Evaluation on the Efficiency of Road Signages and Pavement Markings in DPWH Nueva Ecija II Engineering District Office

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Abstract: - Pavement markings and road signage are essential. This is necessary to ensure that drivers receive the information they require to obey traffic regulations and navigate the road system safely and efficiently. In this light, the researchers conducted an inventory and evaluation of the road signages and pavement markings of roads under the jurisdiction of DPWH Nueva Ecija II Engineering District Office. The general aim of this study is to evaluate the efficiency of road signages in pavement markings in selected roads under the jurisdiction of the aforementioned agency using the determination of the Road Signage Performance Index (RSPI) and Road Markings Performance Index (RMPI) through the use of field inventory technique. The results revealed that the Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch Road, the RSPI and RMPI is 4.165 and 4.058, respectively. The Bongabon-Rizal-Aurora Road revealed an RSPI and RMPI of 4.622 and 4.833, respectively. Lastly, the Cabanatuan City – Carmen Road revealed a performance index for road signs of 3.923 and for pavement markings, 3.889. This indicates a performance of excellent, excellent, and very good, respectively. The study then concluded that overall, the performance of DPWH Nueva Ecija II Engineering District Office in terms of its road signs and pavement markings is Excellent. This entails that the signs and pavement markings within the area is being carefully maintained by the handling agency. Further study is recommended in this subject matter.

Key Words: — ***Road Signs, Road/ Pavement Markings, Performance evaluation, DPWH-Nueva Ecija.***

I. INTRODUCTION

1.1 Background

In order to execute road safety, road signage and pavement markings are required. This is vital to guarantee that drivers get the information they need to comply with traffic laws and navigate the road system safely and efficiently. This serves as the instruction that all road users must follow. They alert drivers to potential threats that aren't always self-evident.

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Road signs and pavement markings must be concise, meaningful, and consistent due to their requirement, and their design location must be matched with the road geometric design.

In this light, the Department of Public Works and Highways (DPWH) follows a manual entitled “Highway Safety Design Standards Part 2: Road Signs and Pavement Markings Manual” that provides the different types of road signs and pavement markings signs as well as their prescribed standard and the conditions where each should be used. However, despite the guidelines provided by the DPWH, accidents still occur because of lack, poor, undermaintained, and inadequate road signs and pavement markings.

According to Saavedra (2021), a member of Cebu's Provincial Board (PB) has asked the Department of Public Works and

Highways (DPWH) to investigate signs and pavement markings that need immediate restoration in order to make them more apparent to motorists and prevent accidents on national roadways. Many DPWH-maintained roads in Cebu, according to the PB member, lack signs and markings that manage traffic flow and provide an early warning of an impending hazard. Apart from the lack of signs and markings, there are also poorly positioned signs and markings, some of which are not well-maintained, some of which are not reflectorized, and many of which have been defaced. Some signs and symbols have already been obscured by vegetation.[1]

Furthermore, Senator Grace Poe is working for a bill that would mandate government organizations to install road and other public safety signage to minimize accidents, which, according to research, also generate high traffic in the metropolis. Senate Bill No. 2293, also known as the Public Safety Signages Accountability Act, mandates that the government give residents with timely and accurate information on traffic instructions, road hazards, and other warning signs. Throughout the years, articles, and photographs of poor or questionable signage have been documented, and they continue to represent a visible menace to both cars and pedestrians. [3]

Aside from this, there has been quite of number of accidents and crashes that occurred in different locations in the Philippines due to poorly maintained and/or inadequate from earlier years. Thus, the researcher aims to determine the evaluate road signages and pavement markings under the jurisdiction of the DPWH Nueva Ecija II Engineering District Office.

Research similar to this have also been conducted in different areas around the world. One example of which is the study of Chengula. The researched conducted an inventory of road signs and marking from Uyole to Iyunga along TANZAM highway in Tanzania where they determined its performance based on preset factors used to assess the signs and marking conditions. The evaluation resulted to a performance of less than 50% which demand immediate maintenance and replacements. The conditions of road markings were characterized with poor reflectivity, missing road marking and faint edge and center pavement lines. [2]

In this matter, the researchers shall then conduct an inventory and evaluation of the road signages and pavement markings of roads under the jurisdiction of DPWH Nueva Ecija II Engineering District Office and will be guided by the "Highway Safety Design Standards Part 2: Road Signs and Pavement Markings Manual" used by the aforementioned department.

1.2 Significance of the Study (Knowledge Gap)

Despite the necessity to research the effectiveness of road signage and pavement markings in the aftermath of automobile accidents and crashes, there are few studies on the subject. When it comes to road signs and pavement markings, research is focusing on driver familiarity and/or awareness, the impact on driver behavior, the effect on young drivers, and so on. However, there is no or just a few published articles in the Philippines that conduct an inventory and evaluation of the current quality and effectiveness of road signage and pavement markings. As a result, the researchers will assess the present quality and/or effectiveness of road signage and pavement markings in a specific site in the Philippines in order to serve as a head start in the nationwide evaluation which may be proposed later on.

As a result, the researchers will assess the existing state and/or efficiency of road signage and pavement markings in a specific site in the Philippines as a starting point for a statewide inventory and evaluation of road signage and pavement markings. This will allow the department and local governments of various provinces, cities, and municipalities to assess the adequacy of road signage and pavement markings, as well as if they constitute a risk to motorists in their jurisdiction. Inevitably, ongoing research on road signs and markings, as well as their relevance, is required.

1.3 Objectives of the Study

a. Create an inventory of road signs and pavement markings of roads within the jurisdiction of DPWH Nueva Ecija II Engineering District Office.

b. Determine the adequacy and/or efficiency of the road signs and pavement markings using the "Highway Safety Design Standards Part 2: Road Signs and Pavement Markings Manual" in terms of indices as road sign performance index (RSPI) and road marking performance index (RMPI).

1.4 Scope and Limitation

The study focused on the efficiency of road signages and pavement markings of roads under the jurisdiction of the

DPWH Nueva Ecija II Engineering District Office using the road sign performance index (RSPI) and road marking performance index (RMPI) based on the study of Chengula (2018).

II. METHODOLOGY

2.1 Description of the Study Area

The study area includes the jurisdiction of the DPWH Nueva Ecija II Engineering District Office. Nueva Ecija, officially the Province of Nueva Ecija, is a landlocked province in the Philippines located in the Central Luzon region. Its capital is the city of Palayan, while Cabanatuan, its former capital, is the largest local government unit (LGU). Nueva Ecija borders, from the south clockwise, Bulacan, Pampanga, Tarlac, Pangasinan, Nueva Vizcaya and Aurora. The province is nationally known as the Rice Granary of the Philippines, producing the largest rice yield in the country.

2.2 Data Collection

The data was collected using the method in the study of Chengula (2018) called the field manual inventory technique. The inventory of road signs and markings is a component of the road management system, and it serves a variety of functions, including keeping track of where signs and markings are located, identifying problem areas, planning and budgeting for sign and marking replacements, and locating missing or dislocated signs and markings. The inventory also included a nighttime visual assessment to see if signs and markings give appropriate retro reflectivity levels, as well as a drive along the road section to count the number of signs and markings that were in compliance with nighttime reflectivity.

During the inventory process, the following groupings of factors were considered for the aim of analyzing the performance of road signs and markings/lines (See Table 1).

Table.1. Factor used during inventory of road signs and markings

Factors	**Road Signs**	**Road/Pavement Markings**
Missing	Signs which are knocked down, vandalized, not installed and miss location.	This includes unmarked places due to pavement maintenance and overlays and completely worn-out due braking and abrasions of tires and miss location.
Poor Reflective	Include all signs manufactured of materials that do not conform to the "Highway Safety Design Standards Part 2: Road Signs and Pavement Markings Manual" and all non-reflective signs.	Include all markings manufactured of materials that do not conform to the "Highway Safety Design Standards Part 2: Road Signs and Pavement Markings Manual" and all non-reflective markings.
Broken/Defected	All signs which have defects on their stems, boards, and faces. Including slanted and bent stem and boards.	All defected markings and lines due to traffic accidents, rutting, potholes, corrugation and wearing of the road surface.
Hidden	All signs which are hampered by vegetation and any other obstruction but also not aligned to the direction of traffic flow.	All marking covered or obstructed by temporary installed facilities and uncleaned vegetations, mud, dust, rubbishes, and oils.
Under & Over Size	All signs that their sizes of the boards, legend (Graphical and word message), offset and height of sign from the edge surface of the road do not conform to the	Markings that their thicknesses, patterns, size of graphical and word messages does not conform to the "Highway Safety Design Standards Part 2: Road Signs and Pavement Markings Manual."

	"Highway Safety Design Standards Part 2: Road Signs and Pavement Markings Manual."	
Comprehend	All signs which conform to the manual of uniform control devices.	All markings which conform to the manual of uniform control devices.

The performance of road signs and markings for the purpose of this study were given in terms of indices as road sign performance index (RSPI) and road marking performance index (RMPI). However, score of 0 to 5 for each assessment factor was given, 0 being the worst condition and 5 being the best condition. For the case of analysis road signs and marking categories were considered to have the same weight. However further investigation is required to determine severity levels of disabilities/defects. Table 2 gives scores for each assessment factor.

Table.2. Categories of road signs and scores to assessment factors

Factors	**Scores for each factor**					
	Regulatory Signs (Type R)	**Warning Signs (Type W)**	**Guide/ Informative Signs (Type G)**	**Traffic Instruction Signs (Type S)**	**Hazard Markers (Type HM)**	**Guide Posts & Delineators**
Missing	0	0	0	0	0	0
Poor Reflective	1	1	1	1	1	1
Broken/Defected	2	2	2	2	2	2
Hidden	3	3	3	3	3	3
Under & Over Size	4	4	4	4	4	4
Comprehend	5	5	5	5	5	5

Using the formula:

$$RSPI\ and\ RMPI = \frac{1}{N}\left[\sum_{K=1}^{N}\left(\frac{\sum_K S * F}{\sum F}\right)\right]$$

Where:
RSPI – road sign performance index
RMPI – road marking performance index
S – score for a given factor
F – number of observations for each factor of a particular sign or marking category
N – number of sign or marking categories

Table 3 shows the ranges of performance indices, class, and condition of road signs and markings used to determine the performance and condition of road signs and markings along the surveyed road segment for the purpose of this study. Excessive traffic delays, accidents, and congestion are caused by poor performance of road signs and markings/lines along road networks, resulting in a loss of per capita and country economy.

Table.3. Conditions, classes and ranges of performance indices for road signs and marking

Range of RSPI & RMPI	0.00-1.00	1.01-2.00	2.01-3.00	3.01-4.00	4.01-5.00
Percentage Range	0-20	20.1-40	40.1-60	60.1-80	80.1-100
Performance Class	E	D	C	B	A
Condition	Poor	Fair	Good	Very Good	Excellent

The road signs performance index (RSPI) and road markings performance index (RMPI) can be used for road network planning and implementation programs for maintenance, replacements and installation of new signs and markings.

III. Results and Discussion

3.1 Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch (Asian Highway 26- AH26/ Pan-Philippine Highway/ Daang Maharlika) = 39.19km

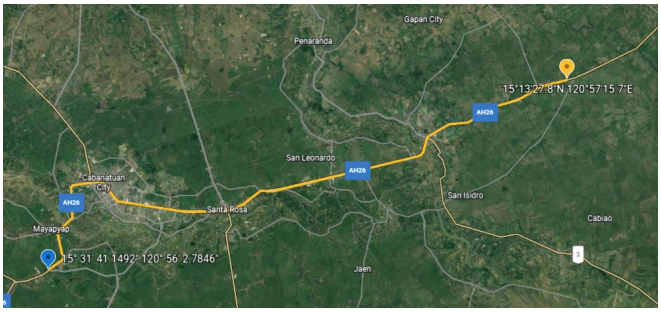

Fig.1. Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch (Asian Highway 26- AH26/ Pan-Philippine Highway/ Daang Maharlika) = 39.19km

The performance of road signs and pavement markings for Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch (Asian Highway 26- AH26/ Pan-Philippine Highway/ Daang Maharlika) road segment determined based on the selected factors and scores given to each factor (See Table 2).

3.1.1 Road Signs

Table.4. Road Signs (Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch)

Sign Categories		R	W	G	S	H M	Guide Posts & Delineators
Scores for each factor	Total Signs	125	109	95	82	72	59
0	Missing	0	2	5	0	0	0
1	Poor Reflective	14	8	1	2	3	2
2	Defected	10	8	11	12	4	3
3	Hidden	15	14	12	12	14	12
4	Under and Over Size	2	0	1	2	0	1
5	Good	84	77	65	54	51	41
$\sum F$		125	109	95	82	72	59
$\sum SxF$		507	451	388	340	308	253

$$RSPI = \frac{1}{6}\left[\frac{507}{125} + \frac{451}{109} + \frac{388}{95} + \frac{340}{82} + \frac{308}{72} + \frac{253}{59}\right]$$

$$RSPI = \frac{1}{6}[4.056 + 4.137 + 4.084 + 4.146 + 4.277 + 4.288]$$

$$RSPI = 4.165$$

INTERPRETATION: 4.01-5.00

PERFORMANCE CLASS A; CONDITION: EXCELLENT

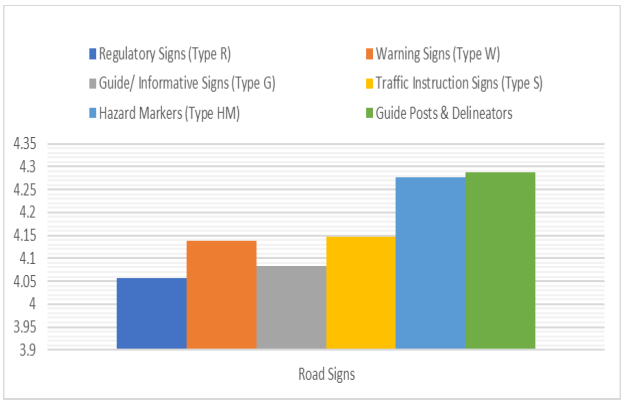

Fig.2. Road Signs Performance Index of Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch (Asian Highway 26- AH26/ Pan-Philippine Highway/ Daang Maharlika) = 39.19km

The average performance of road signs within the 39.19km stretch of Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch was determined to be excellent with an RSPI score of 4.165 which falls on Performance Class A which shows an Excellent condition in the performance of road signs. This aforementioned highway is often travelled by both public and private utility vehicle moving around from Cabanatuan City to the Province of Bulacan. Given so, it is a must for the DPWH Nueva Ecija II Engineering District Office to maintain the signs within this portion of the highway.

3.1.2 Pavement Markings

Table.5. Pavement Markings (Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch)

Marking Categories		R	W	G
Scores for each factor	Total Markings	40	31	35
0	Missing	0	0	0
1	Poor Reflective	0	1	1
2	Defected	5	4	8
3	Hidden	11	7	0
4	Under and Over Size	4	1	0
5	Good	20	18	26

$\sum F$	40	31	35
$\sum SxF$	159	124	147

$$RMPI = \frac{1}{3}\left[\frac{159}{40} + \frac{124}{31} + \frac{147}{35}\right]$$

$$RMPI = \frac{1}{3}[3.975 + 4.000 + 4.200]$$

$$RMPI = 4.058$$

Interpretation: 4.01-5.00

Performance Class A; Condition: Excellent

Similarly, the average performance of pavement markings within the 39.19km stretch of Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch was determined to be excellent with an RMPI score of 4.058 which falls on Performance Class A which shows an Excellent condition in the performance of pavement markings. Since this highway is often travelled by both public and private utility vehicle moving around from Cabanatuan City to the Province of Bulacan, pavement markings, too, should be highly maintained to avoid accidents or road mishaps.

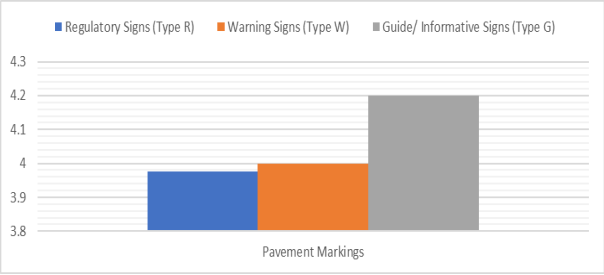

Fig.3. Road Markings Performance Index of Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch (Asian Highway 26- AH26/ Pan-Philippine Highway/ Daang Maharlika) = 39.19km

3.2 Bongabon-Rizal-Aurora Road = 3.54 km

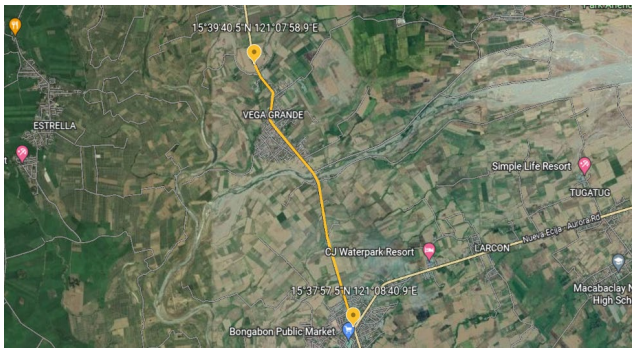

Fig.4. Bongabon-Rizal-Aurora Road = 3.54 km

On a similar note, the performance of road signs and pavement markings for Bongabon-Rizal-Aurora Road segment was determined based on the selected factors and scores given to each factor.

3.2.1 Road Signs

Table.6. Road Signs (Bongabon-Rizal-Aurora Road)

Sign Categories		**R**	**W**	**G**	**S**	**HM**	**Guide Posts & Delineators**
Scores for each factor	**Total Signs**	8	7	7	4	4	2
0	**Missing**	0	0	0	0	0	0
1	**Poor Reflective**	1	0	0	0	0	0
2	**Defected**	1	0	1	0	0	0
3	**Hidden**	1	1	1	0	0	0
4	**Under and Over Size**	0	0	1	0	0	0
5	**Good**	5	6	4	4	4	2
$\sum F$		8	7	7	4	4	2
$\sum SxF$		31	33	29	20	20	10

$$RSPI = \frac{1}{6}\left[\frac{31}{8} + \frac{33}{7} + \frac{29}{7} + \frac{20}{4} + \frac{20}{4} + \frac{10}{2}\right]$$

$$RSPI = \frac{1}{6}[3.875 + 4.714 + 4.142 + 5 + 5 + 5]$$

$$RSPI = 4.622$$

Interpretation: 4.01-5.00

Performance Class A; Condition: Excellent

On the other hand, the average performance of road signs within the 3.54km Bongabon-Rizal-Aurora Road was determined to be excellent with an RSPI score of 4.622 which falls on Performance Class A which shows an Excellent condition in the performance of road signs.

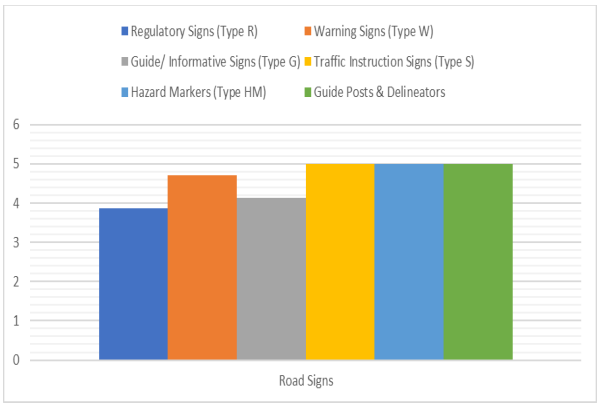

Fig.5. Road Signs Performance Index of Bongabon-Rizal-Aurora Road

3.2.2 Pavement Markings

Table.7. Pavement Markings (Bongabon-Rizal-Aurora Road).

Marking Categories		R	W	G
Scores for each factor	Total Markings	2	1	2
0	Missing	0	0	0
1	Poor Reflective	0	0	0
2	Defected	0	0	0
3	Hidden	0	0	0
4	Under and Over Size	0	0	1
5	Good	2	1	1
$\sum F$		2	1	2
$\sum SxF$		10	5	9

$$RMPI = \frac{1}{3}\left[\frac{10}{2} + \frac{5}{1} + \frac{9}{2}\right]$$

$$RMPI = \frac{1}{3}[5.000 + 5.000 + 4.500]$$

$$RMPI = 4.833$$

Interpretation: 4.01-5.00

Performance Class A; Condition: Excellent

Similarly, the average performance of pavement markings within the 3.54km Bongabon-Rizal-Aurora Road was determined to be excellent with an RMPI score of 4.833 which falls on Performance Class A which shows an Excellent condition in the performance of road signs.

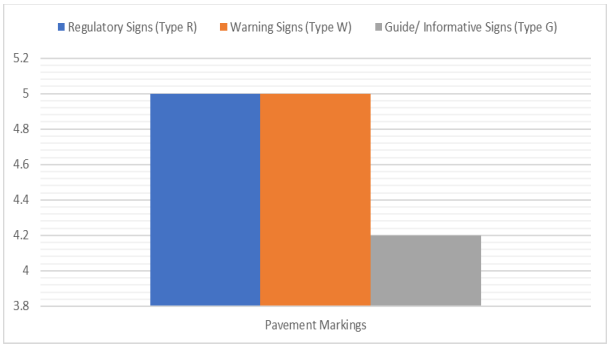

Fig.6. Road Markings Performance Index of Bongabon-Rizal-Aurora Road

3.3 Cabanatuan City – Carmen Road = 4.227 km

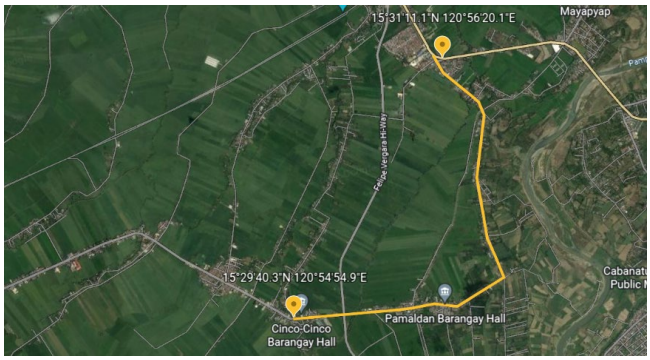

Fig.7. Cabanatuan City – Carmen Road = 4.227 km

The performance of the road signs and pavement markings was also determined in the 4.227 km stretch of Cabanatuan City – Carmen Road based on the selected factors and scores given to each factor.

3.3.1 Road Signs

Table.8. Road Signs (Cabanatuan City – Carmen Road)

Sign Categories		R	W	G	S	HM	Guide Posts & Delineators
Scores for each factor	Total Signs	11	9	6	5	4	2
0	Missing	0	1	0	0	0	0

1	**Poor Reflective**	0	1	1	0	0	0
2	**Defected**	2	0	0	0	1	0
3	**Hidden**	2	2	1	1	1	1
4	**Under and Over Size**	1	0	1	1	0	0
5	**Good**	6	5	3	3	2	1
$\sum F$		11	9	6	5	4	2
$\sum SxF$		44	32	23	22	15	8

$$RSPI = \frac{1}{6}\left[\frac{44}{11} + \frac{32}{9} + \frac{23}{6} + \frac{22}{5} + \frac{15}{4} + \frac{8}{2}\right]$$

$$RSPI = \frac{1}{6}[4.000 + 3.556 + 3.833 + 4.400 + 3.750 + 4.000]$$

$$RSPI = 3.923$$

Interpretation: 3.01-4.00

Performance Class B; Condition: Very Good

The average performance of road signs within the 4.227km Cabanatuan City- Carmen Road was determined to be very good with an RSPI score of 3.923 which falls on Performance Class B which shows a Very Good condition in the performance of road signs.

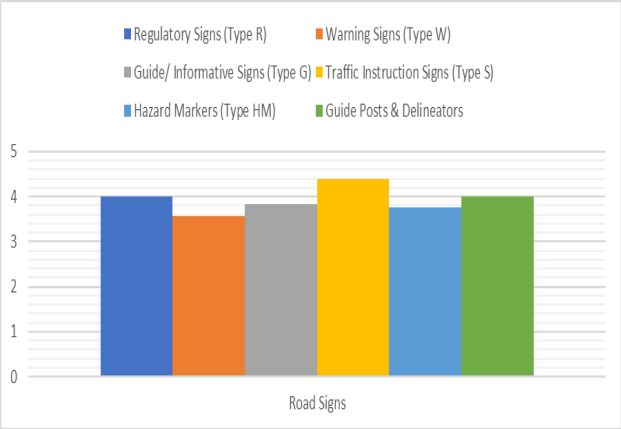

Fig.8. Road Signs Performance Index of Cabanatuan City – Carmen Road

3.3.2 Pavement Markings

Table.9. Pavement Markings (Cabanatuan City – Carmen Road)

Marking Categories		**R**	**W**	**G**
Scores for each factor	**Total Markings**	3	2	2
0	**Missing**	0	0	0
1	**Poor Reflective**	0	0	0
2	**Defected**	0	1	1
3	**Hidden**	0	0	0
4	**Under and Over Size**	1	0	0
5	**Good**	2	1	1
$\sum F$		3	2	2
$\sum SxF$		14	7	7

$$RMPI = \frac{1}{3}\left[\frac{14}{3} + \frac{7}{2} + \frac{7}{2}\right]$$

$$RMPI = \frac{1}{3}[4.667 + 3.5 + 3.5]$$

$$RMPI = 3.889$$

Interpretation: 3.01-4.00

Performance Class B; Condition: Very Good

On the other hand, the average performance of pavement markings within the 4.227km Cabanatuan City- Carmen Road was determined to be very good with an RMPI score of 3.889 which falls on Performance Class B which shows a Very Good condition in the performance of pavement markings.

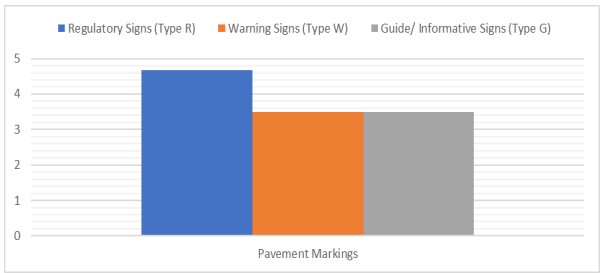

Fig.9. Road Markings Performance Index of Cabanatuan City – Carmen Road

3.4 Summary of Results

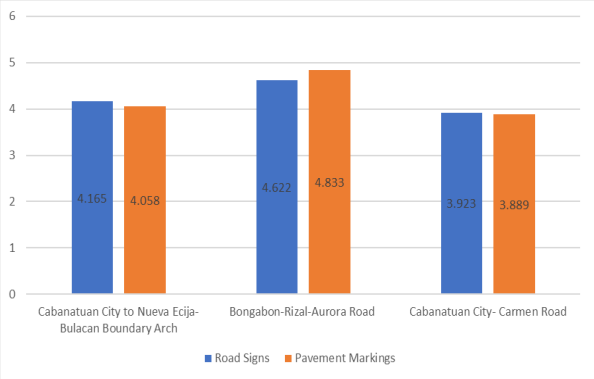

Fig.10. Summary of Results

Upon determining the performance of selected roads within the jurisdiction of the DPWH Nueva Ecija II Engineering District Office, it revealed that their performance in terms of road signs and markings revealed to be excellent and very good. For the Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch, the RSPI and RMPI is 4.165 and 4.058, respectively. The Bongabon-Rizal-Aurora Road revealed an RSPI and RMPI of 4.622 and 4.833, respectively. Lastly, the Cabanatuan City – Carmen Road revealed a performance index for road signs of 3.923 and for pavement markings, 3.889.

IV. Conclusion

This study generally aims to determine the performance of road signs and pavements markings in selected roads within the jurisdiction of the DPWH Nueva Ecija II Engineering District Office. In this light, the following conclusions were drawn after the field inventory was conducted:

Overall, the performance of DPWH Nueva Ecija II Engineering District Office in terms of its road signs and pavement markings is Excellent. This entails that the signs and pavement markings within the area is being carefully maintained by the handling agency. Specifically, the performance of the selected roads was:

- The Cabanatuan City to Nueva Ecija-Bulacan Boundary Arch was rated excellent;
- The Bongabon-Rizal-Aurora Road was also rated excellent; and
- The Cabanatuan City- Carmen Road was rated very good.

Recommendation:

The following recommendations are suggested by the researchers:

- Since this study may serve as a dry run of a full-blown evaluation of the performance of road signs and pavement markings, an annual inventory of road signs and pavement markings, as well as the determination of its RSPI and RMPI, is recommended to the implementing agency to constantly monitor the aforementioned to prevent accidents and road mishaps caused by damaged and/or obstructed road signs or pavement markings.
- It is also recommended for this study to determine the performance of the road signs and pavement markings based on the perception of drivers who frequent the roads included in this study. This may then be correlated with the results of the RSPI and RMPI in determining the effectiveness of putting road signs and pavement markings in its proper location.
- Lastly, further study is recommended.

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