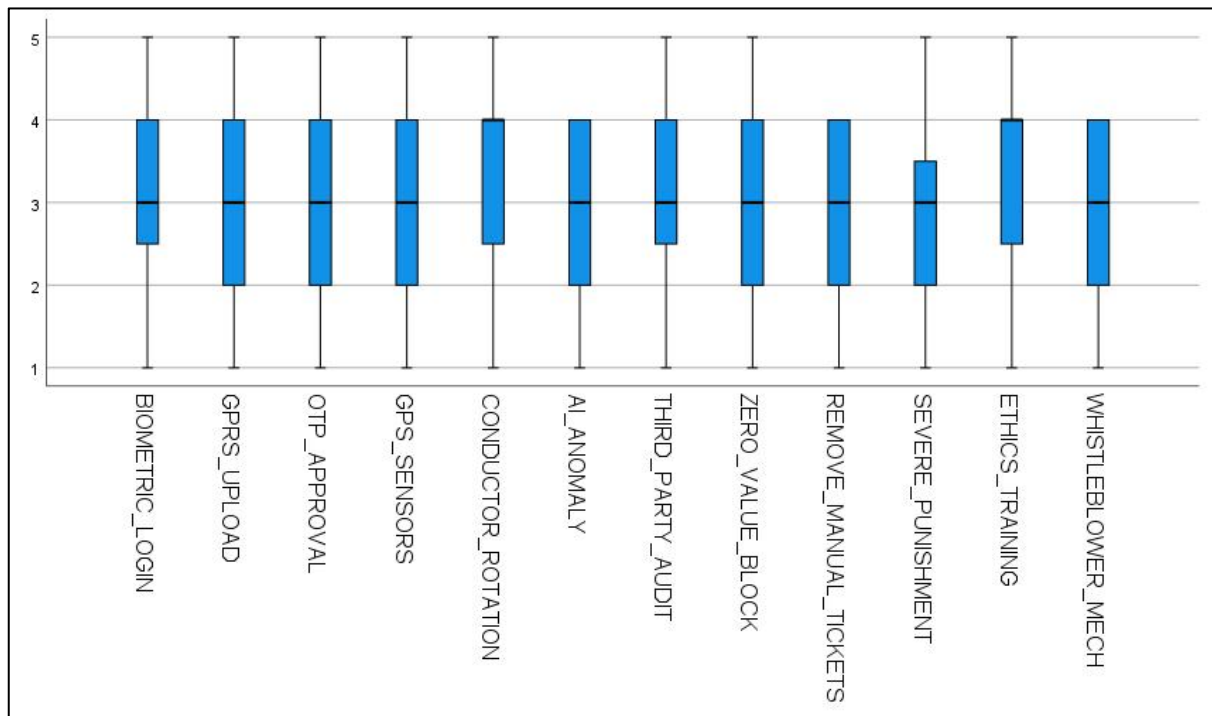


Chart No. 01: Boxplot showing the distribution and median responses for all twelve system-control indicators

Trend Plot Analysis

The line plot (Chart No. 02) demonstrates the response pattern across all cases. Although values fluctuate due to individual differences, the majority of responses cluster around higher values (3-5), with no consistent downward trend. This indicates a stable perception of agreement across indicators.

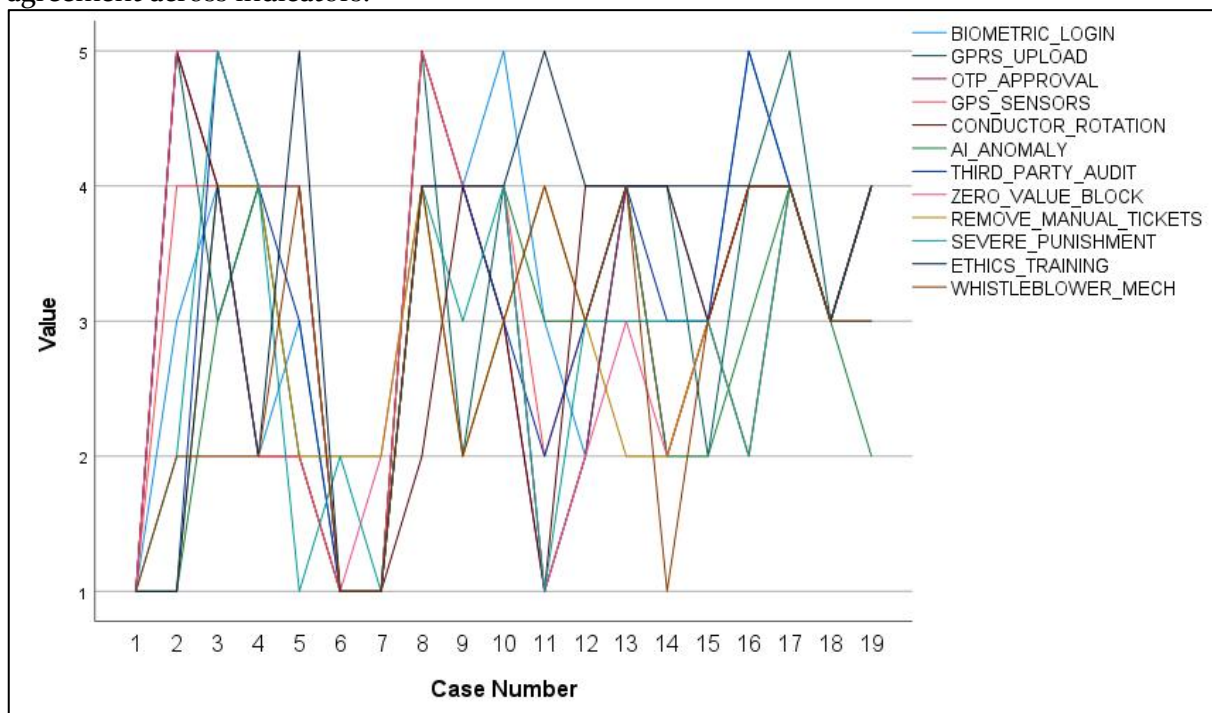




Chart No. 02: Trend plot illustrating respondent patterns across all system-control variables.

Kolmogorov-Smirnov Histograms

The set of histograms (Chart No. 03) visually demonstrates the skewness of each variable. Most histograms show distributions leaning toward higher values, confirming respondent agreement. Only one variable (Whistleblower Mechanism) displays a more neutral or balanced distribution.

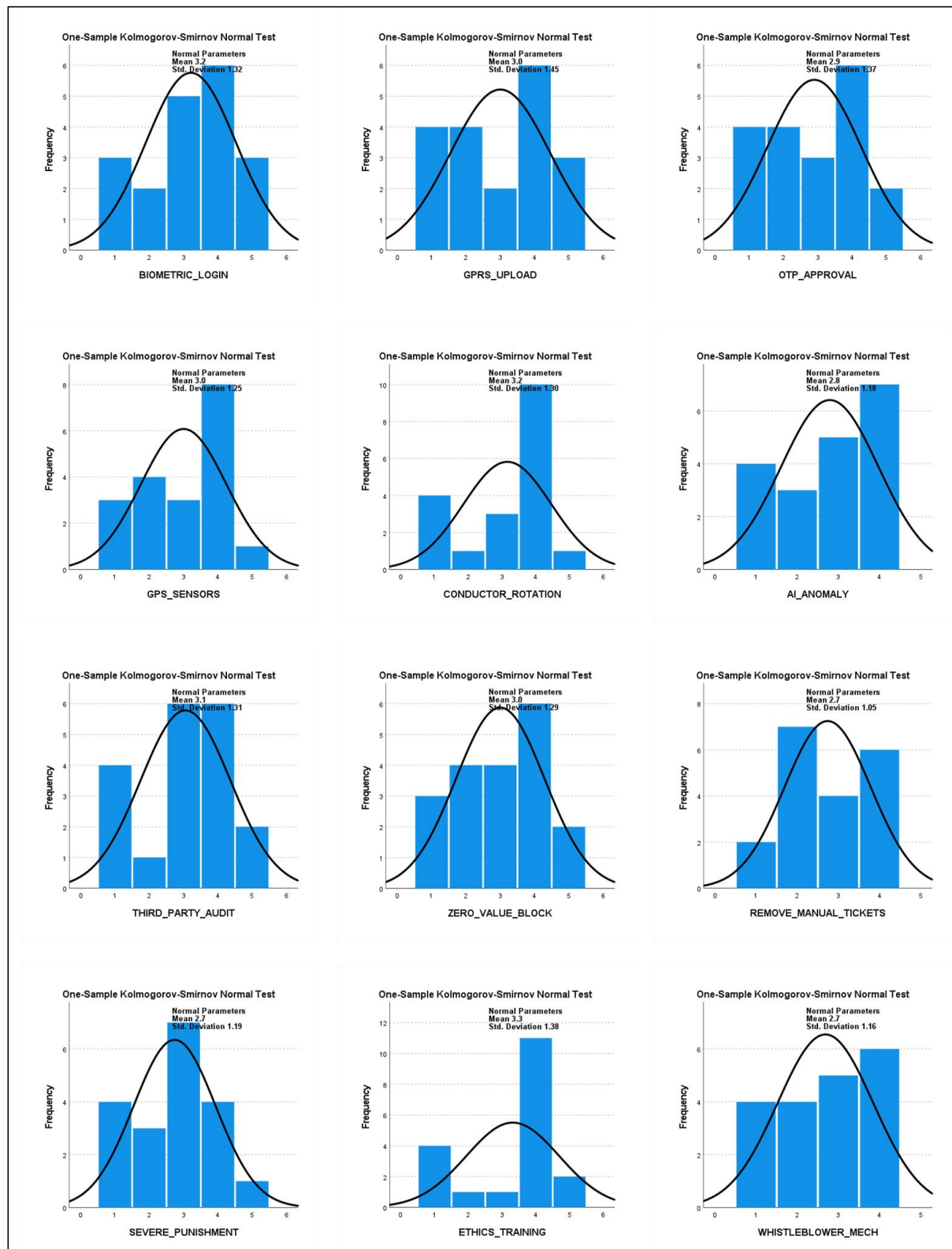


Chart No 03: K-S histograms showing distribution patterns and normal curve overlays for all twelve system-control indicators.

Interpretation of Results

The combined Kolmogorov-Smirnov (K-S) test results provide strong statistical support for this hypothesis. Out of the twelve control indicators, eleven showed a significant deviation from neutrality ($p < 0.05$), which indicates clear agreement among the respondents.

The indicators that showed significant agreement include biometric login systems, GPRS-based real-time data uploading, GPS-integrated sensors, OTP-based parameter changes, conductor rotation policies, AI-based anomaly detection, third-party audits, controls on zero-value tickets, removal of manual ticketing, strict penalties, and mandatory ethics training. Only the whistle-blower mechanism did not show statistical significance, indicating mixed opinions among respondents.

The boxplots and histograms show that most responses are above the neutral value, with medians and peak values indicating agreement. The line plot also confirms consistent agreement across most variables, with no strong trend of disagreement.

Overall, these results clearly show that respondents believe system controls, monitoring measures, and audit mechanisms play an important role in reducing revenue leakage.

Conclusion for Hypothesis 5

The results of the One-Sample Nonparametric Test, along with the supporting graphs, clearly show that respondents generally agree that stronger system controls, monitoring mechanisms, and audit processes help in reducing revenue leakage. Out of the twelve control indicators, eleven showed statistically significant results, indicating strong and consistent support for the hypothesis. Only one indicator showed mixed responses, which does not change the overall conclusion.

Therefore, Hypothesis H₅ is accepted.

3.9 Ethical Considerations

Since this research deals with sensitive issues such as financial irregularities and possible fraud in a public sector organization, strict ethical guidelines were followed throughout the study.

1. All participants were clearly informed about the purpose of the study, that their participation was voluntary, and how the data would be used. Consent was obtained only after providing this information.
2. Complete anonymity of respondents was maintained. No personal identification details were collected, and the data were analyzed in an aggregated form so that individual responses or departments could not be identified. This helped respondents share honest opinions about system weaknesses and control issues.
3. All collected data were securely stored and accessed only by the research team. The results were presented in a way that focused on system-level problems rather than blaming any individual.
4. The study was conducted with the intention of improving MSRTC's financial control and efficiency. Care was taken to ensure that the research did not cause harm or risk to the organization or its employees.

4.0 Practical Implications, Limitations and Conclusion

4.1 Practical Implications

The results of this study provide several important and practical suggestions for MSRTC management and governance.

1. The confirmation of Hypothesis 1 shows that MSRTC should focus more on strengthening its digital revenue systems rather than depending on external financial support. ETIMs and ORS

should not be treated only as ticketing tools but as core financial systems that require continuous security checks and audit monitoring.

2. The strong link between technical weaknesses (such as non-GPRS machines and delayed data synchronization) and revenue leakage suggests that fixing these issues can quickly reduce revenue loss. A key practical step is the complete removal of non-GPRS ETIMs and the use of real-time GPS-based tracking for all ticket transactions.
3. The results of Hypothesis 3 show that control weaknesses are closely connected. Therefore, correcting only one issue is not enough. MSRTC should implement a comprehensive control framework, including multi-factor authentication for staff access, clear separation of duties between IT and finance, and centralized control over fare and parameter settings.
4. The structural weaknesses identified under Hypothesis 4 highlight the need for a dedicated forensic audit unit. This unit should continuously monitor fraud-related activities such as bulk ticket cancellations, excessive offline usage, and unverified refunds, and should also ensure regular external audits.
5. The acceptance of Hypothesis 5 clearly indicates that technology-driven monitoring and audit mechanisms can play a decisive role in reducing revenue leakage. MSRTC should move toward advanced, automated oversight by adopting AI-based anomaly detection systems, centralized dashboards for real-time exception reporting, and continuous audit trails. Regular data analytics-based reviews of ETIM and ORS transactions can help identify unusual patterns early, enabling preventive action rather than post-facto investigation. This shift from reactive auditing to proactive, data-driven governance can significantly strengthen financial discipline and transparency within the organization.

4.2 Limitations of the Study

Although this study provides strong and meaningful findings, it has some limitations that should be considered while interpreting the results.

1. The study mainly used survey data collected through Likert-scale questionnaires, which reflect the opinions and experiences of MSRTC employees and experts. While this method is useful for understanding internal control issues, the results are based on perceptions rather than direct analysis of actual transaction data.
2. The study used a non-probability sampling method, such as purposive or convenience sampling. This limits the ability to apply the findings to the entire MSRTC organization. Since respondents were selected based on their knowledge and experience, there is a possibility of bias toward reporting known problems.
3. The analysis focused only on ETIM and ORS systems and centralized financial structure. Other possible causes of revenue loss, such as fuel misuse, spare parts management issues, or external competition, were not included in the study.
4. Data was collected at one point in time, which means the study does not track changes over a longer period. A long-term (longitudinal) study would be needed to measure the actual effects of improved control measures over time.

4.3 Conclusion

The financial problems faced by the Maharashtra State Road Transport Corporation (MSRTC) are mainly caused by systematic revenue leakage. This study clearly shows that these losses are strongly linked to major weaknesses in the centralized Electronic Ticketing Machine (ETIM) and Online Reservation System (ORS) structure.

The research confirms that technical weaknesses, administrative control gaps, and structural flaws are closely connected and play a significant role in causing financial losses. Although the centralized revenue system was introduced to improve control and transparency, weak internal controls have turned it into a single point of failure that can be misused.

The findings clearly indicate that MSRTC's financial recovery depends on the complete improvement of its control systems using technology. By applying the suggested technical and administrative reforms, especially mandatory GPRS integration, multi-factor authentication, and centralized control of system parameters, MSRTC can strengthen its revenue collection system. This will help create a more secure, transparent, and reliable system, reduce revenue leakage, and ensure MSRTC's continued role as an important public transport service.

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