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FACTORS IDENTIFICATION FOR STRATEGIC FINANCIAL MANAGEMENT OF AN EFFECTIVE ROAD MAINTENANCE: A REVIEW

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Graphical abstract

Abstract

Road maintenance works need to be carried out regularly to maintain pavement conditions and ensure road user safety. However, road maintenance management is becoming more complex due to large numbers of ageing roads and limited funds for maintenance. Finance is among the crucial components of road maintenance operations. Ineffective financial management leads to the inefficient use of funds and delay of maintenance work. It has been demonstrated that strategic management practices have contributed to increasing the effectiveness of financial management due to the practices that centre on methods towards achieving maintenance goals. Therefore, this paper conducts a review to identify the financial management factors that will impact the effectiveness of road maintenance financial management. Data were sourced from electronic databases with specific searched keywords related to financial management. Factor searching focused on prevalent domains such as financial goals, financial planning, financial organizing, financial leading, and financial monitoring. A total of seventy-two (72) papers have undergone review, unveiling fifty-two (52) distinct factors. Financial goals contribute about seven (7) factors, financial planning to twenty-one (21) factors, financial organizing about seven (7) factors, financial leading to nine (9) factors, and financial monitoring to eight (8) factors. The review conducted in this paper sheds light on the multitude of factors influencing financial management effectiveness in road maintenance. Identifying key areas can develop targeted strategies to enhance financial efficiency and optimize maintenance efforts. The findings also underscore the necessity for continued research in this field to address the complexities of road maintenance and ensure the long-term sustainability of transportation infrastructure.

Keywords: Road maintenance, review, road funding, financial management, strategic management

1.0 INTRODUCTION

In the construction industry, civil engineering is concerned with developing public infrastructure, such as roads, which requires maintenance work and constructing a new structure [1]. Road infrastructure is a vital public asset significantly contributing to a country's social and economic development [2]. Currently, the road network worldwide is extensive and regular maintenance is essential to preserve the road condition [3]. Moreover, road maintenance consumes large amounts of materials and requires sufficient funds to carry out the work [3]. However, due to the uncertain economic situation, many countries are experiencing budget issues in which the government has to limit the financial resources for road maintenance [4, 5, 6]. This has led to the further deterioration of road structures, which has shortened their lifespan and ultimately imposed more maintenance and replacement costs [7].

One of the most crucial aspects of operating a road maintenance program is finance, and it is necessary to ensure that public capital assets are preserved for their economic and social value [7]. Currently, road authorities are paying more attention to the issue of budget management [8]. This is due to

the large number of roads reaching the end of their useful life, which requires more financial resources for maintenance, but many countries have a restricted budget for road maintenance [9]. Moreover, operating and maintaining road assets are very costly, and the increase in maintenance costs increases the difficulties of maintenance tasks [10, 11, 12]. Among the costs involved in road maintenance are supervision, administration, contract management, legal expenses, professional expenses, and contractors' fees to carry out maintenance works [13].

Since there is an increasing demand for road maintenance funds but with a limited budget, transportation agencies must maximize the available financial resources by exploring rehabilitation alternatives and selecting the most economical maintenance. Despite numerous efforts to enhance road maintenance management, road maintenance issues are still present, as evidenced by road users' complaints about the road condition [14]. Lack of financial management skills is recognized among the causes that require a more strategic approach to managing maintenance [15].

Financial management for road maintenance is defined as the business function concerned with investment appraisal, budgeting, and forecasting. Investment appraisal is the process of evaluating opportunities to determine if the benefit of road maintenance work is greater than the cost, such as road safety [16]. Budgeting is known as planning and setting targets for the financial resources towards achieving road maintenance objectives. Budgeting sets clear objectives during the planning stage, helps to identify scarce resources, and acts as a basis for communication and coordination [17]. Forecasting is an estimation of maintenance financial performance for a specific period. Forecasting provides organizational control towards financial responsibility by setting benchmarks to measure and evaluate financial performance [18]. It applies financial management principles such as planning, organizing, leading, and controlling financial resources [19].

Recently, an increasing number of scholars have taken an interest in strategic management from a public value approach. As strategic practice may offer several benefits, local governments increasingly use strategic planning to anticipate and address complex challenges [20]. The strategic management process helps organizations track progress towards goals. It is a process of planning, organizing, directing and controlling activities to meet the organization's goals, supported by tools and techniques [21]. Therefore, this paper aims to identify the strategic factors of road maintenance financial management under strategic components of goal, planning, organizing, leading, and monitoring.

2.0 METHODOLOGY

This study aims to provide an understanding of strategic financial management for road maintenance through a comprehensive analysis of the Literature Review. This is because a Systematic Literature Review (SLR) is suitable for analyzing existing knowledge and identifying potential research gaps [22, 23]. An initial search is performed systematically by following the listed database and according to the keywords [24]. Figure 1 shows the flow of the SLR process. It was conducted through four phases: planning, selection, extraction, and execution. The procedure starts with planning and organizing the whole data collection process activity. During the following selection process, data was searched through electronic databases, including Web of Science, Science Direct, Scopus, Emerald, and Wiley, with the searched keyword of strategic financial management for road maintenance. The process followed by extracting the data with the inclusion criteria of English-language articles published between 2017 and 2024. The final step is the execution phase, which focuses on identifying critical factors through five (5) dimensions known as financial goal, financial planning, financial organizing, financial leading, and financial monitoring.

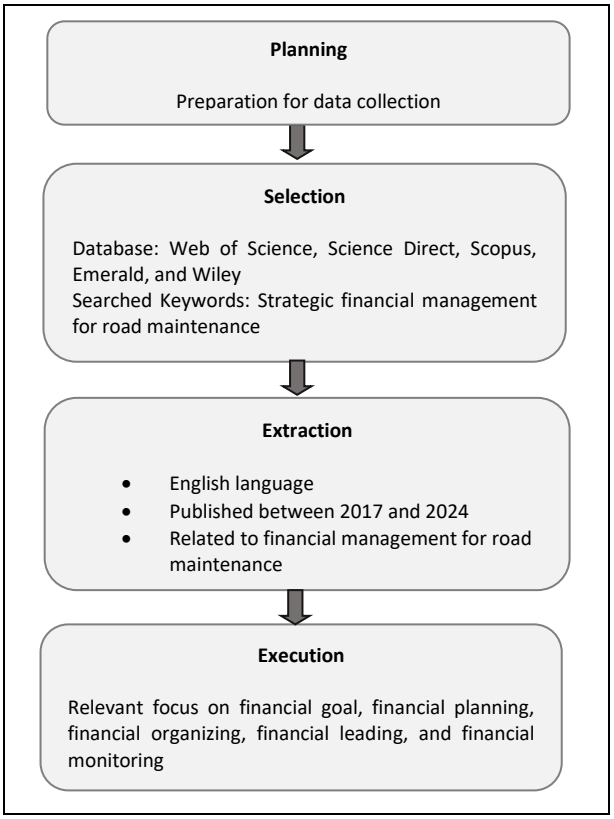

Figure 1 Systematic Literature Review Process

The VOSviewer tool version 1.6.20 was used to conduct a bibliometric analysis based on the Scopus database publication list related to financial management for road maintenance. Figure 2 displays the result of network visualization. Topics of interest are represented by a label in which a more prominent label denotes a more frequently discussed theme [25]. For instance, the finding indicates that maintenance is the most frequently discussed topic, followed by highway roads and streets, highway administration, highway planning, financial resources, decision-making, risk management, pavements, finance, and transportation. The link between these topics indicates co-occurrences, and stronger ties indicate more frequent co-occurrences. For example, the topic of financial resources co-occurs with decision-making, risk management, maintenance, roads and streets, highway administration, and pavements. Clusters within the network group indicate a specific area of interest for research. The first cluster demonstrates the interconnectedness of the themes related to

financial resources, maintenance, highway administration, decision-making, and pavements. The second cluster suggests there are similar primary concerns about finance, roads and streets, highway planning, transportation, and risk management.

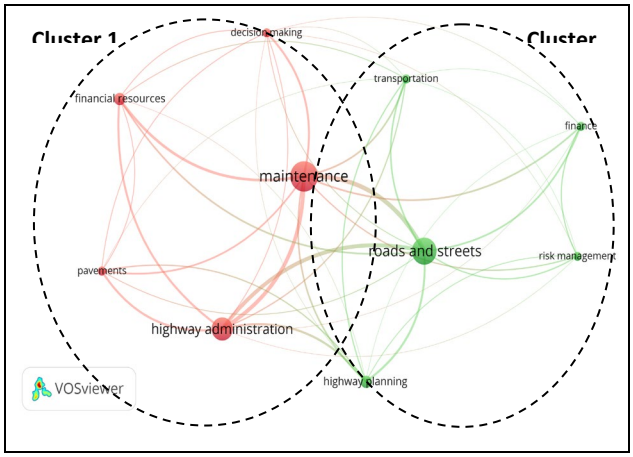

Figure 2 Key Network Analysis (VOSviewer)

3.0 RESULTS AND DISCUSSION

Table 1 summarizes the findings from prior research endeavours, which centre on financial management for road maintenance. These encompass strategic management components, including financial goals, planning, organizing, leading, and monitoring.

Table 1 Strategic Factors of Financial Management for Road Maintenance

Factors for Road Maintenance Financial Management		Source
A)	**Financial Goal**	
1.	Establish a clear financial goal	[2, 3, 9, 26, 27]
2.	Establish a time-bound financial goal	[20, 26, 32]
3.	Senior management support in financial goal-setting	[20, 26]
4.	Evaluate each dimension of the financial goal	[28]
5.	Align optimized financial resources with the financial goal	[2, 29]
6.	Identify financial management challenges	[13, 29]
7.	Formulate strategies for each challenge	[30]
B)	**Financial Planning**	
1.	A continuous improvement of the Road Maintenance Policy	[4, 5. 30]
2.	Develop a financial management framework	[2, 4, 6]
3.	Establish a long-term financial plan	[30, 31, 32, 33]
4.	Establish a financial risk mitigation plan	[34, 35]
5.	Evaluate the cost-effectiveness each of procurement type	[13, 36]
6.	Improve the guideline for Performance-Based Contracts (PBC)	[13, 36, 37, 38]
7.	Innovate pavement management system to optimize road maintenance fund	[11, 13, 39, 40, 41]
8.	Utilize Geographic Information System (GIS) for prioritizing road maintenance allocation	[42, 43, 44]
Factors for Road Maintenance Financial Management		**Source**
B)	**Financial Planning**	
9.	Utilize Building Information Modelling (BIM)	[45]
10.	Explore alternative sources of funds for road maintenance	[4, 47]
11.	Effective prioritization or intervention model for allocating maintenance fund	[2, 9]
12.	Conduct effective Pavement Condition Assessment (PCA)	[11, 13]
13.	Improve Key Performance Indicator (KPI) evaluating road concessionaire's work performance	[48, 49, 50]
14.	Include road safety factors in maintenance budget planning	[51, 52, 53, 54]
15.	Include environmental factors in the maintenance budget planning	[55]
16.	Study the infrastructure line services and their impact on the financial costs	[56]
17.	Conduct Life Cycle Cost Analysis (LCCA)	[1, 55, 57, 58]
18.	Analyze traffic loading impact on pavement deterioration rate	[3, 55]
19.	Analyze weather impact on pavement deterioration rate	[57, 59]
20.	Conduct Cost-Benefit Analysis (CBA)	[60, 61]
21.	Develop a financial schedule	[2, 62, 63, 64]
C)	**Financial Organizing**	
1.	Reevaluate the effectiveness of current financial management	[65, 66]
2.	Assess each aspect of financial management	[67, 68]
3.	Establish a Stakeholder Management Plan	[13, 69, 70, 71]
4.	Evaluate the role of each of the funding categories	[34, 72]
5.	Improve dynamic capabilities among employees	[4, 6, 73, 74]
6.	Measure Human Resource (HR) Cost	[65, 75]
7.	Analyze the cost for handling road material	[72, 76]
D).	**Financial Leading**	
1.	Leader to convey a clear vision of financial management	[4, 77]
2.	The leader leads the strategy of financial management	[4]
3.	Consistently review the financial guidelines	[5, 78]
4.	Gives valuable feedback to the employee	[79]
5.	Professionalism in leading the organization	[9, 79]
6.	Interpersonal skills in communication	[77]
7.	Embrace change management	[80]
8.	To increase asset management awareness among employee	[81]
9.	Support the use of technology	[9, 11, 82]
E).	**Financial Monitoring**	
1.	Monitor financial performance regularly	[2, 63]
2.	Monitor physical performance regularly	[2, 63]
3.	Monitor the actual cost incurred	[2]
4.	Monitor the causes of variation order	[83]

5.	Monitor increase in material price	[11, 84, 85]
6.	Monitor project cost impact due to project location	[83, 85]
7.	Monitor project cost impact due to site geological condition	[83, 85]
8.	Monitor weather conditions and delay the project	[85, 86, 87]

Figure 3 shows the composition of identified factors under each strategic domain. Financial planning contributes the highest percentage, followed by financial leadership, financial monitoring, financial goals, and financial organizing.

Figure 3 Composition of Financial Management Factors

3.1 Financial Goal

A financial goal for road maintenance is defined as an idea or future result that a group plans and commits to achieve for road maintenance financial management [2]. The basic goals of road maintenance include preserving the economic value of the road, preventing further deterioration, ensuring road safety, reducing user costs, and protecting the environment through sustainable construction [3]. However, the restricted financial resources available for road maintenance require the authority to identify the most optimal maintenance [9]. Moreover, road maintenance management is a complex process due to continuous activities, and road agencies need to establish clear financial goals for road maintenance. A clear goal means a goal that can explain to employees what they are working towards, why it is important, how to achieve the goal, and how performance will be measured [26, 27]. Having a well-defined financial goal will facilitate the creation of a strategic financial management framework for road maintenance [2]. Additionally, road authorities must establish time-bound financial goals, such as short-term and long-term. In road maintenance management, short-term represents a duration of two years while long-term is four years or more [32]. Short-term and long-term goal enables transportation agencies to consistently review and update transportation planning [20, 26]. Besides, senior management assistance is essential during the goal-setting process, and their valuable experiences enable them to assist employees effectively towards attaining efficient goal-setting [26]. Furthermore, the organization needs to assess each dimension of the financial goal during the goal-setting process, including specificity, goal difficulty, persistence, effort, commitment, progress, feedback, and resources. Assessing each dimension will help to understand the goal further and increase the effectiveness of the goal-setting process [28]. Due to budget constraints for road maintenance, road authorities shall align and optimize financial resources with financial goals, as this will lead to the development of a strategy to achieve cost-effective maintenance [29]. Aside from budget constraints, numerous other challenges will influence financial management in road maintenance, requiring road agencies to recognize each challenge. Recognizing each challenge allows road agencies to formulate strategies to address every challenge [13, 29]. Formulating strategies allows for maintaining the stability of financial management, such as sound budget preparation and allocating funding across the network [30].

3.2 Financial Planning

Financial planning for road maintenance is defined as the process of preparing a plan that will act as a guide to utilize financial resources effectively and achieve maintenance goals [2]. Due to numerous challenges influencing financial management in road maintenance, road agencies need to continuously improve the Road Maintenance Policy. The Road Maintenance Policy guides the organization in governing maintenance management to improve road infrastructure [4, 5, 30]. Furthermore, road agencies shall develop a strategic financial management framework as it provides direction towards achieving the financial objective [6]. Besides, a long-term financial plan is needed to outline the maintenance budget needed over an extended period, forecast maintenance costs, anticipate incoming risk, and assist in achieving timely investment [30, 31, 32, 33]. As road maintenance is exposed to various risks, road agencies must establish a financial management risk mitigation plan to mitigate extra costs due to the risk [34, 35].

Different procurement methods for road maintenance work have varying cost impacts, necessitating road agencies to assess their cost-effectiveness and select the most efficient method [13]. A performance-based contract (PBC) is the procurement method that emphasizes the contractors' outcomes and quality of work, and it has been applied for several years in many countries [36]. Among the contributions of PBC implementation include enhancement in quality of work, improvement in workmanship, better affiliation among stakeholders, minimized work discrepancies, promotion for cost savings, and reduced environmental impact [37]. However, due to the unclear framework mechanism for evaluating performances, there is a need to continuously improve, particularly in measuring contractor's work performance, which will further improve the work performance and avoid extra costs [38].

Currently, highway agencies are utilizing pavement management systems to administer road maintenance management, such as maintaining road maintenance data and monitoring pavement maintenance performance [8]. Nevertheless, due to the uncertainties of the pavement deterioration process, road authorities need to revisit the effectiveness of financial management through the current pavement management system to innovate the system to optimize financial resources [8, 11, 13]. For instance, Philip and

AlJassmi (2024) developed an expert decision framework for the pavement management system that can capture uncertainty, manage incomplete information, and produce optimal decisions for road maintenance work. Furthermore, in this modern era, applying advanced information technologies may aid managers in efficiently managing financial resources for road maintenance work. Artificial Intelligence (AI) is a broad field of study that refers to the ability of machines or artificial products to perform the same functions as human thinking, coping with complex data, and nonlinear problems. Current practices have been gradually explored in advanced Artificial Intelligence such as integrating machine learning algorithms, smart sensing technology, and image pre-processing technologies towards a deep learning approach [40]. Among the main contributions of AI in road maintenance financial management include early road deterioration detection and generating effective maintenance prioritization plans, which maximizes maintenance work production and minimizes maintenance cost [41].

In the realm of transportation planning, Geographic Information Systems (GIS) has garnered attention for its pivotal role in facilitating the process [42]. A GIS is a system that functions as a comprehensive platform for storing, displaying, and analyzing maps [43]. Currently, GIS displays maps and is integrated with other tools that automate the selection of the most suitable and cost-effective repair technique for road infrastructure [44]. GIS has assisted in capturing several important aspects of road maintenance budget planning road, such as pavement condition, traffic volume, road utility value, and road connectivity [43]. Besides that, building information modelling (BIM) has also assisted in road maintenance financial management. For example, BIM can display a digitized model of a bridge structure and store relevant technical data features and is connected with sensors for real-time detection of defects, allowing for early maintenance intervention by road agencies and avoiding prolonged defects and extra cost [45].

Exploring alternative funding sources becomes imperative in light of the challenges posed by ageing pavement, increased social pressure, and declining maintenance funds [46, 47]. Obeng and Tuffour (2020) identified the potential of generating revenue from on-street parking charges to raise financial resources for road maintenance. Besides, due to limited financial resources for road maintenance, effective maintenance prioritization is also essential during the planning stage. Prioritization or intervention systematically identifies, assesses, and addresses a road network's most critical maintenance and budget needs [2]. Effective prioritization ensures that available funds are allocated to projects and activities that deliver the highest impact in terms of safety, functionality, and overall road infrastructure quality [9]. Among the prioritization strategies is conducting a Pavement Condition Assessment (PCA), which can determine existing pavements' functional state and structural condition [11]. It will provide road authorities with the current pavement condition and assist in identifying suitable rehabilitation designs and generating remedial costs [13].

A concessionaire is a private company appointed by the government to maintain road infrastructure for a period aiming to achieve Value for Money (VFM) by providing all the necessary service provisions at an optimal cost [48]. It is imperative to monitor the performance of concessionaires as a good performance will result in project completion and avoid additional costs [49]. Among the strategies is improving the measurement of financial key performance indicators (KPI) in evaluating concessionaires' work performance. The financial KPI measurement includes investment optimization and cost-effectiveness [50].

Road maintenance aims to provide safe roads and minimize road crashes, which signifies that road authorities need to optimize the road maintenance fund by considering road safety factors in the maintenance budget planning. The strategies include road surface improvement, selecting cost-effective road marking types, establishing effective potholes management, and analysis of traffic patterns [51, 52, 53, 54]. Besides that, sustainable planning will have less impact on the environment. For example, estimating the construction cost causing the emission of greenhouse gasses (GHG) allows road agencies to select construction methods that will less impact the environment [55]. Additionally, there is a need to study the infrastructure line services and their impact on the financial costs. Analyzing the complex interdependencies among road structures, underneath water pipes, and the impact from traffic loading will help road managers prevent additional costs such as repairing pipe breaks, traffic blockage, lane closure, and repaving of road surface [56].

The road needs to be maintained regularly, necessitating road agencies to conduct a Life-Cycle Cost Analysis (LCCA). By conducting LCCA, road agencies can properly assess, forecast, and observe the cost impact of building and maintaining infrastructure over its entire lifespan [1, 55, 57]. LCCA depends on input factors such as discount rate, time, interest rate and Net Present Value (NPV) [58]. LCCA will include the estimate of initial construction costs, maintenance cost over the pavement design life, construction costs that cause emission of Green House Gases (GHG), and road user's cost travel on the road. Initial construction costs include design, equipment, raw materials and overhead charges [55]. Road maintenance costs include maintenance, rehabilitation, and overhead charges while road users' costs include fuel consumption and tire wear [50]. Additionally, as external factors such as traffic loading and weather will impact the road life cycle, road agencies shall analyze traffic loading and weather impact on pavement deterioration rate [3, 54, 55]. Regarding the benefits, road agencies need to conduct a Cost-Benefit Analysis (CBA) to continuously improve the benefit of maintenance work to the road user. CBA allows road agencies to plan for the best investment in road projects, offering more benefits at a minimal cost [60]. The benefits include saving in travel time, saving in vehicle operation costs, and road safety [61].

During the planning stage, it is imperative to establish a financial schedule as it will allow road authorities to plan and track financial performance more effectively [62]. Earned Value Analysis (EVA) is a useful tool that monitors, predicts, and controls road maintenance projects' financial performance [2]. This is because the analysis can integrate financial and physical data. Financial data include the actual cost incurred while physical data are the planned and actual progress [63]. Data is tabulated in the form of tables and graphs for easy visualization. EVA formulas not only show schedule variances and cost variances but also estimate completion costs and the days to complete the works [64]. Furthermore, EVA also discovers cost overruns during the construction's early stages, allowing road agencies to take remedial actions to minimize cost overruns [2].

3.3 Financial Organizing

In the realm of road maintenance, financial organization entails the systematic management of financial resources to ensure the efficient upkeep of roads [65]. Assessing the current effectiveness of financial management in road maintenance allows for ongoing improvements in resource organization [66]. Furthermore, organizing financial management necessitates evaluating each aspect of financial management. The initial aspect involves suppliers providing human, financial, and material resources. In contrast, the second aspect pertains to parties responsible for project delivery, while the third involves clients who invest financial resources in the projects [67]. By evaluating all dimensions of financial management, road agencies can effectively secure financial resources, including acquiring client funds, ensuring financial support for maintenance activities, and covering maintenance operation costs [68].

Since road maintenance financial management involves diverse stakeholders, road agencies need to establish Stakeholder a Management Plan to manage each stakeholder effectively. A stakeholder is an individual, group, or organization with an interest or involvement in a project's decision-making [69]. Among the stakeholders include the public or road users, clients, ministries, treasury departments, technical departments, local authorities, consultants, and contractors [13]. Establishing a Stakeholder Management Plan will facilitate efficient financial management by recognizing each stakeholder's expectations, establishing an effective communication strategy, and managing financial resources strategically [71].

Kothari et al. (2022) highlighted that road maintenance fund consists of several funding categories based on the sorts of projects or works. Road agencies need to evaluate the role of each funding category as it would assist in deploying financial resources to attain identified and desired goals [77]. This is because there are many financial uncertainties, such as government revenue, changes in work scope, and variations in cost estimates. An effective allocation of financial resources according to their category will ensure the work will be implemented according to the schedule, avoid redistribution of funds, save time, and avoid underspent allocation [34].

An organisation's ability to manage and mobilize resources effectively can be measured through organizing skills and capabilities [59]. Therefore, improving employees' dynamic capabilities is among the key factors in responding to the current unpredictable and volatile environment, which can be improved through pioneering. Pioneering is about exploring new methods, approaches or areas of knowledge [73]. Artificial neural networks are among the practical and advanced approaches to organizing financial resources effectively, such as generating optimal maintenance strategies [4, 6]. Besides, improving the dynamic capabilities will also enhance employees' financial administration skills, which can reduce errors when performing financial tasks. For example, a productive employee will reduce job mistakes, reduce rework, and avoid budget increases due to rework [74].

Human resource management is one of the most significant factors contributing to any organization's success. Road agencies must assess Human Resource (HR) expenditures to enhance cost-efficiency in managing human resources. Activity-Based Costing (ABC) represents one method utilized in recruiting, selecting, employing, training, and integrating human resources [75]. This approach entails identifying the cost per employee by analyzing the expenses associated with each activity. Managing human resources cost-effectively will enhance employee knowledge and skills and increase motivation and productivity [65].

Furthermore, road agencies must also evaluate the costs associated with the organization and management of road materials. Research suggests that handling road materials contributes to approximately 50% to 65% of the total project costs [76]. Roads consist of large structures constructed from various raw materials such as aggregate, concrete, bitumen and asphalt [72]. The necessity to transport substantial amounts of materials to designated locations significantly impacts the overall cost of road construction projects, necessitating road agencies to conduct cost analysis for each stage of the material-handling process [76].

3.4 Financial Leading

Effective road maintenance financial management leadership entails the capacity of a leader to direct and inspire team members towards achieving maintenance objectives [4]. Strong leadership skills are essential in the construction industry, as they set the tone for the workplace and contribute to project success. A leader must articulate a clear vision to unite the team toward a common goal [77]. Additionally, the leader is responsible for driving continuous improvement in financial management strategies and guiding employees through consistent review of financial management guidelines [5]. Employees can be effectively guided through consistent review of the financial management guidelines [78]. Furthermore, monitoring performance and providing valuable employee feedback is crucial for enhancing work performance [79]. Professionalism in organizational leadership, such as possessing a good visionary skill, fosters a positive workplace atmosphere and facilitates goal attainment [9].

A leader also needs to possess good interpersonal skills, such as effective communication with the team members, as effective communication will help to collaborate and improve teamwork [77]. Road maintenance management is subject to various external factors that will impact the management, including changes in land use, demographics, traffic demand, and climate. As such, leaders must embrace change management as it will contribute towards the sustainability of road maintenance management and maintain the organization's stability [80]. It is essential to assess and increase asset management awareness among employees as it will increase accountability in financial management and ensure assets are always at an optimal level [81]. In addition, promoting the use of technology will support team members in speeding up financial decisions for road maintenance works [82]. For example, an online application for road maintenance allows field workers to update road information so that the managers at the workstation can make maintenance decisions [9]. Managers may also alleviate the workload by providing an advanced system that can process vast amounts of financial data and generate reliable cost estimates for road maintenance work [11].

3.5 Financial Monitoring

In road maintenance management, financial monitoring is the process of tracking financial performance for road maintenance works [2]. Throughout the implementation phase, both financial and physical performance must be regularly updated as this provides insights into progress status and enables the implementation of corrective measures [63]. Additionally, road agencies must regularly update actual costs incurred to identify occurrences of cost overruns [2]. Cost overrun is defined as the amount by which actual cost exceeds the budgeted cost [84]. To mitigate cost overruns, road agencies need to monitor the factors contributing to them, such as variations in project orders. Variation orders entail changes during construction concerning designs, specifications, and scope, resulting in additional project costs [63]. Besides that, road agencies also need to monitor the material price increase as it will assist in developing mitigation plans that will reduce cost overruns [11, 85].

Moreover, project costs are also vulnerable to geographical factors such as project location and site geological conditions, prompting road authorities to monitor project costs that are affected by these factors [83]. Additionally, extreme weather conditions such as heavy rain, flooding, and high winds significantly impact construction projects, leading to delays, and increased project costs [85]. Therefore, road authorities must monitor weather conditions that could affect project completion [86]. For instance, obtaining historical weather patterns aids in developing reliable work schedules to mitigate delays and avoid additional costs associated with such delays [87].

3.6 Relationship between Financial Strategy and Research Objectives

The relationship between financial strategies and research objectives is evident through the comprehensive analysis provided in this study. Each financial strategy, from financial goal-setting to financial planning, organizing, leading, and monitoring, directly addresses the study's objectives of enhancing road maintenance management. Financial goals are essential for setting a clear direction and ensuring resources are used efficiently to meet both immediate and long-term maintenance needs. The strategic financial planning discussed, including the use of advanced technologies such as Pavement Management System (PMS), Artificial Intelligence (AI), Geographic Information System (GIS) and Building Information Modelling (BIM), aligns with the objective of improving cost forecasting and risk management. Organizational practices, such as effective stakeholder management and resource allocation, ensure that financial resources are effectively mobilized to achieve maintenance objectives. Strong leadership, characterized by vision and communication, plays a pivotal role in guiding financial strategies and addressing challenges, thereby supporting the attainment of maintenance goals. Furthermore, diligent financial monitoring ensures that any deviations from budgetary expectations are promptly addressed, thus supporting the objective. This discussion illustrates how targeted financial strategies address theoretical aspects and offer practical solutions for achieving the study's objectives in road maintenance management.

4.0 CONCLUSION

In conclusion, the literature review discovers the essential domain of strategic financial management for road maintenance. The integration of several studies has illuminated major themes and trends, putting light on the field's varied difficulties and potential. The literature review stressed the significance of proactive financial planning, risk management, and the incorporation of innovative financing approaches. The findings also highlighted the importance of leveraging technology and data-driven techniques to improve financial decision-making in road maintenance. It was discovered that the majority of the previous studies stress budget constraints, thus revisiting the financial planning strategy, which includes utilizing advanced technology, continuous improvement of road maintenance policy, conducting Life Cycle Cost Analysis, and performing Cost-Benefit Analysis. Previous studies also focused on the goal-setting process, organizing financial resources, leading financial management, and monitoring financial performance. Based on the analysis, good financial strategies are critical to the long-term viability of road infrastructure. Moving forward, policymakers, practitioners, and researchers must work together to implement and advance these strategic financial management methods to preserve the durability and resilience of global road networks. This comprehensive assessment lays the groundwork for future research and practical initiatives aimed at optimizing budgetary solutions for continuous and sustainable road infrastructure maintenance. Additionally, this study recommended that further research concentrate on developing a strategic financial model for road maintenance that includes more strategic components to optimize financial resources and achieve maintenance goals. Those components include financial goals, financial planning, financial organizing, financial leading, and financial monitoring. It was also recommended that the future financial management model present the connection between variables such as critical success factors and their impact towards financial management effectiveness. As road maintenance operations demand immediate decisions, the future model will assist in making more prompt and justifiable financial decisions.

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Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper

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