Effect of Fuel Management Information Systems (FMIS) on the Operational Performance of Government Vehicles in Tanzania

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Abstract

The study examines the effects of Fuel Management Information Systems (FMIS) on the operational performance of government vehicles in Tanzania, focusing on digital tracking, fuel monitoring, and digital reporting. Conducted at the Ministry of Minerals headquarters in Dodoma, it adopted a pragmatism philosophy, a mixed-methods approach, and a cross-sectional design. A sample of 62 respondents, including drivers, transport officers, IT staff, procurement staff, and departmental heads, was selected through random and purposive sampling. Quantitative analysis employed multiple regression techniques. Findings revealed that digital tracking had a positive and significant effect on operational performance (β=0.387, p=0.000), which increased with individual moderators but became insignificant when combined. Fuel monitoring showed a strong positive and significant effect (β=0.595, p=0.000), remaining significant after individual moderation but turning negative under combined moderators (β=-0.225, p=0.020). Digital reporting had a positive but insignificant effect (β=0.016, p=0.795), which remained insignificant after individual moderation but became significantly negative under combined moderators (β=-0.896, p=0.024). The study recommends institutionalizing GPS-based tracking in all government vehicles, conducting training for drivers and fleet managers, and establishing robust data governance policies to secure information and enhance trust in FMIS usage.

Keywords: Fuel Management Information Systems, Operational Performance, Digital Tracking, Fuel Monitoring, Digital Reporting

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Introduction

Fuel Management Information Systems (FMIS) are digital platforms designed to monitor and optimize fuel consumption in vehicle fleets through technologies such as telematics, GPS tracking, real-time monitoring, and driver behaviour analysis (Abediasl et al., 2024). Globally, FMIS has been adopted by governments to improve operational performance by reducing costs, enhancing fuel efficiency, and improving fleet productivity (Limerick et al., 2023).

Studies highlight that FMIS addresses challenges such as fuel wastage, theft, excessive idling, and unsafe driving behaviours, which are common in manually managed fleets (Infrastructure, 2024). International evidence from the United States and the European Union shows FMIS as an effective tool for controlling fuel consumption and supporting data-driven decision-making in fleet management.

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In Tanzania, FMIS adoption is growing in government entities to centralize fuel usage control, enable vehicle tracking, and facilitate maintenance scheduling (Ngonyani, 2019). However, implementation remains limited, with most fleets still relying on traditional fuel management methods. The problem arises from high operational costs due to irregular vehicle use, poor driver behaviour, and limited technological integration, despite the government's efforts to establish centralized FMIS (Kanuku & Ng'eno, 2023).

While global literature documents FMIS benefits (Abedias et al., 2024), local empirical studies on its role in Tanzania's government fleet performance are scarce. The study seeks to determine the effects of Fuel Management Information Systems on the operational performance of government vehicles in Tanzania. The study's objectives are to examine FMIS's role in fuel optimization, operational cost control, and performance enhancement in state-owned fleets.

The research is important for providing evidence-based insights to improve government fleet management practices and policy decisions. The limitation lies in the study's focus on Tanzanian government fleets, which may restrict generalizability. The study employs a descriptive research design, using both primary and secondary data to analyse FMIS's impact on operational performance.

Theoretical Reference

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was developed by Wu & Chen (2012) to describe human behaviour and psychology towards the utilization of new technology. The model introduced two key dimensions, namely perceived ease-of-use (PEOU) and perceived usefulness (PU), in relation to technology acceptance (Amin et al., 2014; Chen & Aklikokou, 2020; Moslehpour et al., 2018). According to the model, in the first dimension, PEOU, technology users accept a technology if they believe it requires less effort to operate (Cheung & Vogel, 2013).

In the second dimension, PU, users accept technology if they believe it will help them solve specific problems or tasks and provide expected outcomes (Wu & Chen, 2017). The model was later modified to include a third dimension, attitudes toward usage (ATU), which encompasses the emotions and feelings towards the technology, highly influenced by cultural and social perspectives. The TAM is widely applied in business and technology-related studies to explain how users adopt and utilize innovations (Kennedy & Thornberg, 2018).

In the context of the present study, the TAM is relevant for guiding the investigation into the impact of Fuel Management Information Systems (FMIS) on the operational performance of government vehicles in Tanzania. The adoption of FMIS has increased within government fleets as a strategy to control fuel consumption. The technology, primarily used by transport officers and drivers, operates through specialized digital components within a networked information system.

The theory supports the study in exploring how perceived usefulness and perceived ease-of-use influence the application of FMIS. It helps assess how users perceive the usefulness of FMIS in digital tracking, fuel monitoring, and digital reporting, and whether the ease of applying FMIS in these areas affects their acceptance and continued use of the technology.

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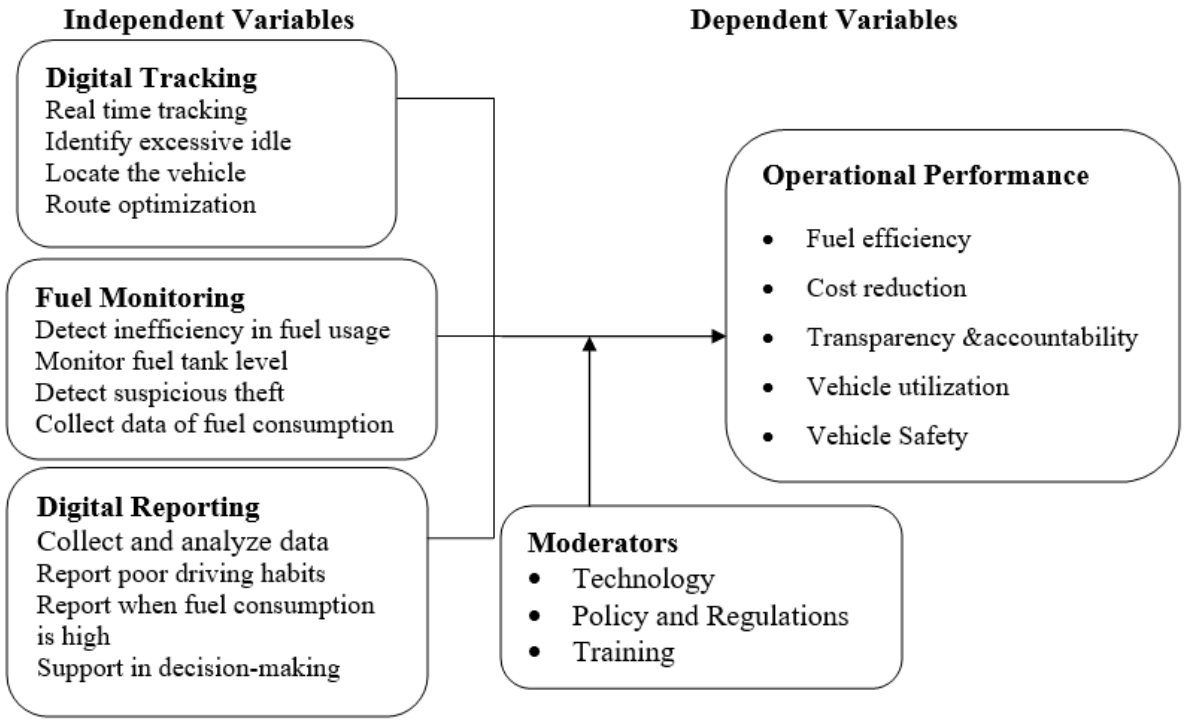

Figure 1. Conceptual Framework
Source: Adopted from Ansari (2025)

Methods

The The study adopts a pragmatism philosophy to guide planning, data collection, and analysis, combining quantitative and qualitative approaches to address the research problem effectively. This philosophy provides the theoretical basis for investigating the influence of technology on fuel usage efficiency in government vehicle fleet management, supporting the use of mixed methods for a comprehensive understanding of the phenomenon. A mixed research approach is employed, integrating both quantitative and qualitative methods to collect, manage, and analyse data in line with the study objectives. This approach ensures that the study captures diverse perspectives from participants directly involved in fleet management, thereby enhancing the depth and validity of findings. The cross-sectional research design is used to collect data at a single point in time, allowing the researcher to assess the operational realities of the Ministry's fleet within a defined timeframe. The research is conducted at the Ministry of Minerals headquarters in Dodoma, Tanzania, selected for its significant role in government fleet operations. The target population consists of 161 employees from various departments, with a sample size of 62 determined using Yamane's formula. Simple random sampling is used to ensure representativeness, while purposive sampling targets key informants such as the IT manager, transport officer, and departmental heads, who possess direct knowledge and authority relevant to the study's focus.

$$n = \frac{N}{1 + N(e^2)}$$

Where: n= Sample size

N= Number of individuals in the population (N=161)

e= error precision (0.1)

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The study used primary and secondary data to examine the role of technologies in fuel usage efficiency for government fleet management. Primary data were gathered through structured questionnaires from drivers and ministry staff, and in-depth interviews with five key informants. Secondary data were obtained from reports, records, and publications to validate findings. Quantitative data were analyzed using IBM SPSS version 27 with descriptive statistics (percentages, means, standard deviations) and inferential tests (correlation and multiple regression) at a set significance level. Qualitative data from interviews were thematically analyzed to provide deeper insights and complement quantitative results.

Results and Discussion

Correlation Analysis

The results indicate that digital tracking (r = 0.646) and fuel monitoring (r = 0.632) are both strongly and significantly associated with improved operational performance, while digital reporting (r = 0.048) shows a weak, non-significant effect. The moderating variable has weak positive correlations with all three components, suggesting limited influence. Digital tracking and fuel monitoring are highly interrelated (r = 0.695), whereas digital reporting functions more independently and even shows a negative correlation with digital tracking.

Table 1. Correlation Matrix Results

		1	2	3	4	5
1	Digital Tracking	1				
2	Fuel Monitoring	.695	1			
3	Digital Reporting	-.071	.099	1		
4	Moderating factors	.293	.200	.211	1	
5	Performance	.646	.632	.048	.072	1

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

Source: Field data, 2025

Model Summary

The three models show progressive improvement in explaining operational performance of government vehicles: (1) Model 1 (FMIS components only) explained 76.2% of the variance (Adjusted R^2 = 74.8%); (2) Model 2 (FMIS + moderating variable) increased explanatory power to 79.0% (Adjusted R^2 = 77.4%); (3) Model 3 (FMIS + moderator + interaction effects) achieved the highest explanatory power at 86.4% (Adjusted R^2 = 84.4%), indicating the strongest model fit.

Table 2. Modal Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.873[a]	.762	.748	.34112
2	.889[b]	.790	.774	.32356
3	.929[c]	.864	.844	.26818

Source: Field data, 2025

Regression Coefficients

The study found that digital tracking and fuel monitoring each had a strong and positive effect on operational performance when tested separately, with coefficients of $\beta = 0.387$ ($p < 0.001$)

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and β = 0.595 (p < 0.001), respectively. When moderating factors such as technology, policies/regulations, and training were added, the effect of both variables slightly increased but remained statistically significant. However, when looking at interaction effects, digital tracking became insignificant (β = -0.078, p > 0.05), and fuel monitoring turned negative (β = -1.225, p = 0.020). On the other hand, digital reporting was weak and insignificant in the first two models, but its interaction with the moderating factors became positive and significant (β = 0.896, p = 0.024).

The moderating variables alone had a negative but significant effect on operational performance in Model 2 (β = -0.126, p = 0.011), suggesting that they reduced the positive influence of FMIS components. In Model 3, this negative effect remained (β = -0.801, p = 0.075) but was no longer significant. Interaction analysis showed that there was no significant moderation for digital tracking (β = -0.078, p = 0.454) and a negative significant effect for digital reporting (β = -0.181, p = 0.029). Only fuel monitoring showed a positive and significant moderation effect (β = 0.399, p = 0.001), meaning that it benefits the most from the presence of technology, policies, and training.

Table 3. Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.106	.434		.245	.808
	Digital Tracking	.387	.099	.369	3.914	.000
	Fuel Monitoring	.595	.098	.575	6.085	.000
	Digital Reporting	.016	.061	.018	.261	.795
2	(Constant)	.250	.415		.602	.550
	Digital Tracking	.456	.097	.434	4.684	.000
	Fuel Monitoring	.581	.093	.561	6.250	.000
	Digital Reporting	.055	.060	.062	.927	.358
	Moderating variables	-.126	.048	-.180	-2.650	.011
3	(Constant)	3.598	2.108		1.707	.094
	Digital Tracking	.726	.466	.691	1.557	.126
	Fuel Monitoring	-1.225	.511	-1.182	-2.398	.020
	Digital Reporting	.896	.386	1.004	2.320	.024
	Moderating	-.801	.440	-1.143	-1.818	.075
	Digital Tracking Moderator	-.078	.104	-.657	-.755	.454
	Fuel Monitoring Moderator	.399	.112	3.328	3.548	.001
	Digital Reporting Moderator	-.181	.081	-1.527	-2.246	.029

Dependent Variable: Operational Performance

Predictors: (Constant), Digital Reporting, Digital Tracking, Fuel Monitoring

Predictors: (Constant), Moderating, Fuel Monitoring, Digital Reporting, Digital Tracking

Predictors: (Constant), digital Tracking Moderator, fuel monitoring Moderator, Moderating, Digital Reporting Moderator, Digital Reporting, Digital Tracking, Fuel Monitoring

Source: Field data, 2025

Discussions

Digital Tracking and Operational Performance

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The study found that digital tracking had a strong, positive, and statistically significant relationship with the operational performance of government vehicles. Without moderation, the analysis showed that a one-unit increase in digital tracking corresponded to a 0.387-unit improvement in performance ($p = 0.000$). This suggests that tracking technologies such as GPS and telematics play a crucial role in enhancing fleet efficiency by enabling real-time vehicle location monitoring, route optimization, and reduction of inefficiencies such as detours, speeding, and prolonged idling (Zohari & Nazri, 2021).

When moderating variables such as technology, policy and regulations, and training were introduced (Model 2), the coefficient increased slightly to $\beta = 0.456$ ($p = 0.000$), showing that these contextual factors marginally strengthened the effect of digital tracking. However, in the fully moderated interaction model (Model 3), the coefficient increased further to $\beta = 0.726$ but became statistically insignificant ($p = 0.126$), indicating that while digital tracking is effective on its own, the interaction with moderating variables does not necessarily enhance its impact.

In fact, when digital tracking was directly interacted with moderating variables, the coefficient became negative ($\beta = -0.078$, $p = 0.454$), implying that such interactions may slightly diminish its operational impact. However, consistent with previous studies, digital tracking independently improved driver behavior monitoring, reduced accidents, and enhanced preventive maintenance scheduling, contributing to greater transparency, accountability, and resource optimization in public sector fleet operations.

Fuel Monitoring and Operational Performance

Fuel monitoring demonstrated a strong and statistically significant positive influence on operational performance in all initial models. In the baseline model, the coefficient was $\beta = 0.595$ ($p = 0.000$), indicating that increased use of fuel monitoring systems correlated with notable improvements in efficiency. By installing in-tank digital sensors integrated with centralized platforms, managers were able to track fuel consumption rates, detect anomalies such as theft or leakage, and address inefficient driving behaviors. When moderating variables were included (Model 2), the coefficient was slightly reduced to $\beta = 0.581$ ($p = 0.000$), suggesting continued significance.

However, in the interaction model (Model 3), the coefficient sharply dropped to $\beta = -1.225$ ($p = 0.020$), indicating that combining moderating factors with fuel monitoring had a negative influence on operational performance. This aligns with previous findings showing that while fuel monitoring systems are highly effective on their own, their benefits may be diminished by complex administrative or operational interventions (Rehfuess et al., 2014). Despite this, the technology supported predictive budgeting and accurate forecasting of fuel requirements, reduced unnecessary procurement costs, and extended vehicle lifespan by ensuring engines operated under optimal conditions.

Moderating Variables and Operational Performance

Moderating variables comprising technology, policy and regulations, and training had mixed effects on operational performance. In Model 2, the coefficient for moderating variables was negative ($\beta = -0.126$, $p = 0.011$), indicating a statistically significant but adverse impact. This suggests that while intended to improve efficiency, certain regulatory, technological, or training-related interventions may impose constraints or inefficiencies in fleet operations.

When the moderating variables were included in interaction terms (Model 3), their coefficient further decreased to $\beta = -0.801$ ($p = 0.075$), making the effect statistically insignificant. This

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implies that, when integrated with FMIS components, the combined moderating environment does not substantially enhance operational performance (Olumoh, 2025). Interaction analyses revealed that moderation weakened the relationship between digital tracking and performance ($\beta = -0.078$, $p = 0.454$), slightly enhanced fuel monitoring ($\beta = 0.399$, $p = 0.001$), and negatively affected digital reporting ($\beta = -0.181$, $p = 0.029$). This pattern suggests that the moderating environment may not uniformly benefit all FMIS components and, in some cases, could reduce their effectiveness (Chang et al., 2014).

Novelty of the Study

This study examines how Fuel Management Information Systems (FMIS) influence the operational performance of government vehicles in Tanzania, a context that has received little attention in existing research. Unlike most previous studies that focused on private companies or developed countries, it looks at FMIS use in the public sector of a developing country. It also combines three FMIS components digital tracking, fuel monitoring, and digital reporting while considering how technology, policies, and training affect their effectiveness. This approach provides new evidence and practical insights to help fleet managers improve efficiency, reduce costs, and strengthen accountability in government vehicle operations.

Conclusion

This study found that Fuel Management Information Systems (FMIS), especially digital tracking and fuel monitoring, play an important role in improving the operational performance of government vehicles in Tanzania by increasing efficiency, reducing costs, and improving accountability. Digital reporting by itself showed little effect, but it became more useful when combined with factors such as technology, policies, and training. The findings also showed that while FMIS components are effective individually, the combined effect with moderating factors does not always strengthen performance and can sometimes reduce it. The study is limited because it focused only on government fleets in Tanzania, which means the results may not fully apply to other sectors or countries. It also used a descriptive design and self-reported data, which may affect accuracy and make it difficult to prove cause and effect.

Suggestions

Future research should include private sector fleets and compare results across different countries to make the findings more general. Studies that use longitudinal or experimental methods would also help to better understand cause and effect, and further research should look at other factors such as organizational culture, technology readiness, and user skills to provide deeper insights into FMIS use in different contexts.

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