

Application of Road Engineering NSPM Action Programs on Sub-National Roads in Indonesia

Anastasia Caroline Sutandi^{#1}, Agus Taufik Mulyono^{*2}

^{#1}*Civil Engineering Department, Parahyangan Catholic University, Ciumbuleuit 94, Bandung 40141, Indonesia
E-mail: caroline@unpar.ac.id*

^{*2}*Department of Civil Engineering and Environment, Gadjah Mada University, Bulaksumur, Sleman, DIY, 55281, Indonesia
E-mail: atm8002@yahoo.com*

Abstract— In Indonesia, the norm, the standard, the guidelines, and the manual regarding road engineering for sub-national roads are known as road engineering NSPM. Application of a road engineering NSPM action program is crucial to increase roadworthiness and infrastructure resilience. Sub-national roads in Indonesia are roads at a province, regency, and city level. This research aims to find out the identification and evaluation of existing road conditions of sub-national roads in Indonesia. This research also aims to identify difficulties to increase road engineering NSPM application on sub-national roads. This research recommends action programs to attain roadworthiness of 75 percent of sub-national road length in Indonesia between the years 2015-2019. Sub-national roads in six provinces in Indonesia are the location of case studies. The provinces are Riau, particular region province of Yogyakarta, province of South Kalimantan, province of South Sulawesi, province of Bali, and the province of Maluku. Survey data show that province roads have fulfilled 66 percent of roadworthiness, regency roads have fulfilled 63 percent, and city road has fulfilled 81 percent. The difficulties in NSPM application are the limited support of the financial facility, and substandard application of human resource ability, dissemination of NSPM, evaluation of performance, road technical guidance, and observation on-site. The research methodology used is based on a physical existing road condition. Finally, there is a recommendation of action programs that can be instituted, i.e. dissemination of regulations regarding guidelines of road function and status in Indonesia, regulation of Public Work Ministry of Republic of Indonesia no 03/PRT/M/2012, regular application of technical training and coaching about accurate location where road engineering NSPM will be applied to local government by central government, regular application of technical training and coaching about road infrastructure resilience, and application of road engineering NSPM on sub-national roads, including monitoring and evaluation both internally and externally.

Keywords— NSPM; road engineering; action programs; roadworthiness and infrastructure resilience; Indonesia sub-national roads.

I. INTRODUCTION

Road infrastructure resilience is a concept, process, and action to reduce risk and damage caused by disasters and help communities prepare to withstand and recover as fast as possible. Disaster, especially natural disaster, i.e., earthquake, landslide, flood, or cyclone, can cause people to be killed, lose their homes and belongings, and infrastructures, including roads. Road infrastructure resilience can be reached if there is support from the beginning including fulfillment of NSPM (norm, standard, guidelines, and manual) implementation during planning, design, construction, operation, and maintenance of road infrastructure [1]–[4]. Road infrastructure can only improve infrastructure resilience if the road fulfills the roadworthiness by implementing the NSPM. By definition,

roadworthiness is the condition of the road that fulfills the NSPM.

Therefore, identification, evaluation, challenges, and application of road engineering NSPM in Indonesia are crucial. Besides national roads, sub-national roads, including roads at the province, regency, and city level, are required to fulfill the NSPM as well. Therefore, having, reading, understanding, using, implementing, and evaluating the NSPM to produce roadworthiness in Indonesia is compulsory.

Fulfillment of roadworthiness by which a road can be used as a facility during the evacuation process is closely related to improving infrastructure resilience [1]–[4]. Nevertheless, the existing condition of sub-national roads is not yet as required. In order to provide recommended solutions about application of road engineering NSPM and increased roadworthiness and infrastructure resilience of Indonesia sub-national roads, the objectives of this paper are,

first, to identify existing conditions of the sub-national roads in Indonesia. Second is to evaluate the existing road conditions based on road engineering NSPM. The third is to identify implementation challenges as to why existing conditions cannot fulfill the road engineering NSPM and reach roadworthiness. Finally, to provide action programs to

reach roadworthiness of 75 percent of sub-national road length in Indonesia between the years 2015-2019. Case study locations are in six provinces in Indonesia i.e. sub-national roads in the provinces of Riau, Special Region of Yogyakarta, South Kalimantan, South Sulawesi, Bali, and Maluku, as presented in Figure 1.



Fig. 1 Location of six provinces in Indonesia as case studies of road engineering NSPM implementation [5]

II. MATERIAL AND METHOD

A. NSPM in Indonesia

NSPM implementation has to develop a culture of quality standard towards uniformity and quality insurance of efficient, effective, and sustainable transportation infrastructure [6]–[8]. In the field of transportation, the norm is the regulations of Indonesia road engineering for national roads and sub-national roads. For example, regulation number 38 year 2004 about Road [9], regulation number 22 year 2009 about Traffic and Road Transport [10], regulation of government of Republic of Indonesia number 34 year 2006 about Road [11], and Ministry of Public Works regulation in Indonesia number 4 year 2009 about Construction Quality Management System [12].

Government of Republic of Indonesia regulation number 102 year 2000 about Indonesia National Standard [13] indicated that the standard is an engineering specification regarding procedure and method developed based on consensus of all involved stakeholders regarding safety, security, healthy, living environment, knowledge and technology development, experience, and sustainable development to reach maximal benefit [14].

In the field of infrastructure implementation, guidelines consist of general technical instruction and specific technical instruction, for example regulation number 03/PRT/M/2012 regarding guidelines of road function and status in Indonesia from the Ministry of Public Works of the Republic of Indonesia [15] and book number 008/BM/2009 about general guidelines of life environment management on roads [16]. The manual is an operational reference for road engineering, for example, book number 009/TBt/1995 about the procedure of maintenance of road landscape plants [17].

B. The Methodology of the Study

The methodology is developed based on existing conditions of limited support of the following items, i.e., financial, human resource ability, dissemination of NSPM, guidance of road technical, evaluation of performance, observation on-site, and road infrastructure resilience. The methodology consists of steps of input, process, output, outcome, and impact of road engineering NSPM implementation on sub-national roads in Indonesia in order to improve sub-national road roadworthiness and sub-national road infrastructure resilience. Moreover, innovation in the framework of thinking is as follows and presented in Figure 2.

In more detail, Figure 2 shows that input data concern existing road condition and infrastructure resilience, and also road engineering NSPM implementation including review and study about regulation, policy, literature, and problems of sub-national road implementation. The process of identification and evaluation of challenges and problems is in order to propose recommended application of road engineering NSPM action programs to reach roadworthiness of 75 percent of the total length of Indonesia sub-national roads between the years 2015-2019 [20]. The output of the process of NSPM implementation is in road engineering and infrastructure resilience. The measured outcome is whether recommended action programs and the output are implemented, i.e., achievement of uniformity, the framework of thinking, and performance evaluation of road engineering NSPM implementation on sub-national roads. The impact has occurred if the results of the outcome are implemented in 75 percent of sub-national roadworthiness in the total length of road in Indonesia in the year 2019. Improvement of roadworthiness and infrastructure resilience.

The Policy of the Republic of Indonesia's president. i.e., Nawacita 2015-2019, which is the guideline to determine the goal of infrastructure development connectivity between the sub-national roads and national roads in Indonesia and also infrastructure resilience in Nawacita. In line with the policy

of the strategic planning of the Ministry of Public Works and Housing, Bina Marga, 2015-2019, which is to reach roadworthiness of 75 percent of Indonesia's sub-national road length for the years 2015-2019 [20].

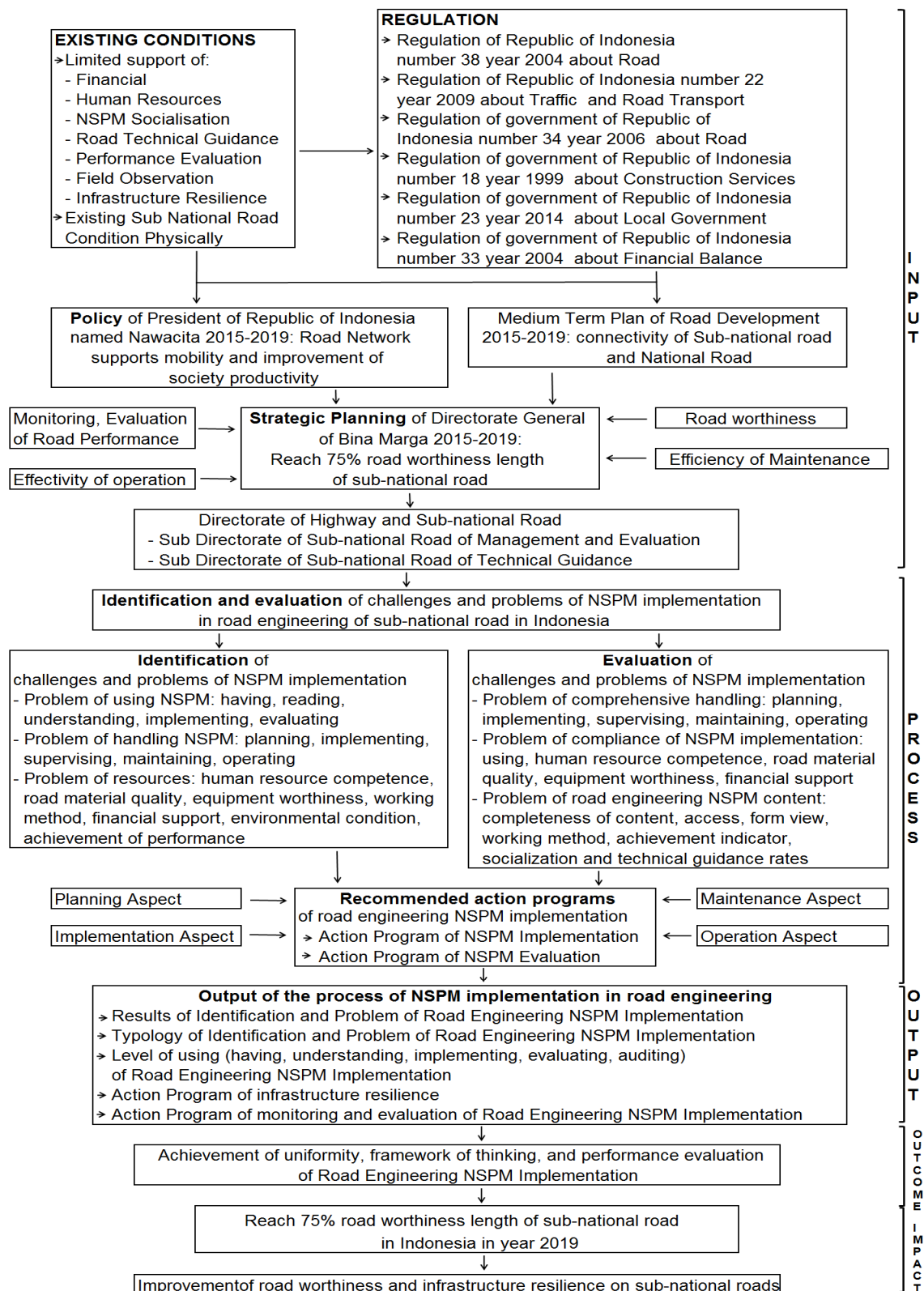


Fig. 2 Innovation in the framework of thinking regarding identification, evaluation, challenges, and problems of road engineering NSPM implementation to sub-national roads in Indonesia [18], [19]

C. Field Data of Sub-National Roads in Indonesia

Road network data in Indonesia show that 91 percent of the road is sub-national roads and only 9 percent is national roads [21]. The data indicate the critical role of the sub-national road in increasing goods and service distribution concerning the rapid impact on society's welfare, especially in Regency areas. The interconnection between sub-national roads and national roads in order to reach domestic economy independence is in line with Nawacita 2015-2019, the president of the Republic of Indonesia's policy.

Primary field data regarding existing roadworthiness in six provinces in Indonesia as case studies, i.e. those in the provinces of Riau, Special Region of Yogyakarta, South Kalimantan, South Sulawesi, Bali, and Maluku, are collected using direct survey method and presented in Table I. Table I show the length and the roadworthiness condition of the sub-national roads. Good roadworthiness condition means that the road has fulfilled the road NSPM, including (a) earthwork, (b) road foundation, (c) asphalt pavement, (d) concrete pavement, (e) road shoulder and drainage, and (f) road furniture and utility. An example of the existing condition of some sub-national roads can be seen in Figure 3.

Other primary data regarding implementation of road engineering NSPM in the six provinces are obtained using interview method and Discussion Group Forum with almost all road authorities in the provinces in 2015. The data regarding the existing condition of NSPM implementation on the sub-national roads in the six provinces in Indonesia are presented in Table II. In more detail, Table II shows data of (1) having, (2) not having, (3) reading, (4) understanding, and (5) implementing of road engineering implementation in the provinces.

TABLE I
ROADWORTHINESS CONDITION OF SUB-NATIONAL ROADS IN THE SIX PROVINCES IN INDONESIA [19]

Province of Sub-national Road	Length (km) [19]	Road Worthiness Condition	
		Good (km/ %)	Not Good (km/ %)
Riau			
Province road	3,033.32	1,667.12 (55%)	1,366.2 (45%)
Regency road	16,490.31	11,761.25 (71%)	4,729.06 (29%)
City road	9,910.5	8,971.93 (91%)	938.57 (1%)
Yogyakarta			
Province road	690.25	579.08 (84%)	1,11.17 (16%)
Regency road	3,039.83	2,342.23 (77%)	697.6 (23%)
City road	246.9	244.45 (99%)	2.45 (1%)
South Kalimantan			
Province road	832.58	345.08 (42%)	487.5 (58%)
Regency road	9,026.89	4,923.78 (55%)	4,103.12(45%)
City road	973.57	784.96 (81%)	188.6 (19%)
South Sulawesi			
Province road	1,113.51	892.02 (80%)	221.49 (20%)
Regency road	23,689.08	14,443.71 (61%)	9,245.38(39%)
City road	2,229.39	1,495.84 (67%)	733.55 (33%)
Bali			
Province road	860.53	695.16 (81%)	165.37 (19%)
Regency road	5,008.54	3,257.29 (65%)	1,751.25(35%)
City road	555.08	449.86 (81%)	105.22 (19%)
Maluku			
Province road	899.77	485.28 (54%)	414.49 (46%)
Regency road	4,026.96	1,848.93 (46%)	2,178.03(54%)
City road	414.74	265.89 (64%)	148.85 (36%)

Legend: Good road worthiness means that the road has fulfilled the road engineering NSPM, including activities (a) earthwork, (b)road foundation, (c)asphalt pavement, (d)concrete pavement, (e)road shoulder and drainage (f)road furniture and utility

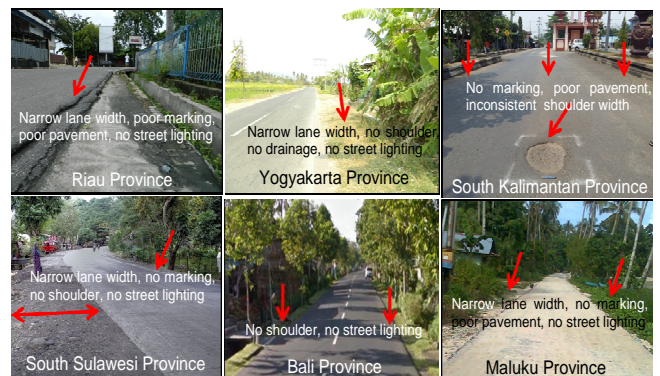


Fig. 3 Example of the existing condition of some sub-national roads in Indonesia [19]

TABLE II
EXISTING CONDITION OF NSPM IMPLEMENTATION ON SUB-NATIONAL ROADS IN THE SIX PROVINCES IN INDONESIA

Province of Sub-national Road	Engineering Road Norm Implementation (%)					Engineering Road Standard Implementation (%)					Engineering Road Guideline/Manual Implementation (%)				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Riau															
Province road	66	34	46	39	22	73	27	53	42	33	67	33	40	31	23
Regency road	69	31	39	31	21	60	40	48	43	34	46	54	31	27	19
City road	69	31	39	31	21	60	40	48	43	34	46	54	31	27	19
Yogyakarta															
Province road	66	34	46	39	22	73	27	53	42	33	67	33	40	31	23
Regency road	69	31	39	31	21	60	40	48	43	34	46	54	31	27	19
City road	69	31	39	31	21	60	40	48	43	34	46	54	31	27	19
South Kalimantan															
Province road	57	43	43	35	18	66	34	45	35	23	62	38	37	29	20
Regency road	40	60	40	31	18	57	43	44	39	34	44	56	30	26	19
City road	40	60	40	31	18	57	43	44	39	34	44	56	30	26	19
South Sulawesi															
Province road	57	43	43	35	18	66	34	45	35	23	62	38	37	29	20
Regency road	40	60	40	31	18	57	43	44	39	34	44	56	30	26	19
City road	40	60	40	31	18	57	43	44	39	34	44	56	30	26	19
Bali															
Province road	66	34	36	38	22	73	27	53	42	33	67	33	40	31	23
Regency road	69	31	39	31	21	60	40	48	43	34	46	54	31	27	19
City road	69	31	39	31	21	60	40	48	43	34	46	54	31	27	19
Maluku															
Province road	53	47	41	34	18	57	43	41	29	22	53	47	30	22	16
Regency road	52	48	34	28	16	53	47	37	28	20	38	62	25	19	14
City road	52	48	34	28	16	53	47	37	28	20	38	62	25	19	14

Legend: 16 Road Engineering Norms in 5 categories i.e. (1)having, (2)not having, (3)reading, (4)understanding, (5)implementing. 6 Road Engineering Standards in 5 categories i.e. (1)having, (2)not having, (3)reading, (4)understanding, (5)implementing. 12 Road Engineering Guidance/Manual in 5 categories i.e. (1)having, (2)not having, (3)reading, (4)understanding, (5)implementing.

III. RESULTS AND DISCUSSION

A. Analysis

From Table I, it can be found that the average of good roadworthiness condition on the sub-national roads in all six provinces is 66 percent on province road, 63 percent on regency road, and 81 percent on city road. These results mean. On average, only city road fulfills 75 percent roadworthiness. Therefore, action programs are needed, especially to improve province road and regency road, to reach at least 75 percent sub-national roadworthiness. From data in Table II, the average of NSPM implementation on the sub-national roads in all six provinces is presented in Table III. Table III shows that having, reading, understanding, and implementing the road engineering NSPM on the sub-national roads is not good enough (less than 70 percent). This is the reason why roadworthiness on the sub-national roads in Indonesia cannot reach the fulfillment target of 75 percent. Therefore, the application of road engineering NSPM action programs are crucial to being consistently carried out as soon as possible.

TABLE III
AVERAGE OF NSPM IMPLEMENTATION ON SUB-NATIONAL ROADS IN ALL SIX PROVINCES IN INDONESIA

Province of Sub-national Road	Engineering Road Norm Implementation (%)					Engineering Road Standard Implementation (%)					Engineering Road Guideline/Manual Implementation (%)				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Province road	61	39	44	37	20	68	32	48	37	28	63	37	37	29	21
Regency road	57	44	39	31	19	58	42	45	39	32	44	56	30	25	18
City road	57	44	39	31	19	58	42	45	39	32	44	56	30	25	18

Legend: 16 Road Engineering Norms in 5 categories i.e. (1)having, (2)not having, (3)reading, (4)understanding, (5)implementing. 6 Road Engineering Standards in 5 categories i.e. (1)having, (2)not having, (3)reading, (4)understanding, (5)implementing. 12 Road Engineering Guidance/Manual in 5 categories i.e. (1)having, (2)not having, (3)reading, (4)understanding, (5)implementing.

Furthermore, the relationship between the average of road engineering NSPM implementation, as presented in Table III, and existing roadworthiness condition of the sub-national roads in the six provinces, as presented in Table I, is provided in Figure 4.

Figure 4 indicates that road authorities at the province, regency, and city level only have around 60 percent of the road engineering NSPM document in Indonesia. Furthermore, around 40 percent of the road authorities read the NSPM, around 30 percent of them understand the NSPM, and only 23 percent of them implement the NSPM. Based on these conditions, the roadworthiness of sub-national roads in Indonesia is 66 percent on roads at province level, 63 percent at regency level, and 81 percent at city level.

Facts on the field show that sub-national roads in Indonesia have not yet fulfilled the regulation in Indonesia number 38 the year 2004 about roads and have not yet reached the strategic planning of the Ministry of Public Works and Housing, Bina Marga, year 2015-2019, which is to reach roadworthiness of 75 percent of sub-national road

length. Therefore, action programs are crucial to be implemented to reach the goal in 2019.

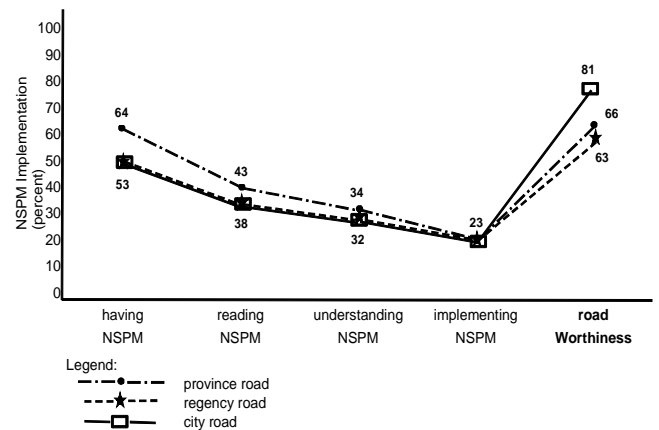


Fig. 4 Relationship between existing roadworthiness condition and road engineering NSPM implementation of the sub-national roads in the six provinces in Indonesia

Moreover, based on interviews and discussion group forums with road authorities and local government at the province, regency, and city level who have at least 10-years' experience of work, the challenges causing the sub-national roads to have not yet fulfilled the NSPM are as follows:

- The arrangement of the sub-national roads has not yet fulfilled the Indonesia regulation of the Ministry of Public Works number 03/PRT/M/2012 regarding guidelines of function and status of roads in Indonesia [15]. By not following the regulation, roadworthiness is hard to attain.
- Poor training and coaching regarding road engineering NSPM implementation.
- Poor road engineering NSPM application on sub-national roads, especially about construction quality and road construction development.
- Poor internal monitoring and evaluation regarding consistency between the implementation and planning of road development programs.
- Poor external monitoring and evaluation regarding the indication of failure construction work and road building.
- Limited financial support and incompetent human resources.

These poor conditions lead to difficulties in achieving the roadworthiness of sub-national roads. Furthermore, they also reduce road quality, road safety, and road sustainability, inhibit the community's productivity, and increase travel time between sub-national roads and national roads. Moreover, this condition cannot support infrastructure resilience.

B. Recommended Action Programs

Based on field data and previous analysis, the recommended action programs to reach at least 75 percent roadworthiness of sub-national roads in Indonesia for 2015-2019 are as follows. They are also presented in Figure 5.

1) Dissemination of Indonesia's regulation of the Ministry of Public Works number 03/PRT/M/2012 about

Indonesian road function and road status guideline [15]: Availability and uniformity of regency and city decree about function, status, and class of road based on the government's decree. Second: uniformity of road technical data format that consist of number, name, function, status, and class of road, coordination of road segment, length and width of road, number and name of districts passed by sub-national roads, type of pavement, roadworthiness condition, average daily traffic, and integration of sub-national roads to national roads. Third: establishment of medium-term and long-term road network general planning at the province, regency, and city level, as needed.

2) *Training and coaching, technically and regularly, about road engineering NSPM specific locations will be done by government at both national and local level.* The accuracy of the proposal of the sub-national road location to improve connectivity. The accuracy is important so that the specified allocation budget can be accounted. Second: uniformity of technical road data in a uniform road network map format.

3) *Application of NSPM about road engineering on sub-national road level:* implementation of Ministry of Public Works regulations about measured road indicators. Second: quality road, safety road, and legal certainty road.

4) *Implementation of internal monitoring and evaluation:* Road technical requirements and planning criteria and road

based on existing road regulations by involving professional association and related stakeholders. Second: uniformity of road technical components and parameters in order to provide road work unit price. By using this uniformity, the road construction quality standard can be reached. Third: consultation on planning and technical program quality and work method, unit price development, document, and database system development.

5) *Implementation of external monitoring and evaluation:* competence test of each contractor by technical road planning, construction, and monitoring certification. Second: competence test regarding road engineering NSPM implementation in the field. Third: identification of road connectivity effort between the sub-national roads and national roads.

Implementing the five steps of recommended action programs will lead to improvement of roadworthiness and infrastructure resilience. Disaster evidence is unpredictable in terms of location, time, and magnitude. Therefore, it has to be anticipated earlier systematically. If a disaster occurs, then society evacuation has to be done as quickly as possible. Roads with a poor condition because they do not fulfil the road engineering NSPM, and which are used as a facility to a safer location might worsen and obstruct the process of rescue and evacuation. This condition can cause more loss of life, property, and road infrastructure.

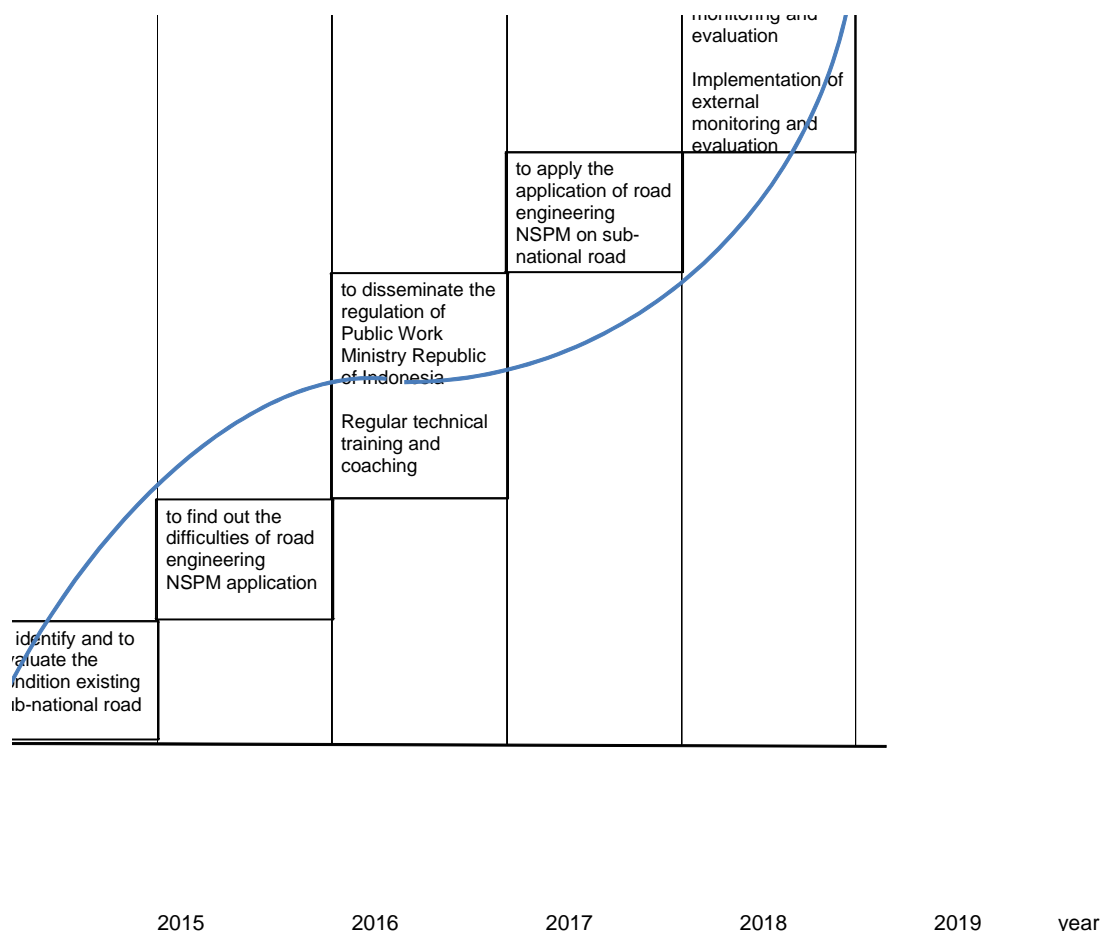


Fig. 5 The recommended action programs to reach at least 75 percent roadworthiness of the sub-national roads in Indonesia for 2015-2019 to improve roadworthiness and infrastructure resilience

IV. CONCLUSIONS

This paper concluded that there is a necessary need for road engineering NSPM implementation in Indonesia in order to reach roadworthiness and infrastructure resilience for sustainable development, of the sub-national roads. Data indicated that 91 percent of the road in Indonesia is a sub-national road. However, without detailed hard effort to fulfill the NSPM, 75 percent roadworthiness of sub-national roads in the year 2019 is difficult to reach. The importance of road authorities at the province, regency, and city level to identify the existing road condition physically is a beginning. Furthermore, understanding, implementing, and evaluation of NSPM implementation has to be done as well. Finally, in order to reach roadworthiness and sub-national road infrastructure resilience in Indonesia, all stakeholders, including government, road construction executors, and society, at their responsibility, have to commit to doing the recommended action programs seriously, consistently, systematically, and continuously.

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