MSIWF 2022 Traffic Safety Research Grant
Report of Research Results

Title: Creating a user dynamic pedestrian traffic crossing- A case study and impact assessment in Chiang Mai University

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Research Summary: Traffic accidents in Thailand are rated the highest amongst the ASEAN region, and amongst the top 10 world-wide (1). And in particular, pedestrians are one of the most vulnerable, between 2013 and 2017, 55 per 100 accidents nation-wide involved pedestrians (2). In recent years, a number of high-profile traffic accidents involved pedestrian crossings bought this topic to the forefront. As a response, this study hopes to contribute to this pressing agenda by developing and testing a prototype Smart Pedestrian-Crossing Warning System (SPWS), that utilizes artificial intelligent motion sensors to activate a set of visual and acoustic warning signals to increase the awareness of pedestrians as they approached a traffic crossing. Two observations were conducted by a field team, over a period of 42 days; pre- and post-installation of the SPWS. The results gathered was used to compare the awareness of pedestrians as they approached a crossing before and after the installation of SPWS. The statistics showed in total 180 incidences of pedestrians not being aware of coming up to the traffic crossing over the first 21 days of observation pre-installation, and 149 incidences of pedestrians over the second 21 days of observation not being aware of coming up to the traffic crossing post-installing the SPWS. A Z-test was used to further analyze the statistics which showed a small reduction in the number of pedestrians not being aware of approaching a traffic crossing (Z-score of 0.59), the results also showed that the SPWS was most effective during morning period (32.4% reduction) and evening period (46.8% reduction), while during the afternoon period, there was a small increase (6%) in the number of pedestrians not being aware as they approached or at the traffic crossing, the study speculated due to the strong afternoon sun which reduced the visibility of the flashing warning lights.

Aim of research: In January 2022, a high-profile traffic accident involving a motorcyclist and a pedestrian at a traffic crossing in Bangkok highlighted the hazards of Thai traffic crossings. The incident spurred on a haphazard effort by local authorities to upgrade many of the city's' and nation's traffic crossings, as well as organizing safety awareness workshops for citizens. Whilst no doubt these are meaningful measures and goes some way to improve the safety of pedestrian traffic crossings on Thai roads, this study argues for a more dynamic, integrative and pedestrian specific approach; by combining the multidisciplinary creative fields of urban design and user experience (UX) design, this study aims to rethink how pedestrian traffic crossings can become more user dynamic, engaging, responsive and ultimately a safer experience. The prototype developed in the outcome of this study was installed at an operational traffic crossing outside the College of Art, Media and Technology in Chiang Mai University, which include 3 main objectives:

- a prototype that can detect pedestrian movement from opposing directions, and then trigger an automated response that serve as an early warning system to approaching pedestrians;

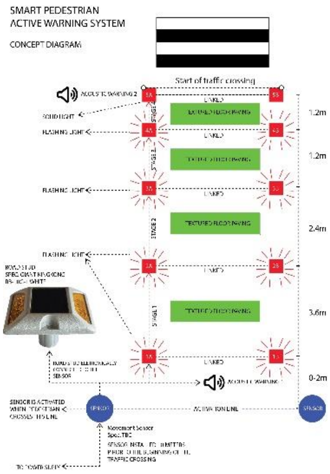
- to install the system on site in Chiang Mai University safely, without obstructing either pedestrian or motorized traffic;

- to evaluate the system's operation effectiveness, by comparing 2 data sets, pre-installation and post-installation;

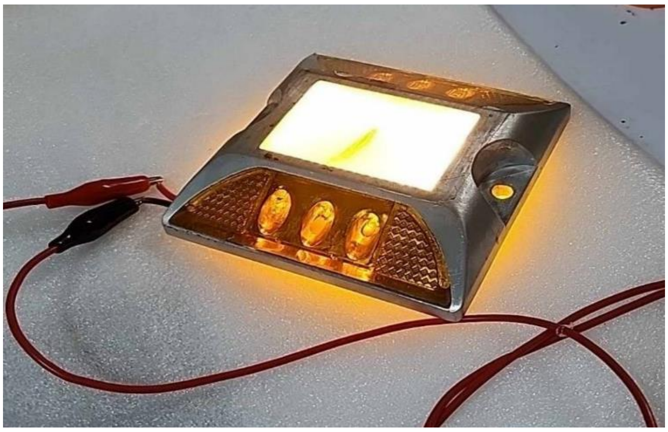
Research methodology and progression, part 1: Concept, Design and installation of Early Warning System:

(*Left image, 01*) Initial observation from the site that formed the basis of the design of the SPWS. The initial site observation showed that the main cause of loss of awareness for pedestrians in Chiang Mai University was the distraction from mobile devices, both as they're approaching the traffic crossing, as well as when they're standing and waiting at the pedestrian traffic crossing, often even when the pedestrian lights have turned green and indicated a go crossing, the study observed pedestrians would sometimes not notice the signal.

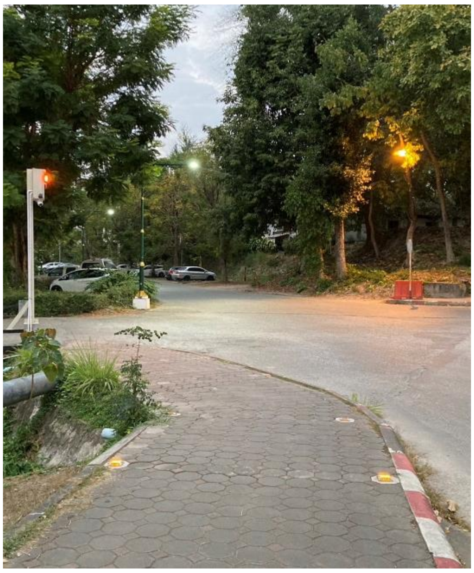
As a response to the initial observations on site in Chiang Mai University, the study concluded that the system has to be a multi-sensory approach, due to the nature of the pedestrian behavior, especially in the context of a university, where pedestrians are often observed engaged in various digital devices, therefore a single sensory system might not be adequate to increase their awareness, but a multi-sensory system approach, could help to increase the chances of successful engagement, and thus the performance of the warning system.



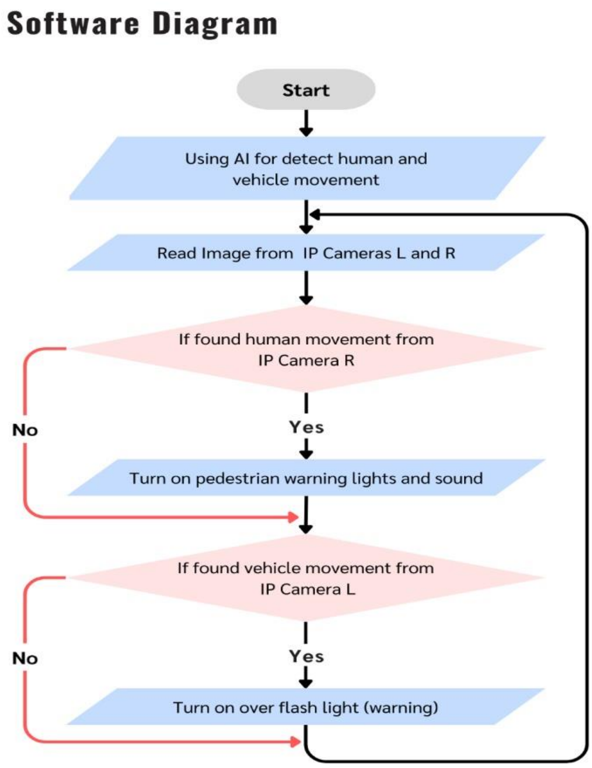
(Above left 02) Concept diagrams of the SPWS, where the multi-sensory approach translates into 10 flashing lights embedded into the pavements approaching the pedestrian crossing, as well as an acoustic warning siren located directly above the crossing point. The distances in-between the flashing lights and the rates of flashing, is designed to match the standard pace of pedestrian walking speed, at around 1.78 meter per second (3). (Above right 03) The finished system installed and in operation on site.

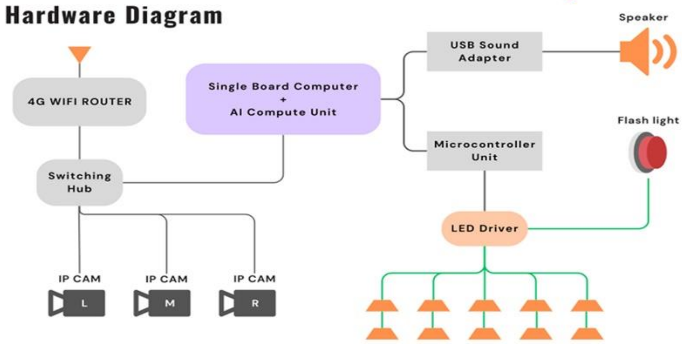


(Above left 04 and right 05) For the flashing devices, the study uses King Kong aluminum stud lights as a shell, but since they usually do not have a flashing element installed, the study commissioned an additional LED flash unit that was custom designed and built that can fit into the shell neatly, and lastly a clear resin coat was used to encase and protect the overall unit.



(Above left 06, center 07 and right 08) In order to install the flashing devices, the study attained permission from the university board to remove a series of paving stones approaching the field test site, and then a series of conduits were laid into the sand under the paving that houses the wiring system. Furthermore, a customed redesigned hexagon paving slabs was made that can house the electrical unit under each slab.





(Above left 09) Software diagram illustrating the operational sequence of the software system, how it detects movement and its activation of the flash lights and sirens. (top right 10) close-up image of the electronic housing which contains the hardware within, and on the exterior, it acts as the main mount for the sensors, cameras and speakers for the sirens. (bottom right 11) Hardware diagram showing how the systems are interconnected with the software.

Research methodology and progression, Part 2: observation, data collection results and evaluation methodology:

Two separate observations were conducted over a period of 42 days in late 2023, the first before the installation of the SPWS, whilst the second after the installation of the system. Each session of observation was done by a field team, and conducted over 3 different periods between 09:00-11:00, 13:00-15:00 and 18:00-19:00. The 2 sets of statistics gathered was used to compare the awareness of pedestrians as they approached a crossing before and after the installation of SPWS, using the Z-test method.

The first observation, conducted over a period of 21 days from September 1 to 30, resulted in total 180 incidences of pedestrians not being fully aware as they were approaching the traffic crossing, the data have a mean of 8.6 per daily average, with a standard deviation of 2.51. After installing the early warning system, the study conducted a second observation over a same 21 days period of time, from 15 of November until 13 of December. The second observation resulted in total 149 incidences of pedestrians not being fully aware of approaching the traffic crossing, with a mean of 7.1 per daily average, and a standard deviation of 2.96.

Results of Research: Findings- Z Test analysis (pre-installation)

Observation period: 01 SEP 2023- 30 SEP 2023, 9-11am/ 1-3pm/ 6-7pm (these periods represent the busiest times and most pedestrian traffic movement along the study site) Total observation returns: 180 with a mean of 8.6 on average per day.

	sep.1	sep.2	sep.3	sep.4	sep.5	sep.6	sep.7	sep.8	sep.9	sep.10	sep.11	sep.12	sep.13	sep.14
9-11am	2	N/A	N/A	0	3	4	1	5	N/A	N/A	5	7	4	3
1-3pm	3	N/A	N/A	4	1	2	3	3	N/A	N/A	8	2	2	6
6-7pm	1	N/A	N/A	0	0	2	0	1	N/A	N/A	1	3	1	4
TOTAL	6	N/A	N/A	4	4	8	4	9	N/A	N/A	14	12	7	13
MEAN	2.0	N/A	N/A	1.3	1.3	2.7	1.3	3.0	N/A	N/A	4.7	4.0	2.3	4.3
S.D	0.88	N/A	N/A	2.94	1.63	0.81	1.63	2.44	N/A	N/A	4.76	3.46	1.63	1.63

sep.15	sep.16	sep.17	sep.18	sep.19	sep.20	sep.21	sep.22	sep.23	sep.24	sep.25	sep.26	sep.27	sep.28	sep.29	sep.30
2	N/A	N/A	2	6	3	4	1	N/A	N/A	6	2	5	0	0	N/A
6	N/A	N/A	5	6	1	6	7	N/A	N/A	2	4	1	3	8	N/A
2	N/A	N/A	3	4	0	0	4	N/A	N/A	0	1	2	0	3	N/A
10	N/A	N/A	10	16	4	10	12	N/A	N/A	8	7	8	3	11	N/A
3.3	N/A	N/A	3.3	5.3	1.3	3.3	4.0	N/A	N/A	2.7	2.3	2.7	1.0	3.7	N/A
2.94	N/A	N/A	1.63	0.81	1.63	4.08	4	N/A	N/A	4.08	1.63	2.58	2	5.53	N/A

Findings- Z Test analysis (post-installation) Observation period: 15 Nov 2023- 13 Dec 2023
Observation time: 09-11am/ 1-3pm/ 6-7pm (these periods represent the busiest times and most pedestrian traffic movement along the study site) Total observation returns: 149 with a mean of 7.1 on average per day.

	nov. 15	nov. 16	nov. 17	nov. 18	nov. 19	nov. 20	nov. 21	nov. 22	nov. 23	nov. 24	nov. 25	nov. 26	nov. 27	nov. 28
9-11am	1	6	1	N/A	N/A	3	5	0	1	3	N/A	N/A	1	0
1-3pm	3	10	4	N/A	N/A	1	0	5	8	1	N/A	N/A	6	4
6-7pm	1	0	0	N/A	N/A	0	1	0	2	3	N/A	N/A	0	0
TOTAL	5	16	5	N/A	N/A	4	6	5	11	7	N/A	N/A	7	4
MEAN	1.7	5.3	1.7	N/A	N/A	1.3	2.0	1.7	3.7	2.3	N/A	N/A	2.3	1.3
S.D	0.81	6.97	2.58	N/A	N/A	1.63	3.46	3.26	5.16	0.81	N/A	N/A	4.32	2.94

nov. 29	nov. 30	dec. 1	dec. 2	dec. 3	dec. 4	dec. 5	dec. 6	dec. 7	dec. 8	dec. 9	dec. 10	dec. 11	dec. 12	dec. 13
0	3	0	N/A	N/A	3	7	0	2	2	N/A	N/A	3	1	2
3	2	9	N/A	N/A	7	4	6	0	3	N/A	N/A	6	2	4
1	0	1	N/A	N/A	0	2	0	1	0	N/A	N/A	0	4	1
4	5	10	N/A	N/A	10	13	6	3	5	N/A	N/A	9	7	7
1.3	1.7	3.3	N/A	N/A	3.3	4.3	2.0	1.0	1.7	N/A	N/A	3.0	2.3	2.3
1.63	2.3	3.46	N/A	N/A	4.76	3.26	4.69	0	1.63	N/A	N/A	4	2.98	1.63

Evaluation methodology: Using a Z-test, a statistical test methodology for determining whether two population means are different when the variance are known and the sample size is large, and with a normal distribution as in this case.

The equation below represents a standard z-test formula, in this case:

Formula

$$Z = \frac{(\bar{X} - \mu_0)}{s}$$

Z = Z-test
$\bar{X}$ = sample average
μ_0 = mean
s = standard deviation

Z = (7.1-8.6)/ 2.51= 0.59
$\bar{X}$ = 7.1
μ_0 = 8.6
s = 2.51

Conclusion: The Z-score of the analysis returns a value of 0.59 (a little over half of a deviation from the mean pre-installation), which represent a small reduction in the number of pedestrians not being aware of approaching a traffic crossing after SPWS was installed.

Furthermore, the results also showed that the SPWS was most effective during morning period (32.4% reduction) and evening period (46.8% reduction), while during the afternoon period, there was a small increase (6%) in the number of pedestrians not being fully aware as they approached or at the traffic crossing. The study speculated the possible reason for this increase during the afternoon period could be due to the strong afternoon sun which reduced the visibility of the flashing warning lights embedded on the pavement, which unlike morning and evening period when the sun is not directly above the testing site, the flashing lights are more visible to pedestrians.

Future study: Overall the research outcome demonstrated that the SPWS can improve pedestrians' awareness when they approaching a traffic crossing. However, the effectiveness of the system needs to be further tested in a controlled environment and with a large population sampling group, as there are numerous variables that can positively or negatively affect its effectiveness. The research also gathered that visual warning cues alone are not enough to increase the awareness of pedestrians approaching to a traffic crossing, due to environmental conditions, therefore additional sensorial cues are required as pedestrians are often visually distracted by other means, e.g. interaction with mobile devices whilst they're walking.

Means of official announcement of research results: These findings are currently being compiled into an official research paper, it will be submitted and aimed for publication in the following Journal: Journal of Traffic and Transportation Engineering https://www.keaipublishing.com/en/journals/journal-of-traffic-and transportation-engineering-english-edition/

Reference:

(1) World Health Organization (WHO) The global status report on road safety (2018);
(2) A study of pedestrian signals in Thailand, V. Thiangpungtham, W. Raksuntorn, B. Witchayangkoon, N. Raksuntorn, S. Chayanan, International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, (2019);
(3) A Case Study on the Walking Speed of Pedestrian at the Bus Terminal Area, M.F. M. Ali, M. S. Abustan, S. H. Abu Talib, I. Abustan, E3S Web of Conferences 34, 01023 (2018);

END OF MSIWF 2022 Traffic Safety Research Grant- Report of Research Results- Zi Liang Huang