

Original Article

Lesson learnt from the characteristics of tactile ground surface indicator utilization in Kupang city, Indonesia

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Received: 22 May 2024; Revised: 16 April 2025; Accepted: 23 September 2025

Abstract

Tactile Ground Surface Indicators (TGSIs), installed on sidewalks, aim to help people with visual impairments. This study aims to evaluate the feasibility level (a ratio of sidewalk length with TGSIs to road links length) and comparing their condition to the standardized TGSIs installation. It was found that only 9 of the 36 portions of the roads with sidewalks actually utilized TGSIs walkways. The ratio for the average level of eligibility is 39.41%. Additionally, only 27% of the total length of sidewalks had installed TGSIs. Other problems include misplaced TGSIs tiles, obstacles on the TGSIs path, poor TGSIs continuity, damaged TGSIs tiles, and even TGSIs paths without a safety fence, endangering people with disabilities. These show lack of understanding of the TGSIs installation criteria. In addition, the criteria should be improved by adding the use of sustainable material of warning blocks at the vehicle's crossing path, and providing guard rails at dangerous sidewalk paths.

Keywords: condition and effectiveness, installation criteria, sidewalk availability, workable TGSIs

1. Introduction

Sidewalks are pedestrian paths that are generally parallel to the road and elevated above the pavement's level. This is done to ensure the safety of the concerned pedestrians (Precision Safe Sidewalks, 2024; World Health Organization - Eastern Mediterranean Region, 2020; XenomatiX, 2024). According to the Decree of the Director General of Highways No.76/KPTS/Db/1999 dated 20 December 1999 (Dermawan, Johannes, Isradi & Rifai, 2022; Public Transport Network Development [PTND], 2016), sidewalks are intended to accommodate the needs of all groups of pedestrians, especially of people with disabilities (StrongGo Industries, 2005) such as blind people, wheelchair users, and pedestrians with visual impairments. However, many sidewalks were built without taking into account such groups of people. When

sidewalks are inappropriate for pedestrian needs, they could make it difficult for individuals to utilize sidewalk facilities and force them to use the road body, increasing the risk of accidents. (Pembuain *et al.*, 2020). That is why, although the number of pedestrians may be small, sidewalks still have to be built to accommodate their journey (American Association of State Highway and Transportation Officials [AASHTO], 2011).

According to prior research, the placement of tactile ground surface indicators (TGSIs) on sidewalks is intended to assist those who are blind or visually impaired since the lumps on the TGSIs surface can be felt when stepped on or touched and transmit messages to those with disabilities. Although TGSIs are widely used and recognized in many countries (Ohno & Tauchi, 2014), installing TGSIs that does not comply with specified standards will make this facility a source of problems for people with visual impairments (ESP, n.d.; Windham City, 2021).

The use of TGSIs in Indonesia is widely spread, but a previous study reported that the use of TGSIs at arterial roads of Yogyakarta City has not been effective and is dangerous for

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people with visual impairment (Pembuain, Priyanto, & Suparma, 2020). Another study reported that different pedestrian groups had different vulnerabilities sensitizing them to environmental barriers (Lakhotia, Lassarre, Rao, & Tiwari, 2020; Ramli, Yaacob, & Zainol, 2022). A similar situation tends to occur in Kupang city because the results of an initial field observation show that some sidewalks only use guiding blocks without using warning blocks at particular segments.

However, since there was no further discussion or information presented on the previous studies, especially about why such condition occurs and how to solve it, this current study aims not only to evaluate the number of installations, the level of feasibility, and identify the characteristic conditions of TGSIs installed on the sidewalks on the secondary arterial and collector roads of Kupang City, but also to discuss their impact on people with disabilities, and how to improve it. The use of this type of road function classification is influenced by the fact that it is the main road to access public facilities such as schools, market/trade areas, offices, etc.

Based on the results of initial field observation, it is assumed that the utilization of TGSIs on sidewalks is influenced not only by the availability of funding but also by the lack of authority's knowledge and commitment in providing better facilities for all types of road users, especially those with visual impairments. It is hoped that the results may be used by local authorities to improve the TGSIs installation criteria, and their commitment as well as their infrastructure management system, to obtain better sidewalk utilization and associated benefits.

2. Materials and Methods

As previously mentioned, bumps on the surface of the TGSIs will be felt when stepped on or touched, and provide information to people with disabilities. Based on the Indonesia's Ministry of Public Works and Housing's Regulation No.14/PRT/M/2017 (Kementerian Pekerjaan Umum & dan Perumahan Rakyat [KPUPR], 2018), ceramics or tiles that have specific patterns such as dots and straight lines, better known as guiding tiles (guiding blocks) and warning tiles (warning blocks), are intended to help pedestrians who have special needs, especially blind people or others with disabilities.

To evaluate the level of application of TGSIs and other types of sidewalks as well as the conditions of installation of TGSIs on sidewalks along the secondary arterial and collector roads of Kupang City, this study uses a safe system approach model. Accordingly, a functional condition survey of sidewalks, especially sidewalks with TGSIs, was performed. For this reason, data on road length, sidewalk length without TGSIs, and measurement data on sidewalk length installed with TGSIs, were collected so that analysis of the ratio of sidewalks with TGSIs to length of sidewalks and its feasibility level can be calculated. The TGSIs ratio can be calculated using equation 1 (Pembuain *et al.*, 2020), where R is TGSIs ratio, A is the sidewalk length with TGSIs, and B is road link's length with sidewalks.

$$R = (A / B) \times 100\% \quad (1)$$

In addition, this research will also evaluate and analyse the feasibility ratio of the characteristics and effectiveness of the Tactile Ground Surface Indicator (TGSIs), which is installed with reference to the Regulation of the Ministry of Public Works and Housing No.14/PRT/M/2017 concerning Building Facilities Requirements, and Guidelines for Building Construction Materials and Civil Engineering Number 02/SE/M/2018 concerning Technical Planning for Pedestrian Facilities (KPUPR, 2018). Based on the regulations and requirements, there are eight (8) points that will be used as a reference in determining the feasibility ratio of the installed TGSIs for each segment of the Kupang City secondary arterial and collector roads. The eight (8) points are:

1. Guiding tiles are placed along the sidewalk
2. The guide tiles must have 600 mm left-right free space.
3. Guiding tiles located in shops/tourists should have more free space.
4. Warning tiles are installed on every ramp up and down the sidewalk.
5. Warning tiles are installed at each end of the desiccant.
6. Warning tiles are installed on the pedestrian path that connects the road to the building.
7. Warning tiles are placed at every turn.
8. Warning tiles are placed in the entrance and exit area of the building.

Therefore, the condition of installed TGSIs was recorded using Timestamp application installed in Android so that a geotagging picture of certain sidewalks or TGSIs could be recorded precisely. The information that could be displayed in the picture are coordinates of a certain location, condition of installed TGSIs, etc. The location of this study is limited to secondary arterial and collector roads in the Kupang urban area, and the colours in Figure 1 show the characteristics of road network, roads with sidewalks, and sidewalks installed with TGSIs. It can be seen that very few roads are equipped with sidewalks and even the road segments with TGSIs are not continuous.

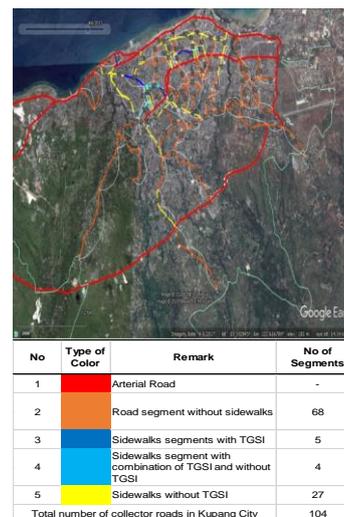


Figure 1. Characteristics of existing roads and sidewalks

3. Results and Discussion

3.1 The ratio of the length of the sidewalk equipped with TGSI to the total length of the sidewalk

The calculation of the ratio is carried out using equation 1. The results are shown in Table 2. It can be seen that: 1) sidewalks are not always available on both the left and right sides of each road segment; and 2) the total length of the left side of the sidewalk using TGSI is 4,810 m, while the right side is 3,700 m, so the total length of the sidewalk using TGSI is 8,510 m. This figure is substantially less than the 31,571 m total length of the sidewalk without TGSI. Thus, the ratio of pavement with TGSI to without TGSI is 27%. Actually, there is not much difference between this condition

and Yogyakarta's, which is 12.67% on average (Pembuain *et al.*, 2020).

In addition, when the data are compared to the results of field observation it can be concluded that the availability and/or the connectivity of sidewalks is influenced by:

- the presence of social-economic activities along the left and right sides of the road segment
- type of road (one-way or two-way traffic, 2/2 UD or 2/2 D)
- the availability of roadside space due to land occupation of small scale social-economic activities along the road segments
- use of all road length to be the access gate of a group of trade center

Table 1. The ratio of the length of sidewalks equipped with TGSI to the total length of sidewalks

No	Code	Names of roads	Type of sidewalks			
			Sidewalks with TGSI		Sidewalks w/o TGSI	
			Left side (m ¹)	Right side (m ¹)	Left side (m ¹)	Right side (m ¹)
1	Sg. 19	Jl. Pulau Indah	-	-	825	825
2	Sg. 20	Jl. Sam Ratulangi	-	-	592	592
3	Sg. 21	Jl. Sam Ratulangi	-	-	640	640
4	Sg. 22	Jl. Sam Ratulangi	-	-	441	441
5	Sg. 24	Jl. RA. Kartini	-	-	932	-
6	Sg. 26	Jl. RA. Kartini	-	-	775	-
7	Sg. 29	Jl. W. Monginsidi III	-	-	690	-
8	Sg. 31	Jl. R. W. Monginsidi	-	-	365	-
9	Sg. 34	JL. Perintis Kemerdekaan	813	830	-	-
10	Sg. 35	JL. Arif Rahman	295	-	-	-
11	Sg. 36	Jl. SK Lerik	-	-	335	335
12	Sg. 37	Jl. SK Lerik	-	-	1240	1240
13	Sg. 38	JL. Perintis Kemerdekaan	387	487	100	-
14	Sg. 39	Jl. Sam Ratulangi I	-	-	780	-
15	Sg. 43	Jl. Nangka	-	-	500	500
16	Sg. 44	Jl. Nangka	-	-	880	880
17	Sg. 45	Jl. Gunung Mutis	420	420	-	-
18	Sg. 47	Jl. Soekarno	-	-	700	658
19	Sg. 51	Jl. Moch Hatta	-	-	1092	1092
20	Sg. 52	Jl. Tompello	-	-	1020	1020
21	Sg. 53	Jl. Cak Doko	812	1004	-	-
22	Sg. 54	Jl. Palapa	866	247	-	-
23	Sg. 55	Jl. Suprpto	-	-	525	525
24	Sg. 56	Jl. W.J. Lalamentik	676	100	-	-
25	Sg. 57	Jl. W.J. Lalamentik	371	450	-	-
26	Sg. 59	Jl. Herewila	-	-	370	607
27	Sg. 61	Jl. Jendral Sudirman	170	162	200	190
28	Sg. 65	Jl. Jend Soeharto	-	-	918	918
29	Sg. 67	Jl. Polisi Militer	-	-	945	945
30	Sg. 68	Jl. W.J. Lalamentik	-	-	610	437
31	Sg. 77	Jl. Bund PU	-	-	405	152
32	Sg. 84	Jl. W.J. Lalamentik	-	-	490	410
33	Sg. 85	Jl. W.J. Lalamentik	-	-	-	272
34	Sg. 93	Jl. Jend Soeharto	-	-	845	845
35	Sg. 95	Jl. H. R. Koroh	-	-	415	192
36	Sg. 96	Jl. H. R. Koroh	-	-	-	225
Total		$\sum c; \sum d; \sum e; \sum f$	4810	3700	17630	13941
Rasio (R) TGSI		$(\sum c + \sum d) / (\sum e + \sum f)$	8510		31571	
Rasio (R) w/o TGSI		$(\sum c d / \sum e f) * 100\%$	27%			
		$100\% - C$	73%			

These facts strongly indicate the poor commitment of local authority in providing an adequate pedestrian facility, whereas it is essential to meet the design and community needs, especially in safety of use (Australian Government, 2008). From a cultural perspective, this situation should be improved so that institutionally, all types of road users, especially pedestrians with disabilities, should be better served.

3.2 Analysis of the feasibility level of installed TGSI

The following parameters, as previously mentioned above, are used to determine the installed TGSI's feasibility level: (KPUPR 2018; Kementrian Pekerjaan Umum [KPU], 2006): 1) the guide tiles should be placed along the sidewalk lane; 2) the minimum width of sidewalk is determined based on land use conditions; 3) the clearance area or sidewalk width on the left and right of the TGSI is 60 cm; 4) warning tiles should be placed on the ramp area; 5) warning tiles should be placed at the end of sidewalk lane; 6) warning tiles should be installed at the midblock crossing area; 7) warning tiles should be placed on the turn lane of roads; and 8) warning tiles should be installed on midblock crosswalk ramp. The results of the feasibility level calculation based on the 8 TGSI installation criteria are as follows.

Only 36 out of 104 roads (around 34.61%) have sidewalks, and only 9 out of 36 roads (25%) provide TGSI, according to Tables 1 and 2. This low level of the TGSI ratio and the poor feasibility level strongly suggest that the

government has not fully understood the significance of having pedestrian facilities that are safe and comfortable for all groups of road users, especially for pedestrian groups who have visual impairments (due to blindness or due to certain diseases). This could be attributed to the lack of funding for the construction of sidewalks with TGSI and to a lack of commitment to achieving equality in the pursuit of rights and in the utilization of public services. However, from Table 3 it can be seen that the minimum width of sidewalks installed with TGSI located in shopping or tourist areas meet the acceptability criteria, i.e., greater width than 1.2 m, and the minimum width of left and right side of TGSI's path is greater than 60 cm.

Subsequently, the lack of ramp availability along sidewalks that cross at building entrance/exit gates and at the crossroads region, exacerbates the government's lack of commitment to providing safe and comfortable pedestrian facilities for each group of users. Table 4 even shows an alarming phenomenon namely: 1) even though on road segments 38 and 57 there is TGSI, none of the total 74 ramps on the sidewalk lane is fitted with warning tiles; and 2) the ratio of the number of ramps fitted with warning tiles to the total number of existing ramps is very low.

Similar phenomenon also occurs at the intersection area, i.e., uninstalled warning tiles at the end of sidewalks lane (Table 5), or in the midblock crossing lane (Table 6). This may increase pedestrian risk of experiencing traffic accidents, in accord with (Hamidun, Kordi, Endut, Ishak, Faudzi & Yusoff., 2015; Reddy, 2017).

Table 2. Criteria 1: Guide tiles are placed along the sidewalk lanes.

No	Code of segment	Length of segment m ¹	Length of TGSI		Average length of TGSI m ¹	Feasibility ratio of TGSI %
			Left side	Right side		
			m ¹	m ¹		
a	b	c	d	e	f = (d+e)/2	g=(f/c)*12.5%
1	Sg. 34	885	813	830	822	11.60%
2	Sg. 35	307	295	-	295	12.01%
3	Sg. 38	512	387	487	437	10.67%
4	Sg. 45	425	420	420	420	12.35%
5	Sg. 53	1120	812	1004	908	10.13%
6	Sg. 54	950	866	247	557	7.32%
7	Sg. 56	728	676	100	388	6.66%
8	Sg. 57	525	371	450	411	9.77%
9	Sg. 61	364	170	162	166	5.70%

Table 3. Criteria 2 and 3: The minimum width of the sidewalk (in shopping/tourist areas) on the left and right of the guide tiles is 60 cm.

No	Code of segment	Minimum width 60 cm left-right (120 cm)	Available width (cm)	Type of land used
1	Sg. 34	120	190	Office building area
2	Sg. 35	120	190	Residence area
3	Sg. 38	120	190	Residence and trading area
4	Sg. 45	120	110	Trading area
5	Sg. 53	120	150	Office building and trading area
6	Sg. 54	120	200	Office building and trading area
7	Sg. 56	120	150	Office building and trading area
8	Sg. 57	120	150	Office building and trading area
9	Sg. 61	120	150	Trading area

Table 4. Criteria 4 and 5: Warning tiles installed on ramp areas and at the end of sidewalks.

a. Warning tiles installed on ramp area

No	Code of segment	Number of ramp (unit)	Number of ramps installed with warning tiles	Feasibility ratio of TGSI %
a	b	c	d	$e=(d/c) *12.5\%$
1	Sg. 34	100	8	1.00%
2	Sg. 35	18	18	12.50%
3	Sg. 38	64	0	0.00%
4	Sg. 45	85	27	3.97%
5	Sg. 53	68	25	4.60%
6	Sg. 54	55	1	0.23%
7	Sg. 56	40	2	0.63%
8	Sg. 57	10	0	0.00%
9	Sg. 61	20	2	1.25%

b. Warning tiles installed at the end of sidewalks

No	Code of segment	Number of sidewalks' end	Number of sidewalks' end installed with TGSI	Feasibility ratio of TGSI %
a	b	c	d	$e=(d/c) *12.5\%$
1	Sg. 34	43	2	0.58%
2	Sg. 35	2	0	0.00%
3	Sg. 38	14	0	0.00%
4	Sg. 45	14	0	0.00%
5	Sg. 53	27	5	2.31%
6	Sg. 54	8	0	0.00%
7	Sg. 56	6	0	0.00%
8	Sg. 57	4	0	0.00%
9	Sg. 61	8	0	0.00%

Table 5. Criteria 6 and 7: Warning tiles are installed in the midblock crosswalks and in the turn lane of road.

a. Warning tiles installed in the midblock crosswalks

No	Code of segment	Number of midblock	Number of midblock installed with TGSI	Feasibility ratio of TGSI %
a	b	c	d	$e=(d/c) *12.5\%$
1	Sg. 34	50	0	0.00%
2	Sg. 35	9	0	0.00%
3	Sg. 38	23	0	0.00%
4	Sg. 45	42	8	2.38%
5	Sg. 53	68	31	5.70%
6	Sg. 54	26	20	9.62%
7	Sg. 56	31	5	2.02%
8	Sg. 57	38	3	0.99%
9	Sg. 61	24	0	0.00%

b. Warning tiles installed in the turn lane of road

No	Code of segment	Number of turning area	Number of turning area installed with TGSI	Feasibility ratio of TGSI %
a	b	c	d	$e=(d/c) *12.5\%$
1	Sg. 34	7	0	0.00%
2	Sg. 35	2	0	0.00%
3	Sg. 38	1	0	0.00%
4	Sg. 45	6	0	0.00%
5	Sg. 53	0	0	0.00%
6	Sg. 54	4	0	0.00%
7	Sg. 56	2	0	0.00%
8	Sg. 57	0	0	0.00%
9	Sg. 61	2	0	0.00%

Table 6. Criteria 8: Warning tiles are installed in the midblock crosswalk ramp.

No	Code of segment	Number of midblock	number of midblock installed with warning tiles	Feasibility ratio of TGSI %
a	b	c	d	e=(d/c) *12.5%
1	Sg. 34	50	0	0.00%
2	Sg. 35	9	0	0.00%
3	Sg. 38	23	0	0.00%
4	Sg. 45	42	8	2.38%
5	Sg. 53	68	31	5.70%
6	Sg. 54	26	20	9.62%
7	Sg. 56	31	5	2.02%
8	Sg. 57	38	3	0.99%
9	Sg. 61	24	0	0.00%



Figure 2. The characteristic of installed TGSI

These findings strongly confirm that the commitment of local authority in providing good urban infrastructure is inadequate. A recapitulation of the feasibility level of TGSI installed on the sidewalks is shown in Table 7 below.

Table 7. A recapitulation of the feasibility level

No	Code of segment	Recapitulation of feasibility of TGSI %
1	Sg. 34	38.18%
2	Sg. 35	49.51%
3	Sg. 38	35.67%
4	Sg. 45	21.09%
5	Sg. 53	53.44%
6	Sg. 54	51.78%
7	Sg. 56	36.32%
8	Sg. 57	36.75%
9	Sg. 61	31.95%
Maximum value (Sg.53)		53.44%
Minimum value (Sg.45)		21.09%
Average value		39.41%

It can be seen that the feasibility rate of installed TGSI at secondary arterial and collector roads of Kupang City is very low (max. 53.44%, min, 21.09%, and average

39.41%).

3.3 Characteristics of problems that occur on sidewalks and installed TGSI

Beside the 8 TGSI installation criteria, the quality of installation of sidewalk facilities is also determined based on the following aspects:

3.3.1 Misplaced TGSI tiles

Based on the field observations, there were mistakes in the installation of TGSI tiles at almost all points on 9 segments of observed roads in the urban area of Kupang, such as no warning tiles on the sidewalk ramp, or at the end of sidewalks, etc. (Figure 2a).

3.3.2 Missunderstood TGSI purposes and/or the requirements of TGSI for a group of people with visual impairments

A colored line is used to indicate the walkway of people with visual impairments without the use of TGSI. This might help people with visual impairment due to a disease, but not for fully blind people.

3.3.3 Obstacles on the TGSi path

There are four types of obstacles on the TGSi path, namely electricity/telephone poles, trees and vegetation, parking lots, and street vendors. Almost all segments of collector roads experience this problem.

3.3.4 Poor TGSi continuity

Disconnected TGSi were found at the study site. The entrance road (number of entry and exit vehicles) found in various sections, including Sg.38; Sg.53; Sg.54; Sg.56; Sg.57; and Sg.61, was the source of certain poor continuity conditions.

3.3.5 Damage to TGSi tiles/blocks

Based on observations and documentation, there are several TGSi tiles cracked or broken in several sections, namely Sg.38; Sg.53; Sg.54; Sg.56; and Sg.57, Kupang City collector street. All of them are located at the vehicle's crossing path. In this particular case, since there is a great number of entering-exiting gates from the social-economic area to the arterial and collector roads, it is suggested that the quality and/or use of TGSi's material at vehicle crossings should be considered diligently, as follows:

- a) The warning tiles should be made from flexible material such as plastic blocks or of a kind of Polyurethane tactile indicators, in accord with (Classic Architectural Group [CAG], 2018). Polyurethane is a mixture of rubber and plastic so that the solution will create a surface that is friction resistant, wear resistant, resistant to some light chemicals, and even stable in cold and hot temperatures. This workable TGSi is strongly recommended for use in such crossings.
- b) Use of a great volume of waste plastic based material as TGSi warning tiles might reduce urban plastic waste significantly. Thus, it may not only increase the quality of warning tiles but also contributes to environment quality concurrently.
- c) Such flexible warning tiles (workable TGSi) should be placed on a reinforced concrete sidewalk surface so that it may resist the vehicle loads on it. Therefore, the plastic blocks should be equipped with a kind of anchor so that it may be well affixed onto the concrete slab.

On the other hand, the building owner should repair the damage immediately (as a social corporate responsibility) because it occurs due to their trip attraction and/or generation. However, the reconstruction should be undertaken by an appropriately trained and accredited installer conversant with the current standards and requirements (Windham City [WC], 2021).

3.3.6 Dangerous path

People with visual impairments may also be at risk on steep sidewalks without pavement ramps, slippery

pavement, and sidewalks without fences or guard rails.

In addition to the aforementioned problems, nine (9) road sections with sidewalks were constructed without taking into account the safety of disabled people. Unplanned sidewalks will make installing the TGSi more difficult and likely to contain faults. Similar earlier studies have suggested that using the space on the side of the road for footpaths may increase pedestrian risk (Hamidun *et al.*, 2015; Lakhotia *et al.*, 2020), endangering the disabled people as a whole. Recently, similar problems continue occurring at sidewalk constructions. This may be caused by lack of local authority's commitment, which might be triggered by their misperceptions about the significance of having pedestrian facilities that are safe and comfortable for all types of pedestrians. As a result, a discussion in Road Traffic and Public Transport Forum of East Nusa Tenggara Province, Indonesia, ends up with a recommendation to empower local authority's building capacity, including by providing financial support to improve the quality of existing sidewalks.

3.4 The implications and lessons learned

We recommend the following in light of the various issues previously discussed:

1. Repairs must be made to ensure that the installation of TGSi elements do not put the impaired community in risk. The type of repair is modified in accordance with the local physical circumstances as follows:
 - a. Installation of ramps on each part of the sidewalk that requires it
 - b. Inadequate existing ramp grades must be repaired
 - c. Installation of warning tiles on each ramp
 - d. Connectivity of the guiding tiles must be maintained to ensure physical connectivity along the walkways
 - e. Edges of sidewalks with different elevations (next to ditches and/or ravines) must be equipped with guard rails
2. All forms of activities that interfere with pedestrian activities on sidewalks and especially on the TGSi path must be strictly prohibited. The forms of treatment required include:
 - a. If the barriers consisting of electricity poles and/or telephone poles cannot be moved, the width of the sidewalk is adjusted so that the minimum width of the TGSi lane and the left and right-side freedom areas of the TGSi lane can be provided.
 - b. Flower pot barriers are to be moved, tree-shaped barriers (roadside vegetation) are treated similarly as electricity/phone pole barriers.
3. Repair of damage to the TGSi due to maneuvering of the vehicles into/out of the yard of the center of the socio-economic activity is the responsibility of the owner/manager of the activity center. It is suggested to install such warning blocks at the vehicle crossings using a combination of plastic blocks and reinforced concrete materials to increase stability and/or durability.
4. Future pavement reconstruction activities without TGSi must be equipped with TGSi according to government standards and regulations (Espaust.net.au & 761, 2019), as well as the dimensions and design/layout of sidewalks and TGSi lanes need to be adjusted to the physical conditions in the field (presence of physical barriers,

- ravines), in accordance with (Hong, Ji & Gong, 2022).
5. Future roadway design should take into account the TGSI installation cost, and the presence of potential obstacles along the planned sidewalk paths, according to government standards and regulations. In addition, the coordination of the installation of manholes in closed drainage channels (located below the sidewalk) must not coincide with the guide tile path.
 6. Sidewalk facilities, including TGSI, should be built along the secondary arterial and collector roadside to accommodate all types of pedestrian's movements, in accordance with previous research (Dermawan *et al.*, 2022; Pembuain *et al.*, 2020; StrongGo Industries, 2005).
 7. The Indonesian criteria of sidewalk feasibility should be improved by adding: 1) use of plastic blocks at vehicle crossings to improve stability and durability; 2) dangerous paths should be equipped with guard rails; 3) modify the TGSI related regulations as also recommended in previous work on TGSI effectiveness in America, Europe, Asia and Oceania (Mizuno *et al.*, 2008); and 4) improve the advocacy strategy to ensure that all recommendations for TGSI installation and effectiveness would be implemented more seriously.

4. Conclusions

As can be seen from the following circumstances, based on the feasibility level and TGSI condition as well as how it may affect people with disabilities, it can be concluded that local government commitment to providing standardized pedestrian facilities, especially for those with visual impairment, is very low:

1. The availability of sidewalks in secondary arterial and collector road network of Kupang City is very poor, and number or sidewalk segments with installed TGSI is very limited. In addition, although some sidewalks have been equipped with TGSI the performance (connectivity and presence of warning tiles on ramps, midblock crossing areas) is very low, causing confusion, discomfort, and accident risk, in accord with (Prabhu & Thilagam, 2019).
2. Since a similar situation also occurs in other places in Indonesia (Pembuain *et al.*, 2020) and also in China (Hong *et al.*, 2022), South Africa (PTND, 2016), and in Australia (ESP, n.d.), it is suggested that the installation of TGSI should be done by an appropriately trained and accredited installer conversant with the current standards and requirements. Subsequently, since these issues have been recognized for over a decade (Mizuno *et al.*, 2008), this strongly indicates that TGSI is a strategic and important issue hindered by non-technical issues such as political will, community curiosity, or others. Moreover, the Indonesia TGSI installation criteria should be improved by using sustainable warning blocks, and adding safety facilities in particular sidewalk paths.

3. Therefore, the local authority's commitment level should be continually improved. They should be reminded of the significance of having pedestrian facilities that are safe and comfortable for all groups of pedestrians, as a mandatory need.

Acknowledgements

The author would like to thank for the Student Community Research of Urban Transportation System, Study Program of Civil Engineering, Faculty of Engineering, Universitas Katolik Widya Mandira Kupang for the data collecting support.

Author Contributions

Don Gaspar Noesaku da Costa: Conceptualization, Methodology, Writing - Original draft, Software. Manek: Data curation, Visualization, Investigation. Suni: Writing - Reviewing and editing.

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