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Road Maintenance Administration in Vietnam: Problems and Solutions

Nguyen Thi Tuyet Dung[1*], Pham Thi Tuyet[2], Do Van Thuan[3]

[1]Hanoi Architectural University, Km10 Nguyen Trai Road, Ha Dong District, Hanoi, 10000, VIETNAM

[2]University of Transport and Communications, No 3 Cau Giay Quarter, Lang Thuong Ward, Dong Da District, Hanoi, 10000, VIETNAM

[3]Institute of Transport Administration and Management Cadres, Co Nhue, Bac Tu Liem, Hanoi, VIETNAM

*Corresponding Author

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Abstract: Vietnam is in the process of economic transformation which involves lots of requirements for road transport infrastructure development to create a driving force for socio-economic growth and to meet the needs of industrialization and modernization. To have synchronous and sustainable process of developing road infrastructure, maintenance should be paid attention to make the most of the capacity of the existing. Understanding the importance of this work, since 2013, Vietnam Government has issued a relatively sufficient series of policies on road repair and maintenance management. However, there are still shortcomings in road maintenance administration (i.e., discrepancies among legal regulations, challenges in maintenance planning, ineffective selection of contractors, insufficient financing, improper spending, limited introduction of science and technologies), which can hardly be resolved all together at once. The article has studied about the administration and use of the Maintenance Fund and mobilization capital in several countries around the world, at the same time analyzes the status quos of maintenance administration in Viet Nam in the following aspects: management strategies; planning and implementation; policies and regulations on maintenance administration; road quality management; management of maintenance fund, and application of science and technology. Along with the questionnaire in a 3-step approach and SPSS software, the authors have built four groups of influential factors to the road maintenance administration, as well as assessed the level of influence and rationality of each factor. The study then has suggested emergent and practical solutions for more efficient road maintenance management towards sustainable operation of road transport infrastructure.

Keywords: Efficiency improvement, maintenance administration, road maintenance, maintenance plan

1. Introduction

By the end of 2012, in Vietnam, there were about 300,000 km of roads of all types. Among them, only about 1,200 km and 2,600 km have their maintenance plans implemented at major level and moderate level respectively (Tien Hieu

*Corresponding author: khuongdungkt@yahoo.com

2013), which may lead to shortened lifetime of the roads (Viet Hung 2021). One of the reasons is the shortage of funding allocated for the job (Nguyen 2018). A government report shows that the average capital for national highway maintenance in the period 2009 - 2012 was 2,615.13 billion VND/year, meeting only 30-40% of the demand (ITSD 2012), and this continued to the next years. Working under extreme natural conditions (rainstorms, typhoons, floods, etc.) and the rapidly increasing traffic volume, without proper road maintenance activities, a significant part of the road network in Vietnam has become rapidly degraded. This leads to the increase in the funding requirements for the road maintenance year by year, resulting in an increasing burden on the budget (Nguyen 2018).

In light of the Resolution No. 13-NQ/ TW dated on January 16th, 2013 from the meeting of the 11th Central Committee of the Communist Party of Vietnam on developing the synchronous infrastructure to make Vietnam become an industrialized and modernized country by 2020 (Central Executive Committee of the Communist Party of Vietnam 2012), a revised master plan for road transport development in Vietnam to 2020 and orientation to 2030 has been approved by the Prime Minister (The Prime Minister 2013). Among other issues, the master plan puts emphasis on the management and maintenance of the existing transport infrastructure to maximize the effective use of them. As such, the Government and the Ministry of Transport, since 2013, have synchronously implemented a set of solutions to further improve road maintenance, specifically reforming administration approach, strengthening of road maintenance planning, improving regulations on maintenance, promoting and the application of technologies in maintenance, revising and supplementing regulations on quality management, economic and technical norms and standards, and raising fund for maintenance (MoT 2013, MoT 2014). Besides the achievements gained, there still have been shortcomings and difficulties along the way to enhance the road maintenance administration and to ensure sustainable road infrastructure development (MoT 2013). Literature shows that, for developing countries, including Vietnam, fund allocated from the national budget is often far less than the demand of road maintenance (Nguyen 2018). In Vietnam, the budget for road maintenance (Road Maintenance Fund - RMF) is comprised of two main sources which are the nation's budget and the toll fees collected, since fund from other sources contributes only a very small portion of the total required fund (ITSD 2012). Therefore, the governments need to find way for mobilize different sources of finance for funding the road maintenance, however, this is not an easy job. Other issues include the distribution of the fund between governmental level and local level, the efficiency and effectiveness, and the level of transparency in using the fund (Nguyen 2018).

The problems identified is not only for Vietnam. Literature shows similar issues have been investigated for both developed and developing countries. Several studies have emphasized the significant importance of strategic planning for road maintenance funding (Costello and Snaith 2000, Obeng and Tuffour 2020), especially the plans at national level (Antameng and Pike 2001). Apart from the allocation from the national budget, alternative funding arrangements such as revenue obtained from fuel taxes (Chrisnarmoko 2010) or donor funding, revenue from on-street parking scheme and related-charges (Obeng and Tuffour 2020), or road-user charges (Mbara, Nyarirangwe et al. 2010), or the VAT collected from vehicles parts sale and fines for overloading (Nyegenye 2011) for maintenance of road networks in developing countries have been proposed. Regarding municipal allocation of road maintenance construction funding, a recent study reveals that a formula is needed for allocation of funding for local streets maintenance and construction (Bonilla, Rasdorf et al. 2020). A comprehensive framework was developed to assess road condition and allocate funding for maintaining the road assets, using a maintenance management system to forecast maintenance expenditures then calculate optimal funding for each maintenance job (Almalki, Rasdorf et al. 2016). In the UK, a model was been developed to estimate a "greater understanding of the wider societal impacts in maintenance appraisal", including the cost of vehicle operation and the time users can save, in order to better value the "full benefits" of expenditure on highways maintenance (Buckland, Abell et al. 2015).

Several studies have discussed the factors that affect the road maintenance fund establishment and operation. Key macroeconomic policy factors have been pointed out, including a policy on establishing and controlling a maintenance plan, additional policy decisions to successfully protect the road maintenance fund, not letting the allocated amount to be redirected to non-road related uses (Nyegenye 2011). The fund flows may be constrained by the factors such as "delay in allocation committee meetings", "requisition of the Authority to Incur Expenditure", "lengthy disbursement channel", "lack of a proper tracking system", "delay in external auditing" and "weak financial management system" leading to negative issues in the work plans implementation, backlog in maintenance and malpractices in procurement (Rambo and Odundo 2014). A study in Indonesia shows that some activities in administering road maintenance fund, such as fund allocation must be supported by relevant regulations (Kurniawan 2017). An earlier study suggested the involvement of road users to planning and management of road funds for maintenance (Nyegenye 2011).

A set of research question was raised for this research study. As a developing country, has Vietnam experienced problems in road maintenance regarding the funding issues? What are the significant influential factors to the administration of road maintenance? And what solutions can be proposed to address the problems? This study tried to find answers for these questions, starting with an exploration of the context of the road maintenance administration in the country, conducting a quantitative analysis of the influential factors to the road maintenance administration, then proposing four solutions to address the problems.

2. The Context of Road Maintenance Administration in Vietnam

2.1. Maintenance Delivery Strategy

Since 2013, along with the establishment of the Road Maintenance Fund, road maintenance delivery strategy in Vietnam has changed from assigning jobs to contractors in a pre-defined list to procuring services through bidding. Individuals and organizations with interest and capabilities are allowed to participate in bidding for maintenance packages. State authorities only perform the administration, supervision tasks; the jobs of state administration and the production and supply of public products and services for maintenance works are separated. The governmental authorities in charge in the state administration of road maintenance include the Ministry of Transport (Directorate for Roads of Vietnam) at the central government for national roads, the provinces' People's Committees (Departments of Transport - DOTs) at provincial levels for provincial roads and urban roads; the district roads and commune roads are managed by the agencies appointed by provincial governments while special service roads are managed by the owners (National Assembly 2008, DfR 2016, ITSD 2018). For expressways and national roads developed by BOT (Build – Operate – Transfer) scheme, the investors are in charge of maintaining the roads (MoT 2017).

Procuring the contractors for road maintenance by bidding, recent years have witnessed a reduction on the bid winning prices of 5-10% or even 30%, occasionally, in comparison with the budgets. In 2018, more than 40% of the total maintenance job by value was bid in online mode, saving more than VND 204 billion (DfR 2019). However, the bidding regulations for road maintenance are still incomplete and reveal shortcomings, e.g. violations in some projects against bidding law have not been handled, some contractors who won the bid were not capable to perform contractual duties, provisions on bidder selection are not consistent, which are interpreted differently by ministries and government agencies. Moreover, the insufficient funding for maintenance has resulted in small packages of periodic repairs (less than VND 5 billion) and low evaluated bid prices of regular maintenance packages (VND 25 million/ km/ year during 2013 - 2018, meanwhile the minimum regulated bid norm VND 64.9 million). Therefore, the maintenance jobs are not very attractive to strong contractors. The interested contractors have little motivation to invest in the research and development activities for innovation and modernization of machineries and equipment (DfR 2019).

2.2. Development and Implementation of Maintenance Plans

The development of the maintenance plans puts emphasis on planning for and assigning medium-term maintenance plans (3-year plans with annual reviews and revisions if necessary). However, the maintenance plans development is not very practically applicable due to the following reasons: (1) lack of road surveillance information system, (2) shortage of funding for maintenance jobs, (3) insufficient and unsynchronized road system database, (4) no official approval of medium-term maintenance plan (Nguyen 2018). Therefore, the annual maintenance budget is estimated based on past year budget allocation and historical trend, which does not truly reflect actual maintenance and funding demands (DfR 2017).

Medium and long-term road maintenance plans have not been developed in practice due to lack of official guidelines. In addition, the incomplete road system database leads to the practice that road condition has not been monitored properly. Therefore, there are insufficient data for estimating the interval and duration of the maintenance jobs. What is more, since only minor periodic repairs and unscheduled maintenance have been carried out for a long time, it is difficult to set the roads back to their baseline state for the development of to build the plans for intermediate maintenance and overhaul of the roads in accordance with the current regulations (Nguyen 2018). Without medium and long-term plans, funding mobilization strategies cannot be developed, resulting in failure to attract private funding for road maintenance. Therefore, the job of developing road maintenance plans needs to be renovated with a focus on medium and long-term issues.

2.3. Policies and Regulations on Road Maintenance Administration

Recently, policies and regulations on road maintenance administration have been reviewed and revised for improving organizational and managerial apparatus, with clear assignment and decentralization of responsibilities of agencies, creating a legal basis for the State to actively exercise administration rights. However, a number of regulations related to road maintenance are not consistent, causing many difficulties for the implementation. Issues related to policies and regulations on road maintenance administration are explored below (Nguyen 2018).

- The inconsistency of selected legal documents and the contradictions between laws and decrees guiding the law.

In the Law on Construction No. 50/2014/QH13 dated June 18, 2014, there are some articles regulating maintenance of *civil works*, which the roads belong to according to the classification system in Vietnam (National Assembly 2014). With regard to the Law on Bidding No. 43/2013/QH13 dated November 26, 2013, the work maintenance is considered as a *non-consulting activity* (National Assembly 2013). However, Decree No. 46/2015/ND-CP dated May 12, 2015 on control and inspection of construction works (two of the five maintenance aspects) classifies these jobs as *conditional construction consulting activities* (Government of Vietnam 2015). The discrepancies among regulations pose major obstacles to the management of bidding processes, because of the different process and templates of invitations to bids applied for civil works, consultancy, and non-consultancy activities.

Another issue comes from different requirements on the type of investment reports to be developed for such type of works. The Law on Construction No. 50/2014/QH13 requires the development of feasibility study reports of investment in civil works, or an economic-technical report of investment in civil works (National Assembly 2014). Whereas, Decree No. 46/2015/ND-CP stipulates that minor repairs (of less than VND 500 million) are not subject to economic-technical report of investment in civil works (Government of Vietnam 2015). This leads to a challenge in the administration of the appraisal and approval of such maintenance jobs before allocating fund and execution of bidding processes.

- An emerging need of special mechanism for the road maintenance administration due to the special characteristics of the maintenance job, such as the requirement for regular, continuous services, natural and weather impacts etc.

According to Decree No. 59/2015/ND-CP the road maintenance administration boards from DOTs in provinces have been moved to be under provincial People's Committees and transformed into civil works investment project management boards. There no longer exist an independent maintenance service unit in the DOTs in provinces. The maintenance services administration are now the duties of the Traffic Control Divisions under the DOTs. Most staff in the Traffic Control Division are the civil servants whose expertise is policy advocacy, not road maintenance. With limited number of staffs while being in charge of lots of additional duties on top of hundreds of national highways and close to 1,000 km of provincial roads (on average, per province), the Traffic Control Divisions do not enough personnel to do inspections and oversights of the contractors. Therefore, the quality of maintenance cannot be secured, many DOTs have experienced delays in approvals to projects and processes in an annual maintenance plan (Nguyen 2018).

For projects of road repairing, Decree No. 59/2015/ND-CP requires that the DOTs shall outsource the jobs to the professional project management board in the province or a project management consulting organization (Government of Vietnam 2015). The procurement process is time consuming, therefore, these bodies in charge may not be responsive to traffic connectivity demand. Hence, it is important to further review and revise the legal regulations to be more realistic and updated to the trend of sustainable development in the coming time.

2.4 Road Quality Management

Quality management is considered a central and cross-cutting task of road maintenance. The current regulations require that quality should be strictly controlled right from the stage of project formulation and appraisal to the operation phase, where regular maintenance plays a very important role (Government of Vietnam 2015).

Regular maintenance administration has been transformed from volume-based acceptance to quality-based acceptance. The development of technical standards and norms has been further completed step by step. Important standards and procedures such as the “Basic standards of Regular maintenance”, the “Basic standard on expressway operation and management”, the “Basic standard of regular maintenance of expressways”, the “Process of large bridge maintenance of special grade and grade I” and cost norms of regular road maintenance have been developed; yet, there is still a lack of standards and norms corresponding to new construction technologies and new materials (Nguyen 2018).

There are still other significant issues in road quality management. Firstly, the lack of official quality criteria and punishment policies leads to the difficulty in quality control of the maintenance contractors, while the road administration agencies have no on-site task teams for carrying out the fieldwork of checking, monitoring and pushing the contractors, if necessary. Secondly, there is no independent body for the inspection of the repairing jobs; the jobs have been assigned to the contractors, therefore, this is actually the internal inspection (Nguyen 2018). These issues must be addressed for enhancing the road quality management in relation with the road maintenance.

2.5. Management of Road Maintenance Fund

Before 2013, the capital for road maintenance was mainly mobilized from the state budget, there was no separate fund for this work. This source of capital is much lower than actual demand, meeting only about 30% - 40% of demand for the national roads and 20-305 demand for local roads (ITSD 2012). The long-lasting large shortage of capital for maintenance work has led to the significantly low quality of Vietnam's road system, among the lowest in the world. Law on Road Traffic No 23/2008/QH12 states that the financial resources for management and maintenance of national highways and local roads are guaranteed from the Road Maintenance Fund, maintenance fund for special-use roads, air roads managed and exploited by the State, roads that are invested by other sources of capital is supplied by the investors (National Assembly 2008). Until 2012, Decree No 18/2012/ND-CP was issued to regulate the Road Maintenance Fund formulation and operation, then, the RMF started to operate from January 2013 (Government of Vietnam 2012). The Fund is comprised of the following sources of capital: (1) road-use toll fee, which is collected based on the counts of motorized vehicles, (2) state budget allocation, at central and local levels, and (3) other sources such as the road owners’ budget, BOT projects, contribution of other sponsors such as the community and individuals (National Assembly 2008, Government of Vietnam 2012) (see Fig. 1).

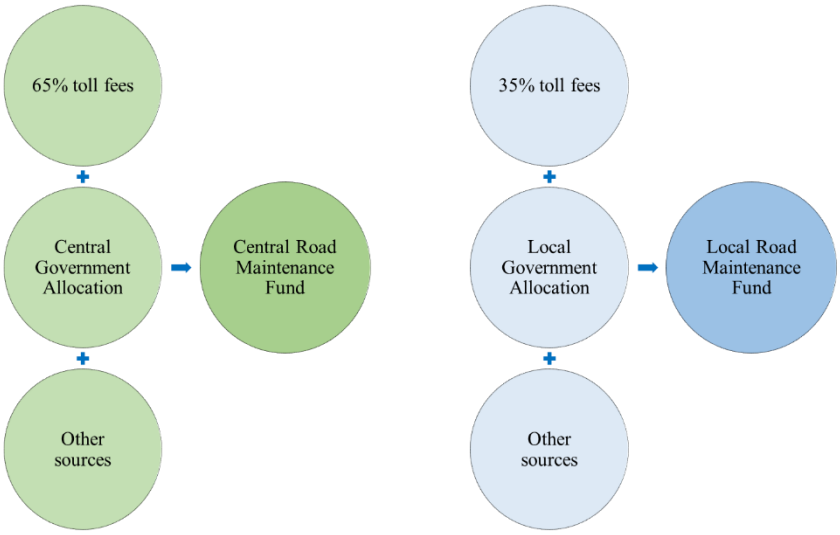

Fig. 1 - Sources of funding for Central and Local Road Maintenance Funds

In 2013, road-use toll fee based on the counts of road motorized vehicles started to be collected to contribute to the Road Maintenance Fund. Hence, in addition to the annual state budget allocated, the road sector can rely on one more source of funding for maintenance. The average annual toll revenue is VND 5,924 billion, which is two times higher than the fund allocated from the state budget (Nguyen 2018). This is a big step towards in the Party and the State policy on fund raising for road maintenance.

However, since 2017, the fund has been managed in the same way as budgetary management and allocation, engaging many levels of authorities in the allocation and disbursement of fund, and failing to meet the frequency and responsiveness to fund allocation in line with the special requirements of maintenance. Major issues are discussed below.

According to the annual budgetary process, the National Assembly approves the annual budget revenue and expenditure in November of the previous year (MoF 2017). Not until then, the Ministry of Transport is assigned with the revenue and expenditure estimates, then VNRA (Vietnam Railway Authority) and DOTs start to prepare, approve budget plan of revenue and expenditures, arrange for bidding, etc. in various levels till its implementation in Quarter 1, or even early Quarter 2 of the following years (Nguyen 2018). At this time of the year, it is the rainy and stormy season, so untimely maintenance of roads and more severe damages of roads have been witnessed, which in all brings up the costs of repairs and maintenance. On the other hand, the quarterly budget allocation makes it difficult for the implementing units. Monthly budget allocation is more helpful to these organizations.

Moreover, contingency, additional budget allocation in addition to the maintenance plan, recovery of damages caused by storms and rain, black spots, and potential points prone to traffic safety risks, repairs on an ad hoc basis, etc. in line with the current regulations, repairs of abnormal damages, etc. will be sent to the Ministry of Finance and only implemented based on the mutual agreement of Ministry of Transport and the Ministry of Finance (Nguyen 2018). Thus, irresponsiveness to ad hoc repairs, failure of response proactively and timely there is not enough time to implement the unexpected repair, not ensuring the proactiveness and timeliness of the maintenance fund.

There are still shortcomings in inspection and supervision and monitoring of expenditures. The local procedures of acceptance, payment and settlement in organizations in relation to periodical and ad hoc repairs still encounter double accounting, excessively measured quantities, and improper payment proceedings. Many packages have been approved without full calculation of price escalation, some packages have been approved by VNRA as “a lumpsum contract”, which is not in line with applicable regulations. In 2017, the State Audit of Vietnam detected and excluded VND 9.7 billion, of which VND 7.6 billion was due to errors in quantities, VND 1.7 billion due to unit price errors, and VND 548 million due to other errors. Given the insufficient funding for maintenance, it is a pressing need to effectively and efficiently manage and spend maintenance funding (Nguyen 2018).

2.6 Application of Science and Technology in Road Maintenance

There have been many progresses in application of science and technology in road maintenance. Some new maintenance technologies and advanced materials have become more popular, such as polymer asphalt concrete, micro surfacing technology for road surface maintenance, Japanese baradrain technology for waterproofing and drainage on bridge decks, technology for raking and recycling of road surface, etc.

Attention has been paid to the intelligent transportation system (ITS). The non-stop electronic toll collection (ETC) system has been deployed on national highways. Calculations show approximately VND 3,400 billion saving every year when compared with conventional toll collection approach (Nguyen 2018).

Apart from the achievements, there have been shortcomings and delayed reforms in the application of advanced technologies in maintenance. The examination and monitoring of the technical status of the works are done manually. The unclear examination criteria make it difficult to bring up proper maintenance measures in terms of time and technology choice. It is not appropriate to categorize all types of maintenance as regular maintenance. The application of information technology to build a database for road system management and maintenance is incomplete.

Therefore, it is essential to have appropriate and synchronous solutions to promote the application of science and technology in maintenance.

3. Research Methodology

As discussed above, the road maintenance administration in Vietnam still reveals lots of shortcomings which can hardly be resolved all at one go. Therefore, it is necessary to assess the shortcomings through analyzing and prioritizing the influential factors to the road maintenance administration by their seriousness and intensity, then solutions can be proposed.

The influential factors can be categorized into four groups: (1) State administration, (2) fund spending management, (3) maintenance planning and expenditure estimate allocation, and (4) quality management and application of science and technology. This study applied a quantitative approach with the use of a questionnaire survey, then SPSS software is used to assess *the extent of influence and the relevance of the issues* to the road maintenance administration, to rate the level of their influence and their relevance, and then to propose practical and appropriate recommendations and solutions to further complete the maintenance management.

The research process has three steps: (1) Questionnaire design, (2) Questionnaire Piloting, (3) Survey and Analysis, as shown in Fig. 2.

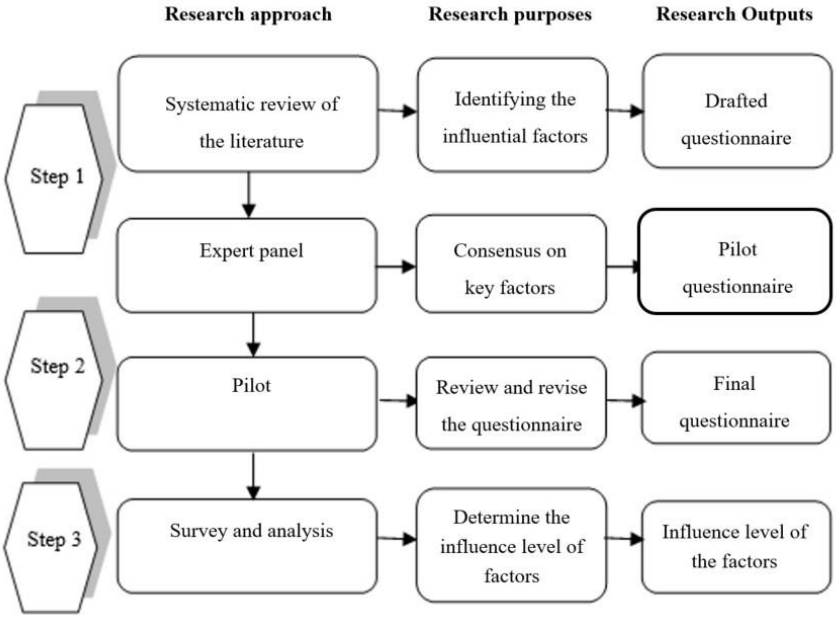

Fig. 2 - The research process

*** Step 1: Questionnaire design**

The questionnaire was designed with a systematic review and expert panel methods. Literature (both domestic and international sources) was reviewed to identify the influential factors to the road maintenance administration. A group of experts was then invited to assess the key factors in the context of Vietnam. The pilot version of the questionnaire was developed as an output of this step.

Apart from the introduction, demographic information sections, selected criteria to survey with the questionnaire are presented in Table 1. Likert scales were applied for both the Levels of influence on road maintenance management (Influence level) and the Assessment of the road maintenance (Rationality level). For the Levels of influence on road maintenance management, 1 =no influence, 2 =little influence, 3=moderate influence, 4 = significant influence and 5 = profound influence (decisive level of influence). Regarding the Assessment of the road maintenance, 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, and 5 = strongly agree.

Table 1 - The level of influence and relevance of the criteria in the road maintenance management

No.	Selected criteria	Influence level					Rationality level				
		1	2	3	4	5	1	2	3	4	5
I	**Criteria for state administration for road maintenance**										
A1.1	Discrepancies in the system of legal regulations on road maintenance										
A1.2	Shortcomings in the selection of contractors										
A1.3	Inadequate emphasis on communication and education on roles and benefits of road maintenance										
A1.4	Different perceptions on maintenance management among agencies: Ministry of Finance, Ministry of Transport, Ministry of Planning and Investment, Inspectors										
II	**Criteria for managing the use of road maintenance funding**										
A1.5	Non-strict inspection, examination and audit of the use of funding										
A1.6	Inappropriate proportion of funding for regular maintenance and periodic repair in the Fund (currently, regular maintenance takes about 18% of the Fund)										
III	**Criteria for maintenance planning and expenditure budget assignment**										
A1.7	Incomplete database on road transport infrastructure system										
A1.8	Unrealistic annual and medium-term maintenance planning										
A1.9	Untimely and unreasonable assignment of expenditure plan										
IV	**Criteria for quality management and application of science and technology in maintenance**										
A1.10	Improper control of quality management of maintenance performance										
A1.11	Delayed innovation and application of scientific and technological advancements in road maintenance										
A1.12	Incomplete system of technical standards for road maintenance, standards and norms related to new construction technologies, new materials										
	Please indicate any additional criteria and insert your comments based on actual implementation in the boxes below:										
A1.13	...										
A1.14	...										

* **Step 2: Questionnaire Piloting**

The purpose of this step is to review and revise the Pilot questionnaire to finalize it, before conducting the main survey. The Pilot questionnaire is sent to respondents in person and by email, the authors explained in detail the issues that need to be consulted. Targeted population of the survey comprise of those who have worked for a long time in research institutes, state administration agencies, construction or consultancy contractors operating in the field of road transport infrastructure. SPSS software was used to analyze the responses obtained, to calculate the reliability statistics and statistical correlation between each criterion with the use of Cronch's Alpha coefficient.

* **Step 3: Survey and Analysis**

The main survey was conducted by convenient sampling method. The sample size for the main survey was determined as 250, based on the accuracy required. SPSS software was again used to assess the influence of the criteria and criteria with the average value (mean), the greater the level of influence. The auditing results of the official questionnaire on the correlation statistics between each criterion with all criteria in the group and the Reliability Statistics is satisfactory. This is entirely consistent with Step 2.

4. Results

In Step 1, 14 factors collected from the literature was proposed to be used to assess the influence and reasonableness in the management and use of the Road Maintenance Fund. After discussion with the expert group, 12 factors were kept in the questionnaire.

In Step 2, the number of questionnaires sent out was 58. 45 valid responses were collected. Regarding the number of years of experience of the participants, the survey sample can be divided into 3 groups as follow: a group for people with 5-10 years accounted for 10%, with 10-20 years accounted for 48%, with over 20 years accounted for 42%. Grouping by the organization types, there are 36% of the participants coming from State administration agencies and research institutes on road maintenance, 44% coming from consultancy contractors, 20% coming from construction contractors. According to education level: people with a university degree accounted for 50%, participants with a post-graduate degree accounted for 50%.

SPSS software was used for Reliability Statistics and correlation statistics between each criterion with all criteria in the group (Item-Total Statistics) to verify the reliability of Pilot Questionnaire. 280 people sent back their completed questionnaires, among which only 250 questionnaires could be used. Among the participants in the survey, the number of people with 5-10 years of experience was accounted for 20%, 45% for people with 10-20 years and 35% for people with over 20 years of experience. The headcount of respondents working for the government agencies in road maintenance was 20%, for a consultancy was 40%, for contractors was 40%. 66% of the respondents have a university degree while 34% have a postgraduate degree.

The auditing results of the Pilot questionnaire on the correlation statistics between each criterion with all criteria in the group (Item-Total Statistics) and the Reliability Statistics is satisfactory, with Cronbach's Alpha index > 0.700 and all Corrected Item-Total Correlation > 0.300.

The evaluating results of the influence and relevance level of the criteria as well as their correlation are shown in Table 2. In Table 2, the authors also rank the influence and relevance of the criteria (columns (4) and (7)), with comments.

Table 2 - Survey results of the Official questionnaire about the level of influence and relevance of the criteria

No.	Selected criteria	Influence level			Relevance level			Correlation	
		Mean	Order of influence level	Standard deviation	Mean	Order of influence level	Standard deviation	r	Sig (p)
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
I	**Criteria for state administration of road maintenance**								
1	Discrepancies in the system of legal regulations on road maintenance	3.64	**5**	0.699	3.60	**1**	0.835	0.250	0.000
2	Shortcomings in the selection of contractors	3.73	**3**	0.714	3.52	**3**	0.701	0.405	0.000
3	Inadequate emphasis on communication and education on roles and benefits of road maintenance	3.58	9	0.597	3.17	10	0.630	0.291	0.000
4	Different perceptions on maintenance management among agencies: Ministry of Finance, Ministry of Transport, Ministry of Planning and Investment, Inspectors	3.58	**10**	0.617	3.48	**4**	0.678	0.355	0.000
II	**Criteria for managing the use of road maintenance funding**								
5	Non-strict inspection,	3.68	**4**	0.673	3.39	**6**	0.732	0.185	0.003

No.	Selected criteria	Influence level			Relevance level			Correlation	
		Mean	Order of influence level	Standard deviation	Mean	Order of influence level	Standard deviation	r	Sig (p)
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
	examination and audit of the use of funding								
6	Inappropriate proportion of funding for regular maintenance and periodic repair in the Fund (currently, regular maintenance takes about 18% of the Fund)	3.61	6	0.809	3.29	9	0.732	0.379	0.000
III	**Criteria for maintenance planning and expenditure budget assignment**								
7	Incomplete database on road transport infrastructure system	3.75	2	0.798	3.32	8	0.851	0.247	0.000
8	Unrealistic annual and medium-term maintenance planning	3.59	**8**	0.690	3.53	**2**	0.729	0.370	0.000
9	Untimely and unreasonable assignment of expenditure plan	4.06	**1**	0.824	3.35	**7**	0.933	0.381	0.000
IV	**Criteria for quality management and application of science and technology in maintenance**								
10	Improper control of quality management of maintenance performance	3.55	11	0.766	3.10	11	0.966	0.268	0.000
11	Delayed innovation and application of scientific and technological advancements in road maintenance	3.60	**7**	0.744	3.43	**5**	0.656	0.235	0.000
12	Incomplete system of technical standards for road maintenance, standards and norms related to new construction technologies, new materials	3.23	12	0.767	3.01	12	0.894	0.297	0.000
	Average	**3.64**			**3.39**				

The correlation between the influence level and the Relevance: "Influence level" of the criteria are positively correlated with "Relevance level" ($r > 0$). In other words, there is a positive correlation between influence and relevance. This correlation is statistically significant with $p < 0.05$ (sig).

5. Discussions

Regarding the influence level of the criteria: All 12 criteria have a certain level of influence on maintenance management, with the average value of 3.64, the largest as 4.06, the smallest as 3.23. In which, the criterion "Untimely and improper assignment of expenditure plan" has the highest influence level with the mean value of 4.06. This result reflects the true nature of the maintenance where it is compulsory to handle damages and force majeure situations quickly, regularly and continuously, to ensure smooth traffic connectivity; thus, funding must be always readily available for timely responses when needed. This factor should be specially attended to in maintenance.

As to the current level of relevance of the criteria: All criteria introduced by the authors have certain levels of relevance, the mean value of 12 criteria ranges from 3.01 to 3.60, all are close to the overall mean (3.39), which shows that there are many areas for improvement in maintenance management due to existing shortcomings. Each criterion has a different mean value, i.e., different levels of relevance, it is recommended to carefully investigate the factors with a higher level of relevance to proactively give directions and solutions for improvement.

On another hand, it is noted that, among 7 criteria with the highest "Relevance", reflecting most shortcomings in road maintenance (ranking from 1st to 7th in column (7), Table 2), 6 factors are ranked of high "influence level" (column (4), Table 2). The factors include:

(1) Discrepancies in the system of legal regulations on road maintenance. This ranks 1st by relevance, 5th by influence level.

(2) Unrealistic annual and medium-term maintenance planning. This ranks 2nd by relevance and 8th by influence level.

(3) Shortcomings in the selection of contractors. This ranks 3rd by relevance and 3rd by influence level.

(4) Delayed innovation and application of scientific and technological advancements in road maintenance. This ranks 5th by relevance and 7th by influence level.

(5) Non-strict inspection, examination and audit of the use of funding. The factor ranks 6th by relevance and 4th by influence level.

(6) Untimely and unreasonable assignment of expenditure plan. This factor ranks 7th by relevance and 1st by influence level.

The above six factors are both of high influence and reflect the most outstanding issues that need to be adjusted and improved in road maintenance administration. This is the basis for proposing practical solutions to improve the efficiency of road maintenance administration. Four solutions have been proposed, which are discussed below.

** Solution 1: To further complete the Legal System on Road Maintenance*

The biggest shortcoming is the discrepancies in legal documents regarding road maintenance, ranking top of the results with the highest level of influence.

It's necessary to give priority to completing the legal system, especially the one related to the selection of maintenance contractors, in accordance with the reality and sustainable development trends. Details are as follows:

(1) State administration agencies need to actively coordinate, amend and supplement legal documents related to maintenance management, ensuring the consistency and uniformity in the direction of:

- Increasing the ownership and responsiveness; perform in a more realistic and relevant manner to the true nature of maintenance. Roads are systematic, interconnected, and subject to strong natural impacts, so the maintenance should be (proactively) performed regularly and timely. The budget should be monthly (instead of quarterly as currently) funded, helping maintenance units to be proactive in their work. Special regulations should be issued specifically on the contingency, additional assignment of plans such as handling and recovering the consequences of floods, handling black spots and points at risk of traffic unsafety, ad hoc damages repair etc. to ensure timeliness. Delays in maintenance and repairs may cause major social and economic losses.

- Selection of contractors, acceptance of road maintenance work is a part of civil engineering. Regular road maintenance and road repair are most resource consuming, most complicated and crucial items of work in the field of road structure maintenance. Therefore, it is not appropriate to regulate maintenance as non-consulting activities, likewise, minor repairs and ad hoc repairs should not be regulated as construction investment activities, which requires full process procedures applicable to construction investments. In addition, the Ministry of Construction should provide for specific instructions on definitions of change the scope and functionality of works, as a basis for audits and inspections. This is helpful for authorities in charge of maintenance management, state Audits, and inspections to have common understanding in the selection of contractors.

(2) There should be a special mechanism for maintenance management. The Ministry of Transport (MOT) proposes to the Government to promulgate for a pilot mechanism for road maintenance. As such, road maintenance management board can be established and maintained in DOTs, for the function of managing, maintaining and operating national highways entrusted, provincial and urban roads, and others as assigned. This set up is completely suitable with the reality, without additional public administrative staff, and does not increase budget spending because those boards are service-providing entities, whose operations are funded by maintenance project revenues. At the same time, it is not in contrary to the current regulations on the organizational structure of the DOT.

** Solution 2: Strengthening the Inspection, Examination and Audit of Funding Use Administration*

Road maintenance activities are complex activities, taking place throughout the entire territory, affected by many factors, involving many organizations and individuals, using many different technologies, etc. Therefore, inadequate

inspection and supervision may cause loss, corruptions, and waste of resources, which in all can negatively impact the use of funding.

In order for the inspection, examination and supervision of the management and use of road maintenance funding to be effective, it is necessary to implement the following contents:

(1) Determining the inspection and examination as an important task, which should be conducted regularly and continuously, with secure funding for it to be used for the intended purpose, on schedule and in conformity with current regulations. The inspection is done periodically and on ad hoc basis.

(2) To promote community participatory supervision: investment in road maintenance and repair is large and wide, hence, it is very necessary to strengthen community engagement in investment oversight. That local people are engaged as oversight "ears" and "eyes" of the structures that they will use in the future can enhance public ownership and hold contractors, consultants be more responsible for the quality and progress of the works.

Investment supervision by community is a difficult and complex job, and subject to a multidimensional impact. For effective supervision, attention should be paid to the following aspects: (1) members of the Community Supervision Board must be reputable, experienced and have certain legal qualifications; (2) it is necessary to regulate for mandatory acknowledgement of and adhering to comments from the Community Supervision Board with timely responses.

(3) To closely supervise the disbursement and payments by State administration agencies to civil contractors for compliance with legal regulations. Maintenance plan detailed lists should be notified by the Ministry of Transport and the Directorate for Roads of Vietnam to relevant agencies to strengthen the inspection and supervision of implementing units, while ensuring secure funding for timely payments to the right recipients.

(4) Allocation of funding for national highways management and maintenance shall be made public, appraised with diligence, with clear priorities, and implemented in conformity to the intended scope, quality and deadlines.

** Solution 3: To further complete the Maintenance Planning, Increasing Budget revenue*

The annual and medium-term maintenance planning are challenged by the lack of information, funding, and inaccurate presentation of the need for maintenance and funding, as well as capital needs, hence, making it difficult to prepare and assign annual expenditure plans.

When developing a maintenance plan, in addition to the collection and addition of databases from domestic and foreign sources, it is necessary to utilize road data from the VRAMP project sponsored by the World Bank, bridge data from VBMS project funded by Japan. Using the PMS assessment model of road surface condition and road surface surveillance vehicles to inform the annual maintenance plan more scientifically.

The development of a maintenance plan must both allow prioritization and balance among regions. Periodical repairs should be planned not only based on the criteria of the extent and nature of damages of the works, time when the works is put to operation, the role and function of roads as per legal regulations, but also vehicle traffic, topographic conditions, hydrogeological and weather, and climatic conditions… for the purpose of prioritization, forming the basis for a portfolio of work to implement during the planned year, in line with the funding availability.

The Ministry of Transport can consider and study the degradation patterns of the road surfaces using the following indices: IRI Roughness, Cracking Ratio and Rutting Depth. They can be combined to form Maintenance Control Index (MCI). The Ministry of Transport is to regulate the value of MCI at which repairs are required.

Funding constraints for road system maintenance is common in Vietnam, and many other countries in the region and in the world, particularly the developing countries. In order to overcome the situation, governments have made efforts to generate more funding for road maintenance in many ways, such as:

- Establishing a road maintenance fund, with dedicated funding for maintenance. Currently, over 55 countries have established Road Maintenance Funds. The fund is managed in a commercial manner, independent from the government budget (DfR 2019). In Vietnam, the Road Maintenance Fund was established in 2013, facilitating positive progress in the maintenance work. However, at present, the Fund is no longer in operation due to its inconformity with the Law on State budget and the Law on Taxes and Fees.
- Increasing allocation and efficiency of stage budget funding.
- Setting up toll collection system along the routes with high traffic volume
- Engaging private sector and other economic operators in the development and operation of roads with incentives, or concessions for road structure operation (Nguyen 2019).

** Solution 4: To promote the application of Scientific and Technological advancement in Road Maintenance*

The main goal of applying technological advancements in road maintenance is for higher effectiveness and efficiency of time and resources, safe traffic connection and traffic accidents.

For management: To develop an information system on road infrastructure, especially national highways, information system and database on the management of road corridors based on "Road traffic information system construction project" of the Ministry of Transport. All information is fully updated on the information system of the Directorate for Roads of Vietnam, and can be used in planning, scheduling, identifying needs for investment, and repairing the national highway system. In the future, it is also used for road asset valuation, which is the basis for asset tracking, asset management and operation, and costing in case of concession to private operators, or investors' payment to state budget.

For preventative maintenance, medium and major corrective maintenance:

- To upgrade basic standards of road maintenance to national standards. To complete the standards of expressway operation and maintenance management; technical and economic norms for expressway maintenance; special works such as long span bridges, and tunnels.
- To further improve the database system of road transport infrastructure, in combination with software to support annual, medium and long-term maintenance planning.
- To promote the application of new, advanced science and technology, and materials in the direction of: Applying motorized solutions in road maintenance, replacing manual jobs or jobs with high manual content with machineries and equipment. In which, emphasis is put on established technologies, including technology for raking and removing hot asphalt concrete, using warm asphalt concrete; carbon fiber pasting, glass fiber gluing technologies in repairs of bridges reinforced concrete structures; cold asphalt concrete technology for road construction, asphalt carbon or technology, use of acidic emulsion in road repairs which is suitable for expressway and high-grade automobile roads, and compatible to Vietnamese conditions.

5. Conclusions

By analyzing the current situation of road maintenance in Vietnam from 2013 on-wards, showing achievements as well as shortcomings and limitations, the paper presents developed, and categorized criteria affecting the maintenance performance, and the research using questionnaires and SPSS software to evaluate the extent of influence and relevance of the criteria. The authors have identified six criteria of high influence level which reflect the biggest issues in need of fixing, and improvement in maintenance management. Accordingly, the paper recommends four urgent and appropriate solutions for maintenance management, specifically: (1) To further complete the legal system on road maintenance; (2) strengthening the inspection, examination and audit of Funding Use management; (3) To further complete the maintenance planning, assigning of the expenditure plans and increasing budget revenues; (4) To promote the application of science and technology. These are the basis for improving the efficiency of maintenance management and ensuring sustainable operation of road transport infrastructure in Vietnam.

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