Pilot study of blue LED-lights in high risk environments

Karolinska Institutet | Region Stockholm

This is a translation of the chapter about blue LED-lights from the report “Resultatrapport till projektet ”Suicidprevention Trafikförvaltningen/NASP” originally written in Swedish.

The project was funded and initiated by the Health and Medical Care Administration of Region Stockholm.

Contact person at The Swedish National Centre for Suicide Research and Prevention (NASP): Johan Fredin-Knutzén, johan.fredin.2@ki.se

Design: Beatrice Johansson
Photographs: Johan Fredin-Knutzén

Reference the as follows: Pilottest av ”Blått LED-ljus i riskmiljöer” [Pilot study of blue LED-lights in high risk environments] in Resultatrapport till projektet ”Suicidprevention Trafikförvaltningen/NASP” [Results report for the project “Suicide Prevention Traffic Administration/NASP]; page 25-33. Stockholm: National Centre for Suicide Research and Prevention (NASP), Region Stockholm and Karolinska Institutet; 2022.

Table of contents

Preface

The Swedish government and Region Stockholm have a policy of working to reduce suicides. Restricting means for suicide in transport environments is a critical area of prevention.

In 2020-2022, the Swedish National Centre for Suicide Research and Prevention (NASP) and Region Stockholm Public Transport Administration worked on a joint project to systematically work with suicide prevention in rail-bound traffic within Stockholm, focusing specifically on the metro system. During this project, several studies were undertaken. An epidemiological study was conducted to determine the number of suicides in the traffic operated by Region Stockholm Public Transport Administration.[1] In addition, three pilot studies were carried out to explore different possible suicide preventive measures: 1) communication with suicidal persons through suicide helpline signs; 2) enhanced security information at platforms; and 3) blue LED-lights in high-risk areas at platforms.[2] The measures employed in the initial two pilot studies have been previously scientifically evaluated with suicide as the outcome. The third measure of enhanced security information was chosen since it is likely easy to implement and has high potential for cost-effectiveness but also indirect support for its effectiveness. Further, as a starting point, these measures serve as examples that should be concurrently implemented across the larger railway system to reduce the number of fatalities in existing rail-bound traffic. This project aimed to answer the following questions about each of the studied measures:

1. Are there risks that we have not been able to foresee? For example, for visually impaired individuals and train drivers.
2. How do the measures affect movement patterns on platforms?
3. Is there indirect evidence of a suicide- or accident-preventive effect? For example, fewer people close to the platform edge.
4. Do the results align with previous studies?
5. Should the method be implemented on a larger scale? What are the estimated effects and benefits of full-scale implementation? What is the cost of full-scale implementation?
6. What does a large-scale evaluation look like?

In this document, only the chapter pertaining to the pilot study of blue LED-lights is translated from Swedish to English.

Pilot test of "Blue LED-light in high risk environments"

Introduction

Influencing motivation and increasing the likelihood of detection/intervention by a third party are types of measures have shown to have some evidence in preventing suicide in rail-bound traffic.[3] For example, a study in Japan found a moderate level of evidence, with the first study reporting an 84% reduction (CI: 14-97%) in suicides at 11 stations where blue lights were installed.[4] This study however has been criticized by other researchers for potentially overestimating the effects.[5] Another study, with partially overlapping stations as the first one, showed a 74% reduction (CI: 48-87%) in suicides, with no substitution to nearby stations found.[6]

Infrabel, Belgium's state infrastructure company, implemented blue lights at four high-risk locations in 2014. Intermediary study results from 2019 showed a 54% reduction in suicide, along with positive feedback from staff and passengers.[7] Since then, Infrabel has implemented the intervention at seven more stations and are planning for wider implementation.[a] Other state infrastructure companies, ProRail in the Netherlands and Network Rail in England, have also used the measure to varying extents.[7]

How the platforms should be illuminated is not clearly defined; the information that the project gathered from Japan, the Netherlands, and Belgium primarily indicates that lighting is implemented in high-risk areas on the platform, although that has not been explicitly described.[7] From Japan, it is also noted that it seems important for the light to have high intensity.[b]

It is not clear what causes the suicide-preventive effect. Suya (2008) suggests that the blue light may have a calming effect, especially on individuals who are stressed. This project hypothesizes that the blue light might influence the movement patterns of passengers and thereby affect the social control of passengers on the platform. That is, risky behaviors become more prominent, impacting the motivation and opportunity for detection and intervention before a suicide attempt occurs.

Material and methods

In the Japanese study, it was not described which fixtures or color (wavelength) of light were used. ProRail in the Netherlands has used fixtures from Pracht, Tubis

[a] Meeting with Melissa Van Eeckhout och Gaëtan Van Overmeiren, Infrabel, 22 March 2021
[b] E-mail communication with Michiko Ueda, Waseda University, 10 March 2021

model, with blue LED diodes falling within the color spectrum of 469-480 nm[c]. Infrabel uses fixtures from Zumtobel with a color spectrum of 468-472 nm[d].

Zinkensdamm station luminaries

Ten units of "Pracht Luminaire TUBIS LED INDUSTRY 1565mm PO 1x46W 125°width 2000lm blue 469-480nm 125°wide 5800lm", complementing existing fixtures with white light, are installed at the southern end of platform section 1 at Zinkensdamm. The installation extends over 25 meters from the short wall on the platform, and the fixtures are spaced 75 cm apart. The lighting has been continuously on during the test, except when turned off for measurement purposes.

Table 5. Measured light levels (lux) ≈ +- 10% variation along the platform at Zinkensdamm.

	By the wall	**In the middle**	**By the white line**
Only platform lighting	115	225	370
Blue light and platform lighting	675	675	475

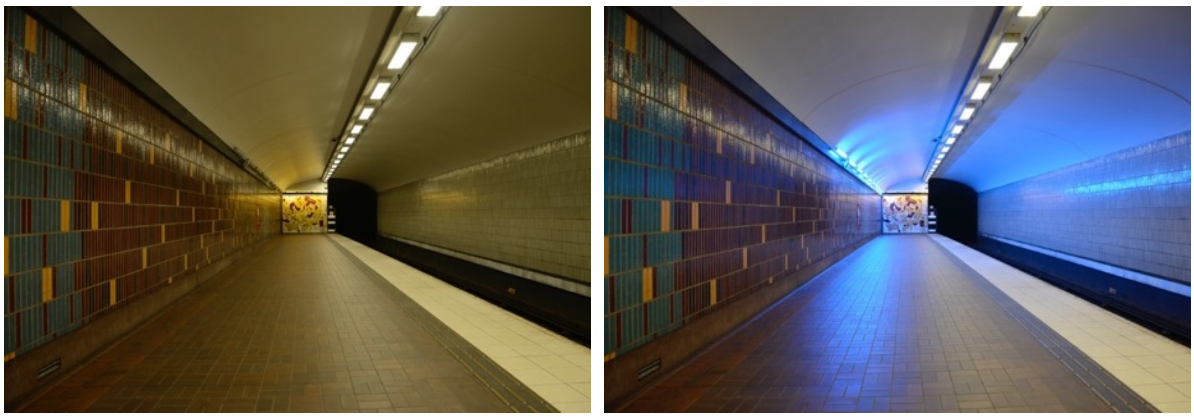

Figure 1 – Zinkensdamm platform section 1 southern end, with and without respective lights turned on.

Bredäng station luminaries

Three 'Flux Flood RGBW 100W, approximately 1350lm, BLUE: LED CCT-bin(s): 465-485nm' have been installed on each of the two lighting poles at the southernmost end of the platform. The pole furthest south is located ≈5 meters into the platform, and the other two are spaced ≈15 meters apart. The blue light complements existing fixtures with white light and has been continuously on throughout the period, i.e., not controlled by a light or time relay, except when turned off for measurement purposes.

[c] E-mail communication with Roald van der Valk, ProRail, 16 February 2021
[d] E-mail communication with Melissa Van Eeckhout, Infrabel, 18 March 2021

Table 6. Measured light levels (lux) ≈ +- 10% variation along the platform at Bredäng when it was dark outdoors.			
	At the pole, direct light ≈ 3 m distance from the fixture	**Midway between the poles, at the center of the platform**	**At the white line, level with the pole**
Only platform lighting	45	3	35
Blue light and platform lighting	2000	7	750

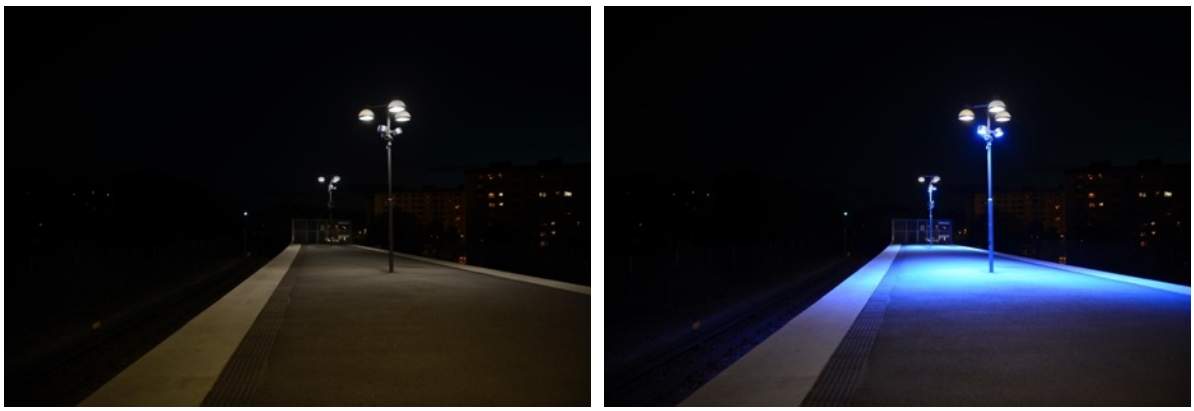

Figure 2. Southern end of Bredäng platform, with and without lights turned on.

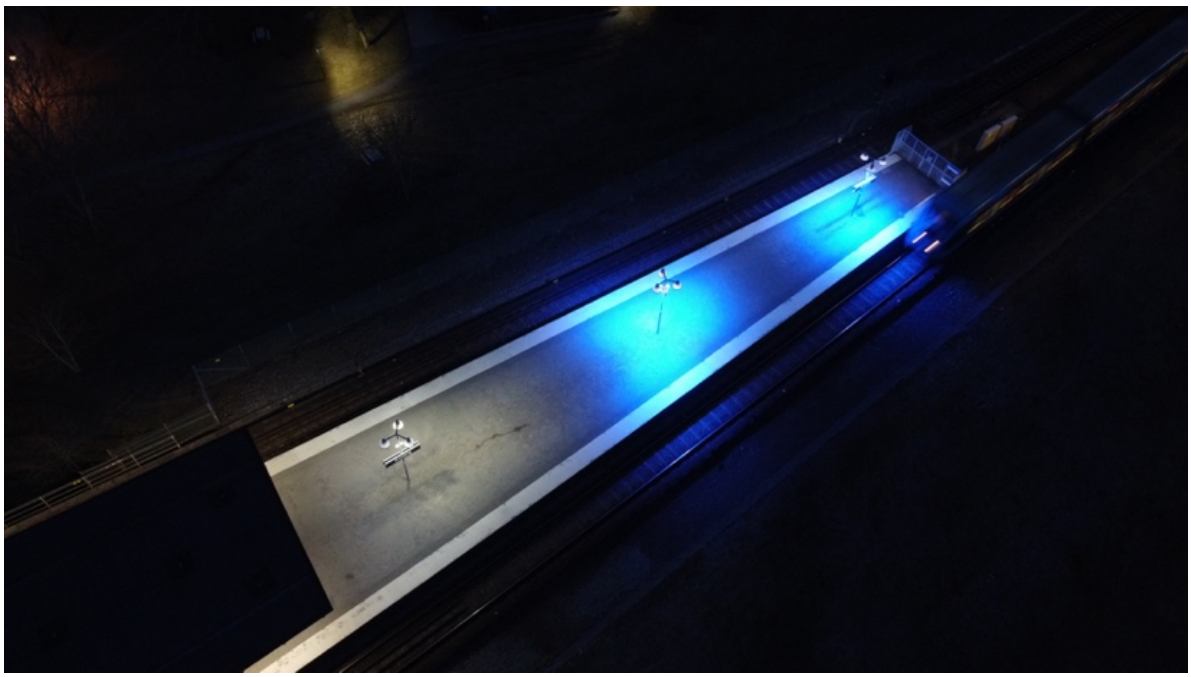

Figure 3. Drone photo showing the spread of blue light over the southern end of the platform at Bredäng.

Video analysis of movement patterns

SL's existing security cameras have been used in conjunction with software that automatically collects metadata (non-personal information) on the number of people observed at the southern end of platform section 1 (where the blue light is located) and

the corresponding area on platform section 2 at the northern end (control area, i.e., no intervention). The equipment is set to detect the number of people present in the zones and when trains are in the frame. The times when trains are in the frame are then used as the basis for filtering out alerts that occurred 60 seconds before the train appears and 90 seconds after the train is visible in the frame.

Subsequently, the number of hits in the different zones that occurred between 07:00 and 21:59 has been compared against itself and the control group when the blue light is turned on or off.

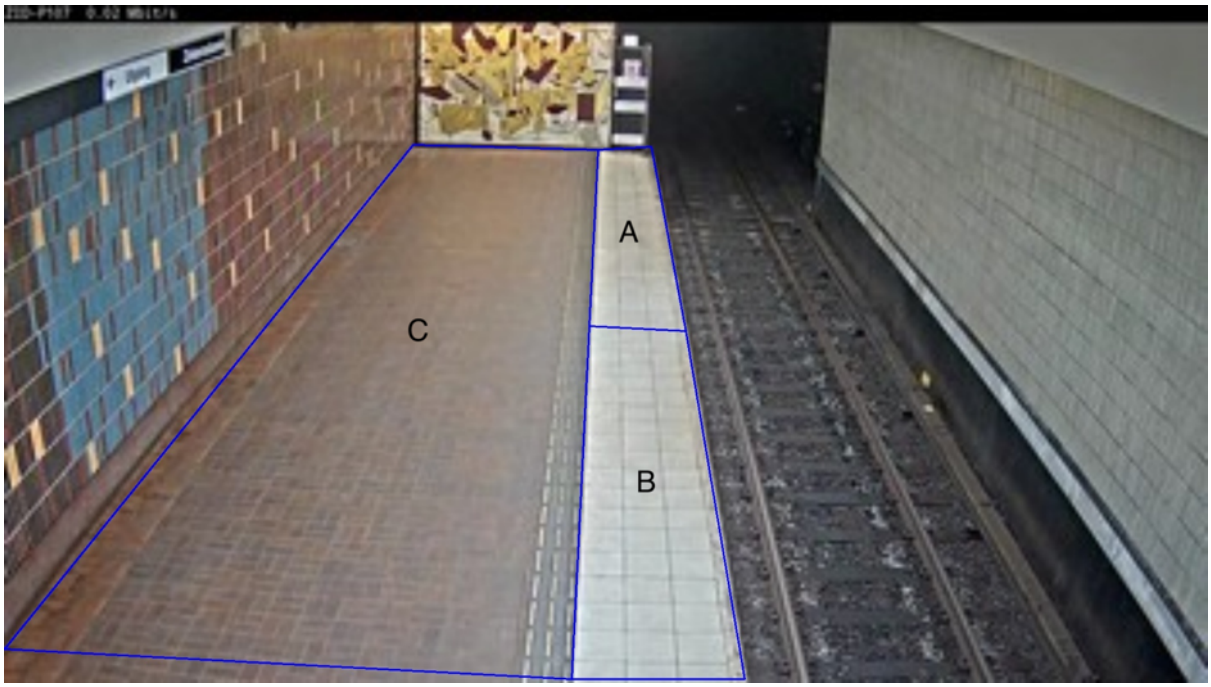

Figure 4. Zones on the platform where individuals have been counted through automated video analysis.

We calculated odds ratios and one-sided/two-sided exact Poisson tests to determine the Incidence Risk Ratio (IRR) for the number of hits in respective areas during the following periods: May 23, 2022 at 07:00 (Period A, blue light off), May 29, 2022 at 19:00 (Period B, blue light on), and June 2, 2022 at 21:59 (Period C, blue light off). We used Fisher's exact test to compare the area illuminated in blue with the corresponding area on the other platform at the same station (control group) during the same time period.

Feedback from drivers, visually impaired individuals, and passengers

At the installation, the driver's safety organization and several working group members with driver competence were present.

A survey was distributed to subway train drivers with the following questions:

- "Has the blue light at Zinkensdamm or Bredäng affected your driving or door closing? If yes, please specify how."

- “What is your experience of the impact of the blue light on passengers at Zinkensdamm/Bredäng?”

A representative from SL, together with representatives from the Swedish Association of the Visually Impaired who have visual impairments but residual vision, have conducted a site visit at Zinkensdamm.

Excerpts from SL's customer service logs for Zinkensdamm and Bredäng have been obtained with the aim of identifying if any cases related to the blue lights have been reported.

Impact on station equipment

Impact on other parts of the platform, such as the visibility of fire hydrants and art, has been assessed on-site.

Cost estimation for full implementation

The costs are based on the expenses incurred for the specific measures in this project.

The results

Feedback from the project

At Zinkensdamm, the light on the platform has been evenly distributed. To increase the light level to a level considered even more suitable, the fixtures could be installed closely adjacent to each other. The blue-lit area should be expanded slightly to cover the area up to approximately 5 meters from the first bench, i.e., the first 30 meters of the platform.

At Bredäng, the light on the platform has been somewhat unevenly distributed. It would be desirable to achieve a more uniform spread of light to avoid areas with insufficient lighting.

Feedback from drivers

At the installation, the drivers' safety representatives and project participants with driver competence ensured that the blue light did not cause any glare for the drivers while driving or door closing.

No feedback regarding the light affecting driving or individual drivers' health has been reported to the traffic control center or management, which are the official channels for feedback affecting traffic safety or working conditions. The union safety organization has not received such feedback from the drivers either. However, the survey distributed to all drivers on the red line (n=26) revealed some individual drivers' opinions that the light affects driving in some respect, see Table 7.

Table 7. Drivers feedback on the blue light. (n=7)
Has the blue light at Zinkensdamm or Bredäng affected your driving or door closing? If yes, please specify how. (Slightly rephrased responses, but intact message)
The light is irritating at the entrance to Zinkensdamm.
Get migraines from the light as it is too strong. Visibility is worse if someone is standing under the blue light. It takes time for the brain to process non-neutral light.
In the beginning, the light at Zinkensdamm was mildly glaring, but I think one becomes a bit more accustomed to it over time.
It has been a bit more difficult to see properly since the blue light is darker.
It doesn't work in Bredäng since it's an outdoor station.
More alert.
At the entrance to the station, you get a bit startled, which sharpens one's attention. That feeling has continued to occur even though you have seen it many times during the trial and should have gotten used to it. It should be tested at more indoor stations.

It was indicated by 48 % of the drivers that they see fewer passengers waiting in the illuminated area at Zinkensdamm, and 33% of drivers said the same about the area at Bredäng. While 10% of drivers mentioned that they see more passengers waiting in the illuminated area at Zinkensdamm, and 6% of drivers said the same about Bredäng.

Table 8. Driver assessments of the impact of the blue LED light on passengers at Zinkensdamm and Bredäng.

Percentage of the total number of drivers who responded, with the proportion excluding those who answered "don't know" indicated in parentheses.

	What is your experience of the impact of the blue light on passengers at Zinkensdamm/Bredäng?	
	Zinkensdamm (n=26)	**Bredäng (n=20)***
1. Significantly fewer passengers have waited in the illuminated area.	19 % (24 %)	10 % (11 %)
2.	8 % (10 %)	10 % (11 %)
3.	12% (14 %)	10 % (11 %)
4. No change compared to before the blue light was installed.	35 % (43 %)	55 % (61 %)
5.	4% (5 %)	5 % (6 %)
6.	0 % (0 %)	0 % (0 %)
7. Significantly more passengers have waited in the illuminated area.	4 % (5 %)	0 %(0 %)
Don't know.	19 %	10 %
* Only drivers who report passing Bredäng in outdoor darkness are included.		

Feedback from visually impaired individuals

No serious concerns were raised during the site visit. The blue light is partially glaring, but the regular station lighting is even more glaring, so the blue light does not worsen the situation in any way. If the solution is to be permanent, where the light is placed

next to entrances must be considered as it could affect the readability of traffic information.[e]

Feedback from passengers

Two inquiries have been received from passengers regarding the blue light at Zinkensdamm, where passengers wondered why they were installed. No complaints have been received.

Movement patterns, video analysis of movement patterns

The number of movements in the illuminated area was influenced by the blue light. Fewer passengers enter the blue-lit areas, then increase when the blue light is turned off. This applies to both comparisons on the same platform with and without light (Incidence Ratio, IRR) and when comparing with the control platform (Odds Ratio, OR), see Table 9.

Table 9. Effect on movement patterns on the platform due to the blue light.

Zone	Type of effect	Incidence ratio (IRR)	Odds ratio (OR)
A	The effect of turning on the light	0.91 (0.36-2.04)	0.49 (0.20-1.22)
A+B		0.59 (0.33-1.04)	0.36 (0.19-0.67)**
C		0.78 (0.60-1.02)	0.53 (0.39-0.70)***
A	The effect of turning off the light	4.00 (1.81-10.01)***	2.25 (0.91-5.57)
A+B		3.57 (1.97-6.46)***	2.85 (1.46-5.57)**
C		1.52 (1.12-2.06)**	1.59 (1.13-2.22)**

** $p < 0.01$; *** $p < 0.001$

Impact on station equipment

The visibility of the fire hydrant has improved as there is increased brightness at the location.

The color of the light illuminating the artwork is partially different, but the overall design of the artwork is not significantly altered.

[e] E-mail communication with Melker Larsson, SL Tillgänglighet [Accessibility], 23 March

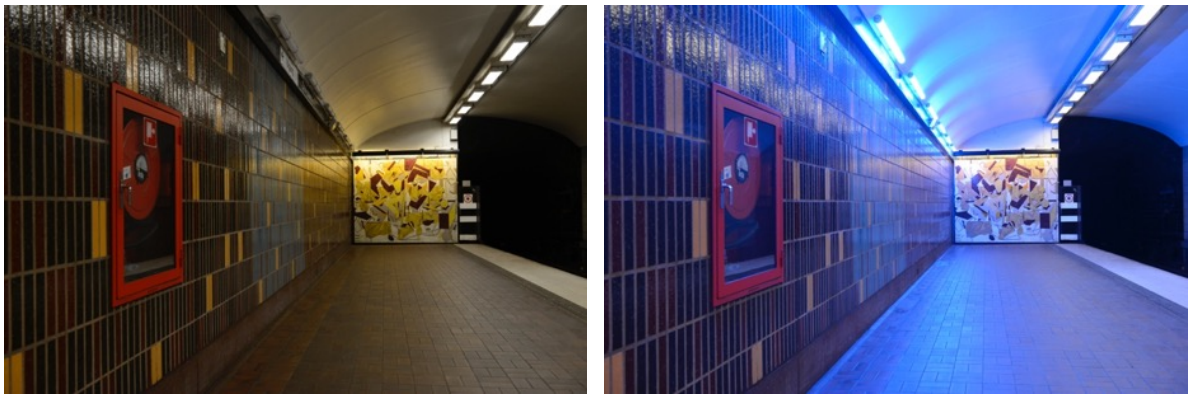

Figure 5. Fire hydrant and artwork with and without the blue light turned on.

Cost estimate for complete implementation

The Traffic Administration's contractor with a framework agreement has been hired for the installation of the blue lights at the two stations. The cost is approximately 170,000 SEK per station for a complete installation, including materials. However, to achieve even stronger light spread over a larger area, the cost is likely to be around 250,000 SEK per fully equipped platform end.

Suicidal acts at current stations

Approximately a week after the blue light was turned on at Bredäng, a person was struck by a train due to a suicide attempt. The incident occurred during the day, which is why the blue lights were not visible from the location where the incident took place. Additionally, the incident did not occur in the part of the platform illuminated by the blue light. The project manager reviewed the surveillance footage shortly after the accident and could confirm that the person involved in the incident had not been near the blue lighting and thus could not have been influenced by it.

Discussion and addressing of issues

Have there been any risks that we could not foresee before the pilot test started? Are there risks specifically for train drivers and visually impaired individuals?

No risks that could not be anticipated and address have emerged. See Appendix 3 [translator's note: the referred document is not translated into English]. In the survey to the drivers, there have been occasional comments that the light has been glaring, causing discomfort and migraines. Since these comments have not been reported to traffic management or work management, which is the formal way to report these types of risks, we consider these risks as mild.

How are movement patterns on platforms affected?

The parts of the platform that are illuminated have significantly fewer passengers when the light is on.

Is there indirect evidence of suicide prevention effectiveness? For example, are there fewer people near the platform edge?

Yes, the fact that the blue light affects movement patterns can be an explanation for the suicide prevention effect demonstrated in previous studies.[4–6]

Is the result consistent with previous studies, or should those be reconsidered?

No results have emerged that support a different assessment than the one presented in previous studies.[4–7]

Should the intervention be implemented on a larger scale? What are the effects of a full-scale implementation? What is the cost of implementing it on a larger scale?

There have been no apparent drawbacks with the blue light that were not known before the current project, see risk analysis appendix 3 [translator's note: the referred document is not translated into English]. There have been occasional complaints in a survey distributed to the drivers, but the individuals who experienced these issues did not report them through the regular channels, so it is assumed that these are of minor significance. In further studies of the blue light, this type of feedback should be closely monitored.

The project recommends that the blue light can currently be used at particularly suicide-prone risk locations in rail traffic where the conditions otherwise appear suitable after a risk analysis.

The project does not currently recommend implementation in places other than suicide-prone risk locations because it is a method with unclear mechanisms of action, which means it is important to learn more about the measure before such a decision is made. The investment cost amounts to ≈ 250,000 SEK per platform end.

What does a large-scale implementation and evaluation look like?

Several different types of evaluations are desirable. One goal would be to understand more about how the method works and what the mechanism of action consists of. Does the color have any significance? What amount of light is necessary? Is there a dose-response relationship? Does it only have an effect if the light is visible and noticed (for example, at night)?

Conclusions

- There is evidence to support that the measure reduces the number of passengers staying in illuminated areas, such as platform sections closest to the ends and the white line/platform edge. This indirectly suggests that the measure may have a suicide-preventive effect.
- No obvious drawbacks with the measure have been identified. Therefore, we have determined that the measure can be used at particularly suicide-prone locations. However, we do not recommend a broader implementation at other locations until further research on the method is conducted.
- It is crucial that the lighting is designed to avoid any glare for train operators and visually impaired individuals.
- The measure has generated significant interest from the public, and several journalists have contacted the project. If implemented in other locations, this must be considered, as media coverage of suicide prevention measures within the transportation system can have a negative and undesired impact on suicide rates.[8–10]

Referenser

1. Fredin-Knutzén J. *Kartläggning Av Suicidhandlingar i Stockholms Spårbunda Trafik*. Nationellt centrum för Suicidforskning och Prevention (NASP), Region Stockholm och Karolinska Institutet; 2022.

2. Nationellt centrum för Suicidforskning och Prevention (NASP), Region Stockholm och Karolinska Institutet. *Resultatrapport till Projektet "Suicidprevention Trafikförvaltningen/NASP"*.; 2022.

3. Fredin-Knutzén J, Andersson AL, Hadlaczky G, Sokolowski M. *Förstudie Suicid i Transportsystemet*. Karolinska institutet, Region Stockholm, Trafikverket; 2020.

4. Matsubayashi T, Sawada Y, Ueda M. Does the installation of blue lights on train platforms prevent suicide? A before-and-after observational study from Japan. *Journal of Affective Disorders*. 2013;147(1-3):385-388. doi:10.1016/j.jad.2012.08.018

5. Ichikawa M, Inada H, Kumeji M. Reconsidering the effects of blue-light installation for prevention of railway suicides. *Journal of Affective Disorders*. 2014;152-154:183-185. doi:10.1016/j.jad.2013.09.006

6. Matsubayashi T, Sawada Y, Ueda M. Does the installation of blue Lights on train platforms shift suicide to another station?: Evidence from Japan. *Journal of Affective Disorders*. 2014;169:57-60. doi:10.1016/j.jad.2014.07.036

7. Havarneanu G. Dispelling blue light source. Restrail Toolbox. Published May 17, 2022. Accessed May 17, 2022. https://www.restrail.eu/toolbox/spip.php?article115

8. Beautrais A. Suicide by Jumping: A Review of Research and Prevention Strategies. *Crisis*. 2007;28(S1):58-63. doi:10.1027/0227-5910.28.S1.58

9. Sinyor M, Schaffer A, Redelmeier DA, et al. Did the suicide barrier work after all? Revisiting the Bloor Viaduct natural experiment and its impact on suicide rates in Toronto. *BMJ Open*. 2017;7(5):e015299. doi:10.1136/bmjopen-2016-015299

10. Nationellt Centrum för Suicidforskning och Prevention (NASP). *Att förebygga självmord: Ett stödmaterial för yrkesverksamma inom media*.; 2022:32.


Karolinska
Institutet

Region Stockholm