

The effect of Fleet Maintenance Management on project performance:

A case study in school bus transportation
In Madinah/Saudi Arabia in SEITCO Company

تأثير إدارة صيانة الأسطول على أداء المشروع:
دراسة حالة في النقل بالحافلات المدرسية في شركة سيتكو
بالمدينة المنورة / السعودية

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DEDICATION

This research is dedicated to my family, parents and colleagues.

Abstract

Project performance is always one of the key concerns of project managers. It is often regarded as the critical indicator to measure the success of project Management.

Organizational performance is one of the most important constructs in management research. Reviewing past studies reveals a multidimensional conceptualization of organizational performance related predominately to stakeholders.

The evolution of fleet maintenance and management policies highlights the growing importance of maintenance issues in both private and public companies.

The need to improve Fleet maintenance performance requires an accurate evaluation of the trade-off between costs and benefits related to alternative fleet maintenance and management policies. However, the complexity of maintenance system makes this evaluation a very difficult task.

The fleet maintenance management influences as the vehicle maintenance process itself as well as the primary transport process but also their environment. In order to increase fleet energy efficiency by means of a more efficient maintenance management, it is indispensable to observe maintenance process, transport process and the environment.

Since different indicators can measure the implementation effects of such measures, this paper analyses the influence of indicators in all three mentioned areas on management decision-making.

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1.1 INTRODUCTION:

Performances in terms of productivity and efficiency. Companies, then, buy the maintenance service from external maintenance firms to reduce their maintenance costs, to close maintenance capacity gaps, and to lower maintenance management complexity. (EDWIN, B., 2022).

Companies with own road vehicle fleets attain profit by performing transport services. The amount of profit is significantly influenced among other things, by the costs incurred by transport and vehicle maintenance processes. Considered companies seek to accomplish all the planned transport tasks while minimizing transport and maintenance costs. (Vujanović et.al. 2012). Maintenance is commonly described as an activity intended to restore or keep an asset in a state in which it can perform its functions. In other words, maintenance can be portrayed as the set of actions carried out on an asset in order to ensure that the asset continues to perform its intended functions by repairing any equipment that has failed and/or by restoring it to its favorable operating condition. (Vujanović et.al. 2012).

Therefore, maintenance is aimed at reducing, in quantity and length, production process interruptions. This implies that the maintenance activity should increase the reliability of production assets by decreasing their failures. However, the objective of failure reduction does not probably yield the best results with regard to the financial objectives, because the costs of higher assets reliability may exceed the returns deriving from the consequent improvement of the production performance. As all company sub-systems, also maintenance has to be intended to increase company profits. (Vujanović et.al, 2012).

Consequently, maintenance management should carefully evaluate costs and benefits deriving from the different maintenance policies. With this regard, Wireman5 defines maintenance management as "the management of all assets owned by a company, based on maximizing the return on investment in the asset". The main objective of maintenance management, (Bivona, & Montemaggiore.,2005). Maintenance and management practices must adopt proper strategies in day-to-day operations.

State that, most of previous researches have been examining considerably issues related to transport and fleet management. (EDWIN, B., 2022).

However, most of them explored effects of fleet management on disasters and relief responses, and general humanitarian. (EDWIN, B., 2022). Basing on the National plans and policies, proper vehicles maintenance shall improve transport operations and services at lower costs, in-line with socio-economic development. (EDWIN, B., 2022).

This will make growth of the sector sustainable without adverse environmental effects. The focus should also be made on setting appropriate policies for guiding maintenance planning and management functions. In addition, number of vehicles being grounded due to poor maintenances shall be reduced. More than so, overall vehicles' running costs shall be cut to a minimum level. (EDWIN, B., 2022)

However, maintenance outsourcing presents some side effects.

First of all, maintenance contractors lack a long-term view that embraces the entire assets. Consequently, they tend to ignore maintenance activities life span of the addressed to improve the working conditions of company's assets. . (EDWIN, B., 2022) Furthermore, maintenance outsourcing may imply an impoverishment of the company know-how. . (EDWIN, B., 2022).

By contracting out the maintenance of equipment's with high level of know-how, companies tend to invest less in maintainers training, reducing, in the longer term, their skills. . (EDWIN, B., 2022) In this sense, for an efficient fleet maintenance management it is necessary to observe jointly: (1) the transport process as a primary (core) process that brings profit to the company; (2) the vehicle maintenance, as logistical support to the core transport process, which by means of maintenance interventions transforms vehicle condition from the state of "unready for operation" to the state "ready for operation"; (3) the environment, associated to safety and environmental protection from the maintenance impact, which is monitored via technical inspections. For an integrated approach to maintenance management an important concept is the "Process based maintenance" (Zhu, et.al, 2002) and (Zhu & Pintelon, 2001).

This concept, among other things, involves the definition of necessary indicators, which allow measuring the implementation effects of specific measures during. (Vujanović et.al., 2012).maintenance management, monitoring the value of indicators in relation to the adopted thresholds and management decision making in the event of unauthorized indicator values deviation from threshold values.(Vujanović et.al., 2012).

The proposed model can be used to evaluate the managers' perception of the importance of maintenance management to increase the fleet energy efficiency, (Vujanović et.al, 2012).

The prospective model will help the firms to operate their fleets more strategically, coordinate effectively utilization of vehicles and human resources, thus attaining optimum efficiency and performance of fleets operations. (EDWIN, B., 2022).

Again, proper execution of maintenance increases significantly vehicles' availability, durability and reliability. (EDWIN, B., 2022).

Therefore, fleet maintenance has a significant role in keeping-up organizational performance, particularly road transportation functions. Evidently, body of knowledge on fleets maintenance and management has enough literatures on. But still it doesn't cover substantially the contribution of vehicles maintenance in facilitating regular organizational activities. (EDWIN, B., 2022).

However, in the last decades, maintenance strategies have been evolving aiming "to carry out as little maintenance as possible [and] as infrequently as possible while at the same time preserving the availability "of company assets. For this reason, managers have been forced to adopt maintenance planning and control systems to revise their policies more accurately. In particular, the aim of these tools is to support managers in identifying the most convenient maintenance policies in accordance with the breakdown patterns of the different assets. (Bivona & Montemaggiore. 2005).

The importance of the relationships between asset e maintenance management has been widely recognized both in literature and in practice.

Maintenance costs represent a relevant percentage of the total costs a company has to bear for the entire life of an asset. As a consequence, purchasing decisions based only on acquisition costs may reduce expenses in the short term but repercussions may be experienced later in the form of increased breakdowns and unavailability. For this reason, the concept of Life Cycle Cost (LCC) was developed. Conceived in the sixties, life cycle costing is a technique for the analysis of the total costs a company forecasts to sustain for the acquisition, operation, maintenance, and disposal of an asset over its expected useful life span. (Bivona & Montemaggiore. 2005).

The life cycle concept “helps managers to understand acquisition costs vs. operating and support costs, i.e. to find a correct balance between investment costs vs. operating expenses”²¹. In particular, LCC creates “awareness among the managers to produce an effective system with not only a low acquisition cost but also low operation, support and disposal costs. (Bivona & Montemaggiore. 2005).

1.2 Research Problem:

The case study intended to assess effects of vehicles’ maintenance on the performance of fleets operation in Madina. Specifically, choice of case study area is due to considerable growth of fleets operations and relevant maintenances within the City.

1.2.1 Theoretical Gap:

Primarily, most of reviewed documents centered on creating awareness on fleet management practices, for large profit making organizations in particular. Each of them contributed much in adding knowledge in that area. However, those case studies did not cover information, which expounded comprehensively how preventive maintenance, corrective maintenance and condition-based maintenance can optimize fleets operation.

1.2.2 Empirical Gap:

Basing on reviewed empirical studies, many case study have been conducted outside the country on vehicles maintenance and fleet management Also Ally (2020) assessed regulation and policies governing fleet management systems, to comply with public fleet management.

This is a significant contribution in a knowledge base related to maintenance and management of allied operations. However, literatures do not contain knowledge on the specifics of stipulated research topic and area.

In this regard, this case study examined effects of vehicles maintenance on the project performance of fleet operation.

1.3 Significance of Research:

Results are based on the facts and opportunities derived from the data collected. The case study outcomes will benefit stakeholders of transport business by providing information, to facilitate relevant operations.

For public institutions, case study results hold useful information to fleets' managers. It shall guide on how to make decisions correctly, by referring to presented results, for the good of their organizations.

This will improve vehicles' maintenance practices in respect with relevant fleets' management plans and project performance, qualitatively and quantitatively.

Basing on the National plans and policies, proper vehicles maintenance shall improve transport operations and services at lower costs, in-line with socio-economic development.

This will make growth of the sector sustainable without adverse environmental effects. The focus should also be made on setting appropriate policies for guiding maintenance planning and management functions. In addition, number of vehicles being grounded due to poor maintenances shall be reduced. More than so, overall vehicles' running costs shall be cut to a minimum level.

1.4.1 Research Questions:

To attain above specific objectives, this work was guided by the following research questions.

1. What are the effects of maintenance on the project performance of fleet operations management?
2. How does effective communication impact project performance?

1.4.2 Questions-Sub Research:

Sub-Question 1: What is the impact of preventive maintenance on the project performance of fleet operations management?

Sub-Question 2: What is the impact of condition based maintenance on the project performance of fleet operations management?

Sub-Question 3: What are the factors affecting project productivity and their implications for project performance?

Sub-Question 4: How does fleet maintenance to project performance improvement?

Sub-Question 1: What are the communication channels used in project teams?

Sub-Question 2: How does team cohesion impact project productivity?

Sub-Question 3: What strategies can enhance stakeholder communication in project performance?

1.5 Research Objectives:

Research objective: To investigate the impact of maintenance on project performance in fleet operations management.

Research objective: To investigate the impact of preventive maintenance on project performance in fleet operations management.

Research objective: To investigate the impact of condition-based maintenance on project performance in fleet operations management

Research objective: To evaluate the factors affecting project productivity and their implications for project performance.

Research Objective: To investigate the relationship between team dynamics and project team performance.

Research Objective: To examine the impact of stakeholder engagement on project

Research Objective: To assess the effectiveness of agile project management methodologies in improving project efficiency.

1.6 Research Hypotheses:

There is statistically significant relationship between fleet maintenance management and project performance.

There is statistically significant positive relationship between preventive maintenance and project performance in fleet operations management.

There is statistically significant positive relationship between risk management strategies (condition-based maintenance) and project performance in fleet operations management.

There is statistically significant relationship between team communication and project success.

There is statistically significant positive relationship between stakeholder engagement and project quality.

There is statistically significant negative relationship between project delays and stakeholder satisfaction.

1.7. Research Model:

The following figure shows the relationship between the study variables and the study hypotheses as follows:

INDEPENDENT VARIABLES

DEPENDENT VARIABLE

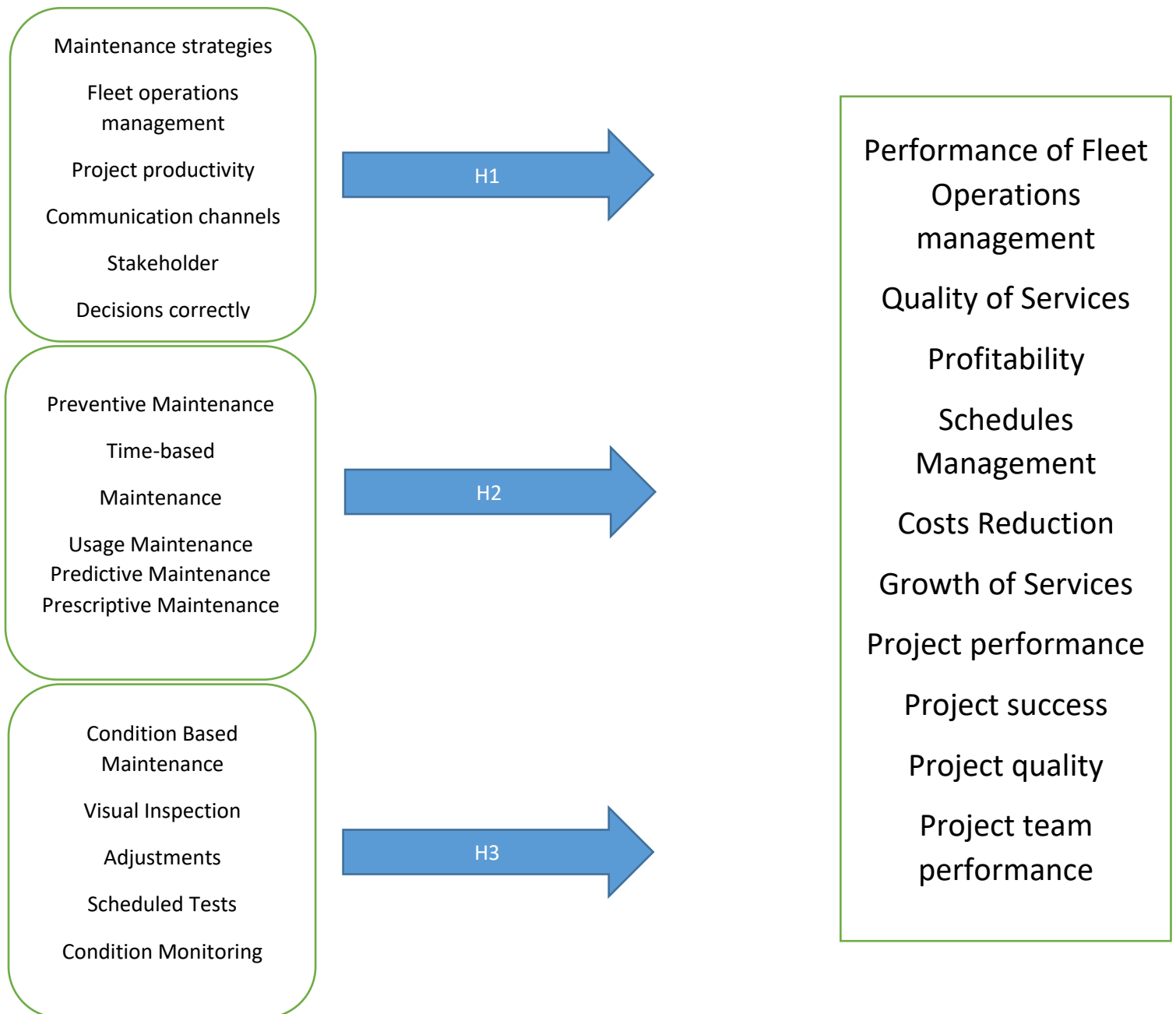


Figure 1.1 Suggested research model: Source Student

1.7.1 Research Design:

In this template, we'll present a structure that covers five important methodological matters (as outlined above). This structure is loosely based on "research onion".

1.7.2 Research Onion

Research Philosophy: Positivist

Research Approach: Deductive

Research Strategy: Case Study

Research Choice: Quantitative

Time Horizon: Cross-sectional

Data Collection and Analysis Techniques: Statistical analysis and Measurements of case results:

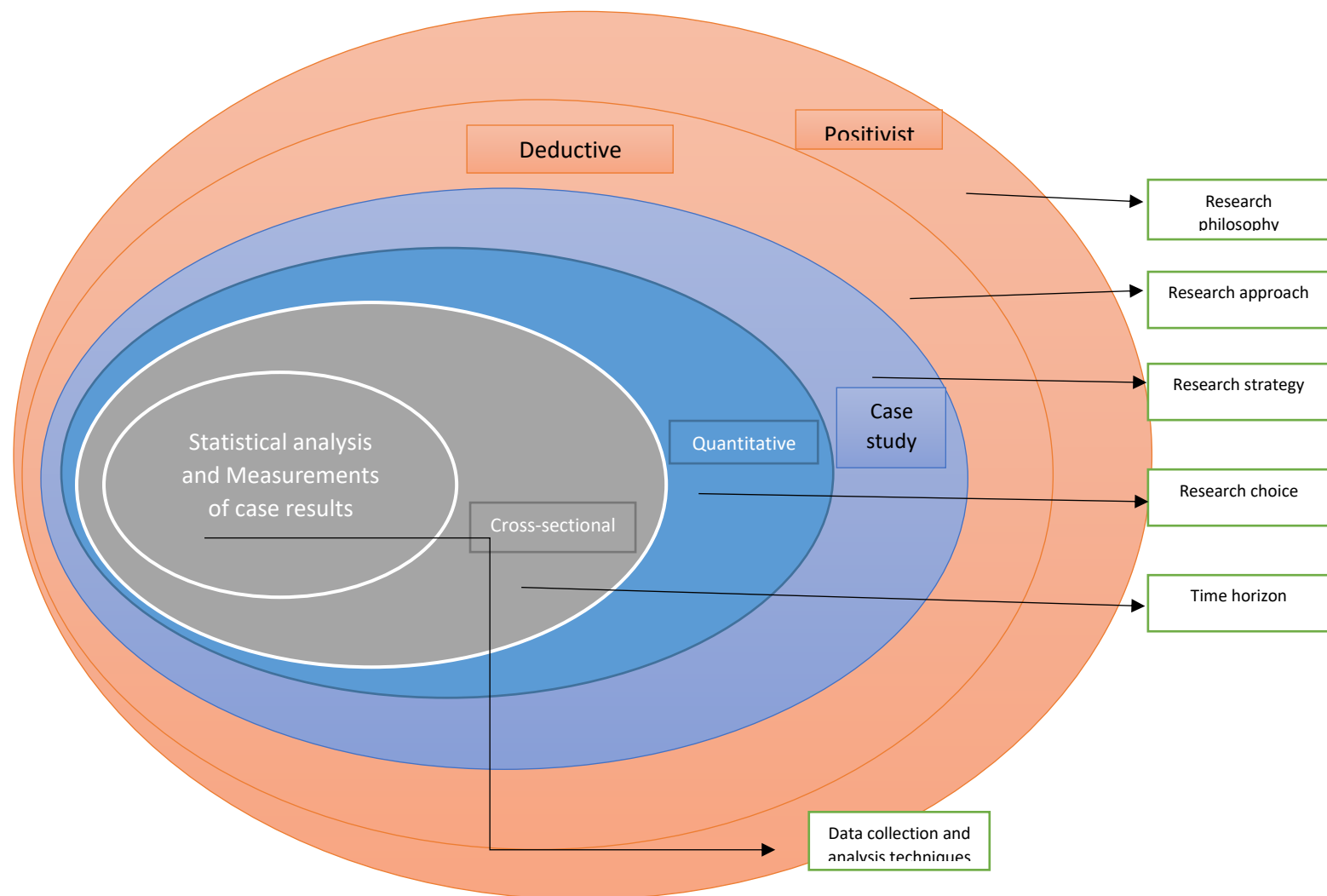


Figure 2: Research Onion

1.8 Empirical Study:

In the year 2014 AD, the company was established between “SAPTCO” and “Emirates Transport” for the purpose of providing safe and reliable transportation services in the office airport sector, as a result of which “SETCO” was designed the Saudi-Emirati Integrated Transport Company (SITCO) is one of the largest educational transport companies in the region, serves more than 500 schools around the Kingdom, and contributes to transporting more than 200,000 students daily.

SITCO's commitment to teaching covers three main regions in the Kingdom of Saudi Arabia, namely Riyadh, the general city, Madinah and Tabuk, with an area of more than 700 thousand km².

Existing studies on project performance improvement mainly investigate project management (PM) execution processes. Limited publications investigate the project management office's (PMO) proficiency in facilitating proper PM practice. This paper identifies the key performance indicators (KPI) of PMO operations and develops a KPI-based performance management system (KPMS) for revitalizing PMO performance for an engineering-service contractor (ESC).

1.9 Suggested Project Structure:

Chapter 1: Introduction •

Chapter 2: Literature Review •

Chapter 3: Research Methodology •

Chapter 4: Statistical Analysis •

Chapter 5: Findings` Discussion and Conclusion•

1.10 Conclusion

Maintenance protects vehicles from unplanned downtimes and damages resulted from road accidents due to mechanical, electrical and electronic failures. In addition, poorly maintained vehicles' disrupt activities within organizations. Therefore, this research intended to examine effects of proper vehicles maintenance on the performance of operations related to particular organizations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In order to attain an efficient maintenance management, it is necessary to coordinate the primary (core) process with maintenance, which has been researched mostly in the field of industrial production (Ashayeri et al., 1996, Brandolese et al., 1996, Nikolopoulos et al., 2003, Waeyenbergh and Pintelon, 2002). In these papers different models and systems have been proposed, all with the objective of increasing efficiency and productivity of industrial machines.

However, vehicle operation and maintenance processes differ from those related to industrial machines. The fact that vehicles are mobile assets, further affected by a large number of external environmental factors imposes the need for a different approach in their maintenance management, compared to other static machines

In this sense, for an efficient fleet maintenance management it is necessary to observe jointly: (1) the transport process as a primary (core) process that brings profit to the company; (2) the vehicle maintenance, as logistical support to the core transport process, which by means of maintenance interventions transforms vehicle condition from the state of “unready for operation” to the state “ready for operation”; (3) the environment, associated to safety and environmental protection from the maintenance impact, which is monitored via technical inspections. For an integrated approach to maintenance management an important concept is the “Process based maintenance” (Zhu, Gelders, & Pintelon, 2002) and (Zhu & Pintelon, 2001).

The transit operational planning process includes four basic components that are performed in sequence: (1) network route design, (2) setting timetables, (3) scheduling vehicles to trips, and (4) assignment of drivers. It is desirable for all components to be planned simultaneously in order to optimize productivity and efficiency. (Haghani & Shafahi, 2002).

However, due to the complexity of the problem, transit planning is performed in a sequential manner in which the outcome of one-step is fed as an input to the next step. Fleet maintenance is another major component in bus transit operations and is one of the major problems with which the public transit agencies are faced.(Haghani & Shafahi,. 2002).

2.2 EVOLUTION OF MAINTENANCE POLICIES

Maintenance is commonly described as an activity intended to restore or keep an asset in a state in which it can perform its functions. In other words, maintenance can be portrayed as the set of actions carried out on an asset in order to ensure that the asset continues to perform its intended functions by repairing any equipment that has failed and/or by restoring it to its favorable operating condition. Therefore, maintenance is aimed at reducing, in quantity and length, production process interruptions.

This implies that the maintenance activity should increase the reliability of production assets by decreasing their failures. However, the objective of failure reduction does not probably yield the best results with regard to the financial objectives, because the costs of higher assets reliability may exceed the returns deriving from the consequent improvement of the production performance. As all company sub-systems, also maintenance has to be intended to increase company profits. Consequently, maintenance management should carefully evaluate costs and benefits deriving from the different maintenance policies. (Bivona & Montemaggiore. 2005).

2.3 Fleet management

Transportation is at the center of logistics as it represents the physical movement of materials between points in a supply chain. The problem involve in the transportation industry is fleet management. Fleet management is the broad topic that involve vehicles maintenance, operation capacity, driver selection and so on. (Khalid et al, 2020).

Malekian et al. (2016) defines fleet management as a process of monitoring fleet endeavors to come up with decisions related to available assets, particularly vehicles; their routes, dispatches acquisitions and their disposals. This helps firms to comply with established objectives, optimize efficiency and minimize costs. Furthermore, the term fleet defines any entity such as an individual or organization, having any number of vehicles from five and above. Redmer (2020) defines fleet as a number of motor vehicles owned by a particular organization to meet its transport necessities.

The reliability, safety, and vehicle life in bus transit systems depend on the maintenance system employed by the agencies. Maintenance costs are the second highest expense category after vehicle operations (Bladikas and Papadimitriou, 1986). They account for approximately 21% of the total operating expenses in a typical transit system (Purdy and Wiegmann, 1987). These facts make maintenance one of the most important and substantial elements of transit systems. Considering that maintenance costs have increased 33% faster than vehicle operating costs, and four times faster than general/administrative costs in recent years (Purdy and Wiegmann, 1987), providers of public transportation are being challenged by high costs, dwindling sources of support funds, and pressures to improve services. Therefore, transit agencies make capital investments in maintenance systems with the objective of having a reliable, safe and attractive transit system.(Haghani & Shafahi,. 2002).

In most bus transit agencies' operations, buses are not assigned a fixed daily service schedule. To meet the daily route service requirements, buses are assigned to a scheduled route service on a daily basis. (Haghani & Shafahi,. 2002).

This is mainly due to parking space limitations in bus depots which force the depot managers to park the buses, one after the other, in long lines that are sometimes as long as 14 or more buses. In such situations, a bus that is parked in the middle of a line cannot move until all the buses that are parked in front of it are moved. (Haghani & Shafahi,. 2002).

Since the buses generally arrive randomly, they are parked in the same order as they arrive in the garage. Therefore, there is no guarantee that the parking pattern is the same every day. Under these circumstances, the buses cannot have a fixed schedule. (Haghani & Shafahi,. 2002).

To meet the daily service schedule, the dispatchers decide which bus must serve a particular line on a daily basis based on the day's parking pattern. In such an operation, scheduling maintenance services is very simple. The entire fleet can be basically viewed as a pool of buses from which buses can be drawn either for daily service or for maintenance. (Haghani & Shafahi,. 2002).

The evolution of fleet maintenance and management policies highlights the growing importance of maintenance issues in both private and public companies. The need to improve maintenance performance requires an accurate evaluation of the trade-off between costs and benefits related to alternative fleet maintenance and management policies. However, the complexity of maintenance system makes this evaluation a very difficult task.

2.3.1 Vehicle Maintenance

Jun et al. (2015) defines vehicle maintenance as a combination of technical and managerial activities carried out to retain the functionality of a vehicle during its life-time. Merriam Webster Dictionary (2019) pointed that, maintenance is a number of actions to retain a property such as a vehicle in its good operating condition through repairs, adjustments or calibrations, replacement of parts, cleaning, etc. Thus, vehicle maintenance restores vehicles in standard working conditions. (Haghani & Shafahi,. 2002).

Werner et al. (2019) state that, maintenance is one of the leading challenge in many industries, automotive being among them. Chowdhury and Fahim (2019) also state, vehicles which are not road worthy are dangerous to road users as they can cause road accidents.

Gul et al. (2019) declare that, regular vehicles maintenance is one of the measures, which can be taken to reduce risks related to road transport hazards. Daily and Peterson (2017) determined that, proper vehicle maintenance increases vehicles' reliability. (Haghani & Shafahi,. 2002).

In this regard, firms should involve proper management and continuous monitoring on vehicles' conditions. Cebe et al. (2018) state that, detailed and accurate vehicle maintenance record or history helps to solve most of its complex problems. Sridhar and Venkateswaran (2021) state that, the alerts and 15 updates on maintenance requirements can reduce downtime and disruption of activities. This can be achieved by using IoT for continuous monitoring of critical systems. (Haghani & Shafahi,. 2002).

2.3.2 Importance of Vehicles Maintenance in Fleets Operations

Satheeskumar (2021) postulated that, running a bus services or trucks company business requires good maintenance strategies, to ensure efficient running of its operations. Again, effective fleet maintenance contributes much in maximizing profits. Thus vehicles should be regularly monitored to ensure their availability and reliability in serving intended operations. Kunz et al. (2015) states that, poor vehicle fleet management affects transportation operations. It reduces productivity, cause customers' dissatisfaction and bring harmful effects to the environment. (Haghani & Shafahi,. 2002).

Transporters should devote enough efforts to overcome such effects. Evidently, maintenance optimizes fuel consumption and reduces late deliveries of goods, thus it favors profit maximization. (Haghani & Shafahi,. 2002).

2.4 Theoretical Review

Distinctly, three theories have been used to explain issues regarding effects of vehicle maintenance on the performance of fleet's operations. Some of key theories reviewed underpinning vehicle maintenance and fleet performance are; Human Capital Theory, Resource Based Theory and Technology Diffusion Theory. . (Haghani & Shafahi,. 2002).

2.4.1 Human Capital Theory

Hayek et al. (2016) state that, human capital theory is a theoretical context, explaining objectively the success within organizational settings. Again, human capital development brings better pays due to improved work performances. But this is a challenge in most of developing countries. Pasban and Nojedehe (2016) indicated human capital being vital in upgrading organizational assets, since it improves work performances, as a result of competences of all individuals within organizations. (Haghani & Shafahi,. 2002).

Accordingly, this research examined effects of vehicles' maintenances using the highest qualified and competent personnel on improving fleets operations. In the context of this research, human capital is meant for competent workforces, such as fleet managers, drivers, clerks, technician, etc., working within organizational fleets. In this regard, vehicles maintenances and management should comply with minimum requirements of job performances in hiring relevant personnel. (Haghani & Shafahi,. 2002).

2.4.2 Resources Based Theory

Radjenović and Krstić (2017) state that, level of success of any firm is dependent on the level of performance relative to resources employed. Thus, the higher the workers perform, the higher the success the firm derives. This means, improvement can only be achieved following improvement of possessed resources. Relevant improvements can be made through regular training to staff and use of modern tools or technologies. (Haghani & Shafahi,. 2002).

In the context of this research, Resource-Based Theory is used to indicate relevance between resources and the success of the organization, relative to other external factors. In particular, it ascertains relationship between resources owned by organizations such as vehicles, personnel, technology and funds with the performance in transportation activities. (Haghani & Shafahi,. 2002).

2.5 Fleets Operations Management

Chulze Spüntrup et al. (2022) postulated that, managing transportation activities involves planning, monitoring and controlling transport operations, to attain organizational goals. The process involves fleet management functions, focusing on optimizing effectiveness, mainly minimizing costs. Ahn et al. (2020) identified transportation as a part of overhead costs within organizations. Similarly, Thomas et al. (2020) state that, fleet management operations include cost management, vehicles maintenances, shifts management and drivers' roisters management. More than that, it involves tracing the use of assets, managing driving behaviors, managing fuel consumption and managing occupational health and safety issues within organizations. (Haghani & Shafahi,. 2002).

In addition, Rane et al. (2020) pointed that, companies undertake fleet management practices to reduce risks linked with invested vehicles. It also helps to optimize fleets' efficiencies and comply with government regulations on vehicles' safety and roadworthiness. Kameme (2019) recognized importance of real-time data on trucks movements in bringing the required changes. (Haghani & Shafahi,. 2002).

Moreover, it was pointed that employees' performance management being a key role in bringing deemed changes. Again, poor leadership badly affects changes. More than that, Ozkeser (2019) mentioned human resources management, recruitment, selection, communication and training as the motives 18 to change. As well, real-time information on trucks' movements, drivers' monitoring, and customers' services improvement and fleet management improvement as the motivations to change. (Haghani & Shafahi,. 2002).

Dembetembe (2017) states that, open-pit operations bring more than 60% of surface based productions. As well, haulage costs generate 60% of entire operation expenses. This shows how challenging is keeping-up effective resources management systems. Besides, fleet management practice does not contain an approach applicable in solving all fleets' concerns. Bogh et al. (2022) state that, the challenges in fleets' management increase as the intensity of fleets operations or size becomes higher. The main cause for this problem is disorganized nature of optimization issues. (Haghani & Shafahi,. 2002).

This means, modelling can be done to combat relevant challenges statistically, but prediction cannot be done accurately and statistically. . (Haghani & Shafahi,. 2002)

Eswar et al. (2018) states that, as a number of transportation facilities such as buses, trucks and cars increases, fleet management role becomes more challenging. This means, management of assets cannot be efficient and effective. Specifically, the common challenges are on-site operation errors; unscheduled downtime for critical equipment; unfavorable weather conditions and limited budgets for buying equipment. This raises a need to determine specific fleet needs and priorities, to relate designs specifications and the requirements of particular fleets. . (Haghani & Shafahi,. 2002).

2.6 Preventive Maintenance

Er-Ratby and Mabrouki (2018) state that, preventive maintenance reduces possible failures of items. This is performed at the scheduled intervals or as per the recommended conditions or requirements. Xu et al. (2021) state that, preventive maintenance reduces wear and tear rates of vehicles. In addition, it reduces occurrence of major vehicle faults and overall maintenance cost. . (Haghani & Shafahi, 2002).

Regular checkups of vehicles is another necessary part of preventive maintenance, as it helps to take relevant proactive measures, to avoid consequences that are more serious. Ramakrishnan and Nallusamy (2017) states that, preventive maintenance is the best practice that can greatly reduce or prevent vehicle breakdowns. . (Haghani & Shafahi, 2002).

This is due to the fact, it bases on distance travelled by a vehicle, duration the vehicle operates, engine-working hours, or amount of fuel the vehicle has consumed.

Suryadarma and Ai (2020) pointed that, the practice involving inspection, calibrations, adjustments, cleaning, testing, parts replacement, oiling, greasing, repairing to mention by few. Again Basri et al. (2017) state that, preventive maintenance involves operations management perspectives. Management part facilitates the making of decision related to fleets' activities, which are; defining maintenance objectives and approaches needed in solving relevant problems. . (Haghani & Shafahi,. 2002).

Additionally, maintenance operations focus on maintaining vehicles to their standard conditions. . (Haghani & Shafahi,. 2002).

Zvolenský et al. (2021) indicated how preventive maintenance could facilitate availability and reliability of diesel locomotives indexes. (Haghani & Shafahi,. 2002)

The aim was to assess the capacity to which preventive maintenance affect the economic part of the fleet operations, either positively or negatively. The research used Fault Tree Analysis, also Monte Carlo simulation. A sample of 75 diesel locomotives 20 was used to accomplish the process. The results revealed that, the opted approach provided the relevant results when matched with the real vehicles maintenance plans. . (Haghani & Shafahi,. 2002).

Purnamawati and Radam (2019) determined effects of aging on adding to the vehicles' operating costs in the public transport services in Banjar Regency, Indonesia. Data were collected through interviews with the transporters and vehicles' operators' or drivers. This involved both primary and secondary sources. Data were processed and analyzed by regression method so that to formulate the model. The research revealed a very strong relationship between the vehicles' aging and the relevant costs of operations. The vehicles aged up to 25 years indicated a correlation of 0.901, whereas those of above 25 years of age indicated a correlation of 0.995. These coefficients were meant for the costs of fuel, general maintenance and depreciation. (Haghani & Shafahi,. 2002).

2.7 Corrective Maintenance

Er-Ratby and Mabrouki (2018) state that, corrective maintenance means the repairs performed following the breakdowns, caused by identifiable failures. Sukma et al. (2019) state that, corrective maintenance involves replacing failed components, systems or subsystems, to restore the vehicles to their good operating conditions. In general, the costs of the respective corrections need to be set to minimum possible levels, to reduce the costs for their relevant inventories. (Haghani & Shafahi,. 2002).

Otieno (2016) researched on how corrective maintenance can influence operational performance of the manufacturing companies. Additionally, it aimed to determine the extent to which the companies use corrective maintenance as a part of their strategies. The collection of data was done through questionnaires, then processed by SPSS and MS excel programs. The results indicated, 23.1 % of the firms use corrective maintenance. (Haghani & Shafahi,. 2002)

Others use preventive maintenance and corrective maintenance policies. (Haghani & Shafahi,. 2002)

In addition, the research revealed the use of planned corrective maintenance. (Haghani & Shafahi,. 2002)

Again, Voicu and Fuiorea (2021) state that, corrective maintenance involves diagnosing, identifying and repairing the faults as determined by relevant symptoms. Corrective maintenance is categorized into; fail to repair, of which a vehicle is restored to a normal operating condition after failing to operate; salvage, disposing removed or unwanted components; rebuild, restoring the components nearly to designed states.

Furthermore, overhaul; a form of corrective maintenance that restores vehicle systems or components to the specified standards; whereas, the responsible team performs services after specific intervals of time or distance traveled by a vehicle.

Overhaul is performed when performance within a system or component declines beyond lower limits of failure. (Haghani & Shafahi,. 2002).

2.8 Condition Based Maintenance

Alaswad and Xiang (2017) state that, condition-based maintenance spots early symptoms of failures, to determine the correct time to maintain the vehicles. It depends entirely on the real condition of a vehicle component or system. The strategy involves continuous monitoring of the systems, subsystems or components. (Haghani & Shafahi,. 2002).

The gathered information help to decide on the actions to take with respect to transport planning, management of spare parts and vehicles safety concerns. (Haghani & Shafahi,. 2002).

Ingemarsdotter et al. (2021) postulates that, condition-based maintenance considers the vehicles' performance, to anticipate probable vehicles' failures. It was indicated that, the strategy helps to prevent downtimes, thus it minimizes fleets' maintenance costs. Additionally, condition-based maintenance dwells on the theory that, 99% of assets such as vehicles and relevant equipment, 22 show indicators before they actually fail. Thus, through monitoring and evaluation, the faults and their relevant causes can be easily identified and addressed to lengthen life spans of assets. (Haghani & Shafahi,. 2002).

Raza and Ulansky (2019) researched on how to optimize the quality of decisions related to monitored conditions by considering minimum entropy. (Haghani & Shafahi,. 2002).

The research presented a condition based maintenance mathematical model, of which condition monitoring was not well conducted from time to time. Over again, results showed that, the approach used to determine preventive maintenance thresholds minimizes ambiguities in making decisions on assets' conditions, to monitor situations. (Haghani & Shafahi,. 2002).

2.9.1 Project Performance

Project performance has been the subject of discussions in the project management literature. According to Carvalho et al. (2015), the traditional view of project success is associated with the achievement of time, cost and quality objectives (iron triangle). However, several studies have investigated new dimensions of project success (Carvalho & Rabechini, 2015). Thus, there seems to be no simple definition for this construction, since it can be measured differently in different types of projects, from different perspectives, at different stages and in absolute or relative terms, which makes it a multidimensional construct (Carvalho et al. al., 2015).

2.9.2 Project performance measures

In order to appropriately determine project success, some set of criteria or principles are essential to act as standards guiding or regulating project success. These standards are referred to as project success criteria or project performance measures. According to Atkinson (1999), the most conventional standard for determining project success is the ‘iron triangle’, which determines project success in terms of cost, time and quality performance. This framework of criteria has proved to be limited in that it does not focus on a wide range of project stakeholders (Shahu et al., 2012).

2.9.3 Project management practices

According to the project management institute (PMI) (2017), project management is the application of knowledge, skills, tools and techniques to project activities in order to meet the expectation of project stakeholders. For this to be achieved there is need for a good understanding of the dynamics of project management practices by project management personnel. The world is dynamic and technology driven, hence the need for project managers to be updated with contemporary issues in project management. Advances in the management sciences have made the concept of project management to evolve into a whole system of knowledge (Chan and Chan, 2000) thus making it essential for effective management of projects especially in the construction industry (Isik et al., 2008).

This could be traced to the foundation of the PMBOK (A Guide to Project Management Body of Knowledge), an initiative of the Project Management Institute which contains knowledge, methods, processes, techniques, tools, and skills (PMI, 2017) required for effective project management.

There are ten knowledge areas identified in the PMBOK which include integration management, scope management, time management, cost management, quality management, risk management, human resource management, communication management, procurement management and stakeholder management (PMI, 2017), and these consist of more than seventy six practices (Chou and Yang, 2012).

2.10 Relationship between Fleet maintenance management & Project performance

Productivity and profitability are key factors for companies to remain competitive in today's rapidly changing world. Concomitantly, maintenance is beginning to play a more important role in many production-related industries as the impact of maintenance performance on productivity and profitability has increased (Lado and Singh, 2019; Ismail et al., 2022). Therefore, measuring the performance of maintenance activities has become a crucial part of maintenance management. Evaluating maintenance performance supports asset managers and system owners in gaining knowledge about how the outputs of maintenance processes contribute to the business goal (Parida et al., 2015), which, in turn, drives the continuous improvement of maintenance processes and strategies (Choubey et al., 2021; Marquez, 2007).

The immense importance of maintenance performance tracking has generated increasing interest in the development of a maintenance performance measurement (MPM) framework. According to Parida et al.'s (2015, p. 15) definition, MPM is "the multidisciplinary process of measuring and justifying the value created by maintenance investment, and taking care of the organization's stockholders' requirements viewed strategically from the overall business perspective." As an important and integrated part of performance measurement, an MPM framework links organizational strategy to performance measurements using a list of indicators to set criteria (Kumar et al., 2013).

Maintenance performance indicators (MPIs) are the building blocks of an MPM framework.

They quantify maintenance performance as a measurable value and provide direct indications of whether the performance of maintenance activities meets the designated objectives. Well-defined MPIs can pave the way to the desired maintenance performance by supporting the identification of performance gaps (Muchiri et al., 2011).

However, despite the numerous resources and efforts spent on development, MPM systems often do not have enough influence to trigger decision and process changes (Muchiri et al., 2010). On the one hand, in the vast majority of cases, performance measures are overloaded with technical indicators (Rybin et al., 2020). This increases the difficulty of performance management, leaving maintenance databases and indicators undocumented or unregulated (Parida et al., 2015).

Based on the reviewed studies, the authors of this paper summarize the process of choosing a set of MPIS for an MPM framework in three sequential steps: identifying potentially relevant indicators, screening indicators according to the organizational context, and prioritizing indicators with high impacts. The number of MPIS listed in the literature is substantial, yet a widely agreed-upon methodology for deriving the indicators is still unavailable (Kumar et al., 2013, 2018; Maria and Manuela, 2017), leaving a key knowledge gap in MPI formulation. Although the reviewed literature focuses strongly on the ranking methodologies of performance indicators based on aspects of performance evaluation, the reasoning for why one indicator is more relevant than another in the context remains implicit. Moreover, it has been observed that the data collected for performance measurement are not adequately used in decision support (Muchiri et al., 2010). On the one hand, the large number of data collected becomes a problem, as they require more sophisticated methods and algorithms to elicit useful information (Villarejo et al., 2017; Wakiru et al., 2022). On the other hand, the reviewed indicator selection methods take a one-way path from identifying to screening MPIS. Data availability is considered a filter for eliminating non-applicable indicator candidates rather than an input to derive potential indicators. Potential indicator candidates are mostly gathered through literature searches and industrial practices,

Leaving some of the available and potentially useful data behind. Consequently, the links between selected MPIS and the focus on future performance improvement weaken. Despite the various methods for selecting and prioritizing indicators identified in the literature, there is a lack of research on developing. Comprehensive measures for evaluating maintenance processes that consider the entire cycle and are less sensitive to data availability.

To address these issues, a performance diagnostic framework that creates a mutual connection between performance aspects and maintenance data is proposed.

Structure of maintenance performance diagnostic framework Measuring maintenance performance requires time and effort. A detailed investigation of maintenance performance usually requires data from multiple sources. In some cases, data collection, data processing, and text analysis require manual work to update performance results. The lack of automated data for the knowledge process gives rise to the need to conduct an analysis that takes days to months (Parida et al., 2015). To reduce the time and labor costs of regular performance tracking, the proposed maintenance performance diagnostic framework is designed in two parts

The first part of the framework focuses on the action “detect,” namely, detecting the existence of potential performance issues by measuring maintenance outcomes. For equipment types or maintenance strategies with satisfactory maintenance outcomes, additional diagnostics are not necessary; otherwise, an end-to-end investigation at the process level is carried out in the second part. The second part focuses on the action “locate,” namely, locating potential maintenance performance issues down to the process level. The proposed multi-criteria framework has a hierarchical structure at the first three levels (diagnostic objectives, diagnostic domains, and diagnostic aspects). A top-down approach is used to properly formulate the performance measurement structure at these levels. Level 1 determines the top-level objective for the performance diagnostics for each part. Level 2 defines the major performance diagnostic viewpoints under level 1 objectives as domains. Level 3 further expands the domains into categorical diagnostic aspects. The performance result for each thematic category from levels 1–3 is represented by a qualitative indicator, which aggregates the corresponding indicators at the lower level. Level 4 (performance measurement) links MPIs to relevant diagnostic aspects at level 3, depending on the data.

Carvalho & Rabechini (2017) point out a lack of confirmatory studies about the relationship between sustainability and project performance, which are thus sought in this study. The results reinforce the perspective of a positive and significant impact among the constructs. Failing to identify a negative influence on project performance if related to costs.

2.11 Conclusion

From the results of the study, the highest relationship exists between maintenance management and project success, followed by project performance and project success, and stakeholder management and project success.

In recent years, computerized fleet management systems have been developed which allow the transit agencies to assign buses to a specific schedule, and maintain that assignment for a long period of time. When such systems are in place, the transit managers prefer that the operators drive the same bus to the extent possible.

Since the buses have fixed schedules, one can predict when they are available in the garage, and therefore, any inspection and maintenance can be accomplished when the buses...

2.12 Reference

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