

RESEARCH PLAN

Project title: Passenger Density on Subway Platforms with and without
Exposure from Blue LED Lights (BLED)

Table of Contents

Introduction.....	3
Study Aims.....	4
Research Questions.....	4
Methods.....	4
Population	4
Study Setting	4
Study Design	5
Intervention and Control Group.....	5
Spatial Platform Zones	5
Lighting Conditions and Comparisons.....	5
Exposure	6
Outcome.....	6
Measurement of Passenger Density.....	7
Analysis	7
Project Timeline	7
Significance.....	7
References.....	8

Passenger Density on Subway Platforms with and without Exposure from Blue LED Lights (BLED)

Introduction

Two high-profile studies from Japan have revealed striking and unexpected findings regarding the use of blue light-emitting diodes (B-LED) lamps in reducing railway suicides. The B-LED lamps were first implemented by major railway operators in Japan with the belief that they may deter suicides, although this idea was completely unsubstantiated at the time. The hypothesis stemmed from the implementation of B-LED lamps as streetlights in various cities in Japan which were believed to decrease crime rates by having a calming influence on people, even though there was no scientific evidence to support this claim. For similar reasons, B-LED lamps were introduced on train station platforms and at railway crossings, as they were expected to help calm agitated individuals and potentially prevent suicide attempts at these locations. Despite the lack of evidence of effectiveness for deterring suicidal behaviours or any concrete knowledge of the lights' effects, the B-LED lamps were implemented at numerous locations. This included 94 railway crossings by the West Japan Railway Company and at all 29 stations on the Yamanote line, highlighting the widespread adoption of this measure. Remarkably, the B-LED lamps achieved the predicted effect, with an evaluation at 71 train stations (11 intervention and 60 control stations) revealing an estimated 84% reduction in suicides following their implementation (Matsubayashi et al., 2013). There also appeared to be no consistent substitution of suicides shifting from intervention stations to neighboring sites (Matsubayashi et al., 2014). However, these findings were challenged by another Japanese research group, who conducted their own investigation and concluded that the earlier results were likely overestimated (Ichikawa et al., 2014), although failing to consider the differences in B-LED effectiveness between day- and nighttime. To date, these are the only published evaluations of the effectiveness of the blue light intervention for reducing suicides at railways.

The abovementioned findings have bewildered researchers in the field, revealing that a simple intervention like lighting could effectively help prevent railway suicides. But what is even more surprising is that other countries, including the Netherlands, Belgium, and the Great Britain, have already implemented or plan to implement B-LED lamps at railway stations, even though evidence remains scarce (Havarneanu, 2025).

With around 85 of Sweden's 1,500 annual suicides occurring in railway settings (Fredin-Knutzén et al., 2024), and the government committed to halving railway deaths by 2030 as part of a broader goal of zero traffic fatalities (Regeringskansliet Infrastrukturdepartementet, 2020), timely and effective action is necessary. Physical barriers, such as platform doors in railway settings, are known to be highly effective at reducing suicides without significant method substitution (Mann et al., 2021; Pirkis et al., 2013). However, these measures are costly and challenging to implement, meaning there is a demand for simpler and more affordable alternatives that can be implemented on a wider scale (Mishara, 2007). Whilst the B-LED lamps could present an alternative, many unanswered questions should be addressed before considering further implementation.

The most pressing question that requires further exploration is: What psychological or behavioural effects do blue lights have on humans? There are several hypotheses regarding the mechanisms at play.

The first, as mentioned above, is that the blue lights have a calming effect on individuals. Other hypotheses have arisen from conversations with relevant professionals, including psychologists, researchers within the field, and personnel in traffic agencies. Some suggest that blue light may evoke a sense of discomfort or stress, causing individuals to adjust their behaviours, and for example, avoid illuminated areas. While others have speculated that individuals may associate blue lights with certain phenomena, such as law enforcement or emergency services, evoking a sense of heightened alertness and subsequent changes in behaviour. Overall, these varying hypotheses highlight the need for further research to clarify and deepen our understanding of the effects of blue light on humans, particularly since the intervention is already being implemented despite limited knowledge of its impact.

Whilst several hypotheses exist, there is no concrete evidence or knowledge at present, leaving much about the effects still unknown. Despite this lack of understanding, there is considerable interest in its practical applications, underscoring the need for further research. To accurately evaluate the psychological and behavioural impacts of B-LED lighting, controlled experimental studies are essential, complemented by qualitative research to clarify mechanisms and additional studies to validate these findings in real-world contexts.

Study Aims

This study will investigate how exposure to B-LED lamps affects passenger density in defined sections of subway platforms - forming part of a broader research project aimed at expanding the knowledge base and investigating possible underlying mechanisms. The aim is to examine whether B-LED exposure reduces the number of individuals in the illuminated area compared to standard lighting, and whether any such effects diminish over time due to habituation. Understanding the presence, magnitude, and persistence of such effects is essential for decision makers considering large-scale implementation.

Research Questions

- 1. How does blue light exposure influence passenger density across different sections of the subway platform compared to standard lighting conditions?
- 2. To what extent do habituation effects emerge during continuous and intermittent blue light exposure over two-week and long-term (196-day) periods?
- 3. How are potential effects of blue light on passenger density shaped by overall platform crowding and outdoor lighting conditions?

Commented [DS1]: My suggested rephrasing of the following, as I think it is better to have a more open-ended research question: To what extent is passenger density affected in the sections of the platform exposed to blue light?

Commented [DS2]: My suggested phrasing instead of: Are there habituation effects during continuous blue light exposure over two-week periods and across 196 days of intermittent exposure?

Commented [DS3]: My suggested phrasing instead of: Are any potential effects on passenger density influenced by the total number of people on the platform and the lighting conditions at the outdoor stations?

Methods

Population

The study population will include passengers who enter or exit four subway platforms at three designated stations on the Stockholm subway. In measurement zones located in the part of the platform where the trains enter the stations.

Study Setting

The study location comprises four subway platforms (two indoors and two outdoors) at three stations along the Red Line, situated southwest of central Stockholm. Two of these platforms (one indoor and one outdoor) have been previously equipped with B-LED lamps, though currently not in use, as part of a pilot study conducted by the authors and funded by Region Stockholm’s transport administration.

Study Design

A quasi-experimental observational study design will be used allowing for information to be obtained with high ecological validity and little interference from commuters. As this is an observational study, individuals are not randomly assigned to experimental groups or exposure conditions. Instead, we will observe and compare circumstances as they occur naturally in the setting.

Intervention and Control Group

The two platforms (one indoor and one outdoor) equipped with B-LED lamps comprise the *intervention group*. The B-LEDs are installed at the end of the platform where northbound trains enter the station – an area associated with the highest fatality rates from suicide attempts and accidents. At the outdoor station, this same platform end also serves as the departure point for southbound trains. The remaining two platforms, which do not have any B-LED lamps installed, serve as the *control group*.

Spatial Platform Zones

Each platform is divided into two spatial zones:

- The *exposure zone*, located at the end where B-LEDs are installed at intervention platforms (or the structurally equivalent area at control platforms).
- The *adjacent zone*, an immediately neighbouring section of the platform that remains under standard lighting throughout the study.

Lighting Conditions and Comparisons

Lighting conditions are alternated at the intervention platforms over a 196-day period, with two-week intervals of the B-LEDs being switched on and off. This creates two observation conditions:

- *Exposure condition* (B-LED ON): Passenger density is compared between the exposure zone (with blue light) and the adjacent zone (with standard lighting).
- *Non-exposure condition* (B-LED OFF): The same comparison is made while the blue lights remain off, enabling each platform to serve as its own control over time.

Each intervention station is matched with a control platform that has comparable spatial zoning but remains under standard lighting throughout the study. These control platforms help establish typical patterns of passenger distribution under consistent lighting conditions. Because they are matched to intervention sites in both layout and observation period, they allow us to distinguish effects attributable to blue light exposure from natural variation over time.

Commented [DS4]: Is this right?

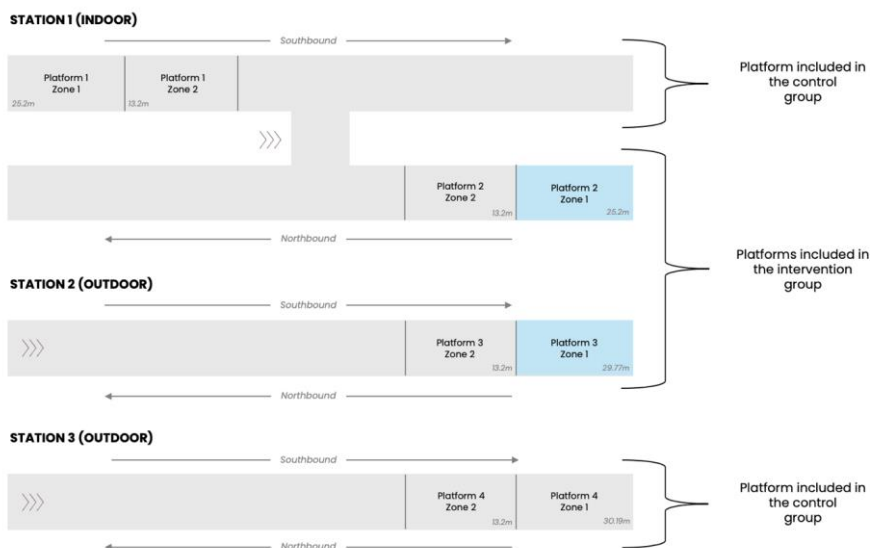


Figure 1. Schematic layout of platforms included in the quasi-experimental observational study. The figure illustrates the spatial layout of three train stations (one indoor and two outdoor) included in the study. Each platform is divided into two zones: an *exposure zone* (Zone 1) located at the end where trains enter the station, and an *adjacent zone* (Zone 2). Two platforms (Platform 2 and Platform 3), equipped with blue-light emitting diode (B-LED) lamps in their exposure zones, comprise the *intervention group* (highlighted in blue). The remaining two platforms (Platform 1 and Platform 4), which have no B-LED lighting, comprise the *control group*. Lighting conditions at intervention platforms alternate in two-week intervals between B-LEDs being ON and OFF across a 196-day period, allowing for within-platform comparisons and matched comparisons with control platforms. Arrows indicate the direction of train travel (northbound and southbound).

Exposure

The exposure consists of B-LED lighting fixtures installed at two platforms (1 indoor and 1 outdoor). The specific luminaires and wavelength properties of the B-LED lamps are: *Station 1 (indoor)* - Ten pieces of “Pracht Luminaire TUBIS LED INDUSTRY 1565mm PO 1x46W 125°width 2000lm blue 469-480nm125°wide 5800lm” are mounted at the Southern end of the platform. The installation extends over 25 metres from the short wall of the platform and the lights are spaced 75cm apart. *Station 2 (outdoor)* - Three “Flux Flood RGBW 100W approx. 1350lm.BLUE: LED CCT-bin(s): 465-485nm” have been installed in each of the two lighting posts furthest south on the platform. The post furthest south sits approximately 5 metres into the platform and the other two it with approximately 15 metres between them. Substantial variation in station conditions necessitated different fixture types and mounting methods.

To ensure accurate exposure, lighting conditions will be measured using a spectrometer, model SR4 VIS400 from Ocean Optics. Measurements will be taken to capture various lighting conditions on the outdoor platform, made possible by the duration of the measurement period. The key light-related variables the measurements will focus on are: daily variation, weather variation, and the influence of the solar angle across seasons.

Outcome

The primary outcome is *passenger density* in pre-defined platform zones, compared across lighting conditions at intervention sites and monitored under standard lighting at control sites.

Measurement of Passenger Density

Storstockholms Lokaltrafik's (SL) existing security cameras will be used together with software that automatically detects when someone enters a predefined zone (on all four platforms) in the camera's field of view—typically a safety zone near the tracks. The system detects the number of entries into the zone every minute. The camera identifies a region of interest (ROI) based on digital models of the human shape. Based on the location of the ROI, the system determines whether the person has entered either of the two zones, which is then recorded as a detection. Detections are recorded by the minute, meaning multiple ROIs may be detected in a zone within a single minute (e.g., 1, 2, 3, ... n).

Passenger density is defined as the number of detections during a given time period, one minute in the raw data, but this can be aggregated over longer time intervals depending on the research question being addressed. To evaluate the effect of B-LED on passenger density, the comparison involves the difference between the exposure and control zones when the lights are on, compared to the same zones when the lights are off. Control stations will be used to compare differences between zones during the same time period but without any exposure. Since the number of people in the zones will be affected by the total number of people at the station, registry data on the number of entries and exits via the station's ticket gates will also be collected.

Analysis

All data comprise *minute-by-minute passenger counts* from the exposure zones, adjacent control zones, and faregate entries/exits. No personally identifiable or demographic data will be collected. Statistical analyses will be conducted using a *Bayesian interrupted time-series design* implemented in the open-source programming language *R*, via the *BRMS* package. Prior distributions for model hyperparameters will be informed by a 2022 internal pilot study conducted by SL using the same B-LED fixtures.

The analysis will focus on seven *exposure periods* and seven *control periods* (each lasting 14 days), corresponding to alternating phases during which the B-LED lights are switched on and off. Primary comparisons will assess changes in *passenger density* between the exposure and adjacent zones before and after B-LED activation. Analyses will also examine trends in *passenger density* over the 14-day ON periods, and the inverse pattern during OFF periods. This approach allows for evaluation of both *immediate effects* (via short-term interruptions in the time series) and *longer-term trends* across the full 196-day observation period.

Project Timeline

Pre-planning: November 2024 – August 2025

Data collection: September 2025 – April 2026

Analysis: May 2026 – August 2026

Writing, reporting and disseminating results: September 2026 – February 2027

Significance

Despite widespread implementation of blue light-emitting diode (B-LED) lamps at railway stations in several countries, there remains a lack of robust evidence regarding their behavioural and psychological effects. The intervention's original rollout in Japan occurred in the absence of scientific justification, yet evaluations reported substantial reductions in suicide rates. However, these findings remain contested and insufficient. Intriguingly, the adoption of B-LED lamps has continued internationally,

even as fundamental questions remain about the underlying mechanisms of action. In Sweden, where suicide prevention at railway settings is a national priority, the need for affordable, scalable alternatives to costly interventions like platform screen doors is urgent. This study contributes to closing a critical evidence gap by examining how B-LED exposure influences passenger behaviours in naturalistic settings. It is the first known investigation to assess behavioural responses using automated passenger density metrics in real-world railway environments over an extended period. By analysing both immediate and sustained responses to blue light exposure, this research offers novel insights into the potential utility and limitations of B-LED lamps as a preventative measure. Findings from this study will provide essential empirical guidance for policymakers, transit authorities, and suicide prevention specialists who are currently making decisions about implementation in the absence of convincing scientific evidence.

References

- Fredin-Knutzén, J., Hadlaczký, G., Wigren, A., & Sokolowski, M. (2024). A pilot study evaluating the preventive effects of platform-end lengthwise fencing on trespassing, person struck by train and traffic delays. *Journal of Safety Research*, 88, 78–84. <https://doi.org/10.1016/j.jsr.2023.10.010>
- Havarneanu, G. (2025, June 29). *Dispelling blue light source*. Restrail Toolbox. <https://www.restrail.eu/toolbox/spip.php?article115>
- Ichikawa, M., Inada, H., & Kumeji, M. (2014). Reconsidering the effects of blue-light installation for prevention of railway suicides. *Journal of Affective Disorders*, 152–154, 183–185. <https://doi.org/10.1016/j.jad.2013.09.006>
- Mann, J. J., Michel, C. A., & Auerbach, R. P. (2021). Improving Suicide Prevention Through Evidence-Based Strategies: A Systematic Review. *American Journal of Psychiatry*, 178(7), 611–624. <https://doi.org/10.1176/appi.ajp.2020.20060864>
- Matsubayashi, T., Sawada, Y., & Ueda, M. (2013). Does the installation of blue lights on train platforms prevent suicide? A before-and-after observational study from Japan. *Journal of Affective Disorders*, 147(1–3), 385–388. <https://doi.org/10.1016/j.jad.2012.08.018>
- Matsubayashi, T., Sawada, Y., & Ueda, M. (2014). Does the installation of blue Lights on train platforms shift suicide to another station?: Evidence from Japan. *Journal of Affective Disorders*, 169, 57–60. <https://doi.org/10.1016/j.jad.2014.07.036>
- Mishara, B. L. (2007). Railway and Metro Suicides: Understanding the Problem and Prevention Potential. *Crisis*, 28(S1), 36–43. <https://doi.org/10.1027/0227-5910.28.S1.36>
- Pirkis, J., Spittal, M. J., Cox, G., Robinson, J., Cheung, Y. T. D., & Studdert, D. (2013). The effectiveness of structural interventions at suicide hotspots: A meta-analysis. *International Journal of Epidemiology*, 42(2), 541–548. <https://doi.org/10.1093/ije/dyt021>
- Regeringskansliet Infrastrukturdepartementet. (2020, February 13). *Regeringen höjer ambitionsnivån i trafiksäkerhetsarbetet*. News Powered by Cision. <https://news.cision.com/se/infrastrukturdepartementet/r/regeringen-hojer-ambitionsnivan-i-trafiksakerhetsarbetet,c3034946>