2503C
Empirical Study on Encouraging Vehicles to Yield at Pedestrian Crossings Without Signals

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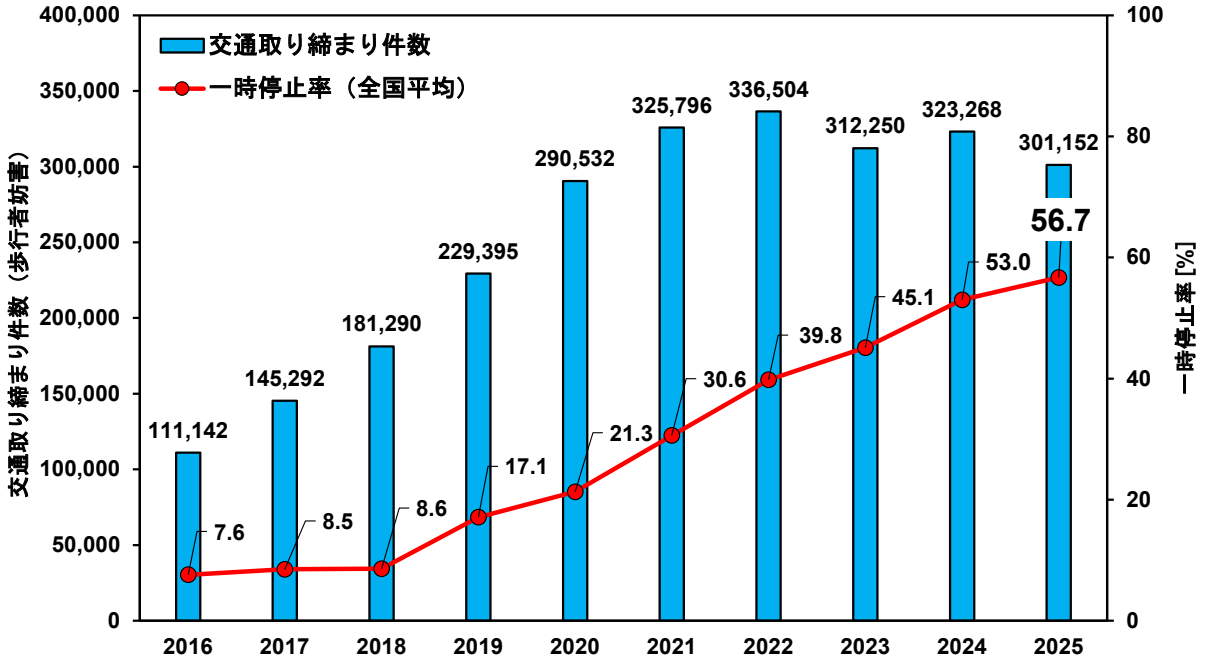
Project Background

- Improving safety at crosswalks is essential for enhancing urban walkability
- Due to aging traffic signals and rising maintenance costs, there is a growing need for safety measures that do not rely solely on signalization.
- The use of unsignalized crosswalks is increasing; however, traditional regulations (signs and markings) may be insufficient for ensuring safety in certain cases

Traffic Regulation Road Signs / Markings	**Non-statutory Safety Measures** Oversized Signs, Colored Pavements, Safety Signboards
	

Japan's Specific Issues: In addition to physical facility challenges, there is a **lack of compliance regarding pedestrian priority rules**

Compliance with Pedestrian Priority at Unsignalized Crosswalks



While yielding rates were low for many years, recent enforcement efforts have led to an improving trend, reaching 56.7% in 2025

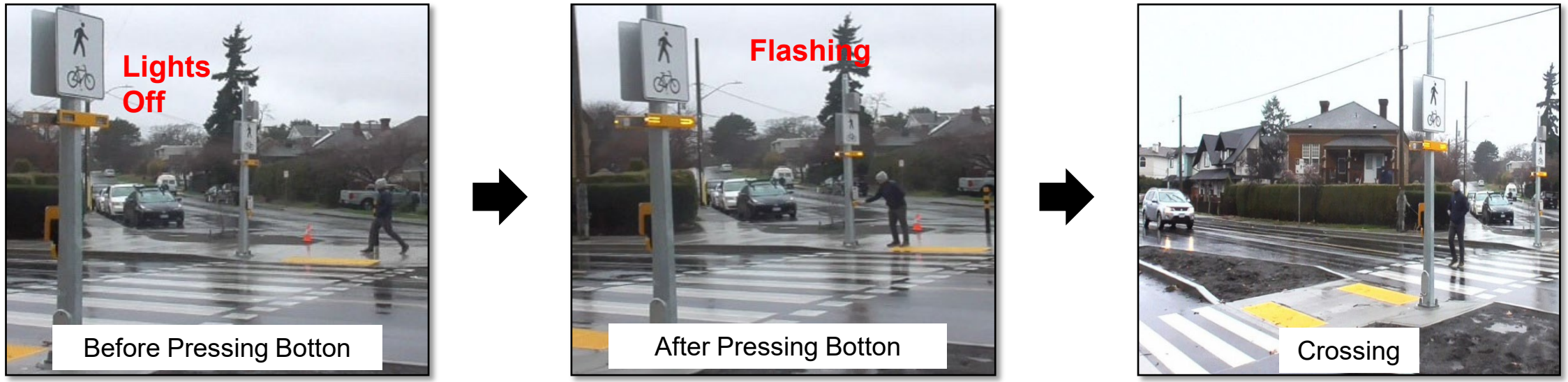
・ Despite approximately 300,000 annual citations for "Pedestrian Interference," nearly 40% of vehicles still fail to stop

[Source]
Japan Automobile Federation (JAF): "Nationwide Survey on Traffic Manners (Driver Stopping Rates at Pedestrian Crossings)"
National Police Agency: "Number of Traffic Violations Cited (Failure to Yield to Pedestrians)"

Some local governments have begun pilot installations of behavior-prompting devices using LED, similar to those used overseas

Behavior-Inducing Device: RRFB (North America)

Rectangular Rapid Flashing Beacons (RRFB) are widely implemented across North America as a highly effective pedestrian crossing enhancement



RRFB in Victoria, Canada

〈Key Features of RRFB〉

- Regulatory Status: Defined as an official traffic control device in the MUTCD*
- Visualizing Intent: Button activation triggers rapid flashing to immediately alert drivers
- Proven Impact: Increases yielding rates and significantly reduces pedestrian-vehicle conflicts
- Ease of Deployment: Solar-powered (self-sufficient) and lower cost compared to full traffic signals

Note: MUTCD stands for the Manual on Uniform Traffic Control Devices, the standard for traffic control devices issued by the Federal Highway Administration (FHWA).

RRFBs are recognized as "Low-Cost, High-Impact" safety infrastructure

Various Pedestrian Warning Systems Implemented Across Municipalities

Chuo-ku, Tokyo (Photo by the author)

Tsuchiura, Ibaraki (Photo by the author)

Saitama City, Saitama (Photo by the author)

Inagawa, Hyogo (Inagawa City HP)

Kimitsu City, Chiba (C-Cube website)

Moriguchi City, Osaka (PR TIMES)

〈**Challenges**〉While various devices are being tested, specifications vary significantly by municipality. Verification of effectiveness and standardization of these devices remain insufficient on a national level.

Project Objectives

① Analyze infrastructure measures and regulatory frameworks (domestic and international) aimed at improving safety at unsignalized crosswalks

② Study driver and pedestrian behavior at unsignalized crossings in Japan to evaluate the effectiveness of RRFBs in promoting yielding behavior.

Project Schedule

FY2023 (Year 1)

International research on behavior-inducing facilities; selection and coordination of social experiment sites; baseline traffic surveys.

FY2024 (Year 2)

Implementation of RRFB social experiments; execution of "Before-and-After" traffic surveys to measure impact.

FY2025 (Year 3)

Analysis of survey results; feasibility study of flashing-type devices in Japan; development of strategies to promote driver yielding.

Definition of “Yielding” and Pedestrian Priority

Differences in Driver Behavior: Japan vs. North America

Japan (Article 38, Road Traffic Act)

Mandatory Stop

North America (Concept of "Right of Way")

Either

Decelerate **Temporary stop**

Yields to the pedestrians

※In North America, stop lines are often absent at unsignalized crosswalks
※ Traffic regulations vary by jurisdiction. This study refers to the regulations of California, USA, and Vancouver, BC, Canada.

〈Definition of “Yielding "in this Study〉

- Vehicle behavior that enables a pedestrian to cross safely is defined as "Yielding." This includes both a full stop and significant deceleration
- Yielding Rate is utilized as the primary performance indicator

Positioning of RRFBs Based on International Reviews and Interviews

① Key Characteristics of RRFBs

・ Defined by the FHWA (Federal Highway Administration) as a device designed to increase driver awareness and visibility）

・ RRFBs do not legally mandate a stop (Source: Interview with Carmanah Technologies)

② Hierarchy of Pedestrian Safety Measures (U.S. Model)

Level	Facility Type	Primary Role
Basic	Signs & Markings	・Presence ・Information
Warning Beacon	RRFB	・Alerting ・Behavioral Prompting
Control	Traffic Signals	・Full Stop Control ・Regulatory Control

RRFB ＝ Behavior-Inducing Device that prompts action without mandating a stop

③ Core Hypotheses for Validation in this Project

・ Do yielding rates increase when the beacons are flashing compared to when they are dark?

・ Does the effectiveness decrease over time as local drivers become "accustomed" to the device?

・ Does the installation of RRFBs improve general yielding behavior even during periods when the beacons are not activated?

Decision Matrix for RRFB Implementation

RRFB Selection Matrix

Use this chart to determine the roadway conditions where RRFBs are recommended or should be considered to maximize pedestrian safety.

Legend

- Engineering judgment = RRFBs are not recommended but are an optional enhancement with or following engineering judgment
- Consider = RRFBs are a candidate treatment to improving crossing safety on this roadway
- Recommended = RRFBs are an ideal treatment for this roadway

Number of Lanes (Crossing Distance)	Refuge Island	Posted Speed Limit (mph) and Annual Average Daily Traffic (AADT)								
		< 9,000 AADT			9,000 – 15,000 AADT			> 15,000 AADT		
Crossing distance (e.g. number of lanes)	Median presence	SPEED LIMIT ≤30	SPEED LIMIT 35	SPEED LIMIT 40	SPEED LIMIT ≤30	SPEED LIMIT 35	SPEED LIMIT 40	SPEED LIMIT ≤30	SPEED LIMIT 35	SPEED LIMIT 40
2 lanes (1 lane in each direction)	-	Engineering judgment	Consider	Recommended	Engineering judgment	Consider	Recommended	Consider	Consider	×
3 lanes (1 lane in each direction with two-way left-turn lane)	Yes	Engineering judgment	Consider	Recommended	Consider	Recommended	Recommended	Consider	Recommended	×
	No	Consider	Consider	×	Consider	Recommended	×	Consider	×	×
4+ lanes (2 or more in each direction)	Yes	Consider	Consider	×	Consider	Recommended	×	Recommended	×	×
	No	Consider	Consider	×	Consider	Recommended	×	Recommended	×	×

※1

※2

Source: Adapted from Federal Highway Administration, Report No. FHWA-SA-17-072, *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations*

Engineering Judgement

Candidate for Consideration

Recommended

Annual Average Daily Traffic (AADT)

Post Speed Limit

※1 Recommendations often apply to speeds below 30 mph

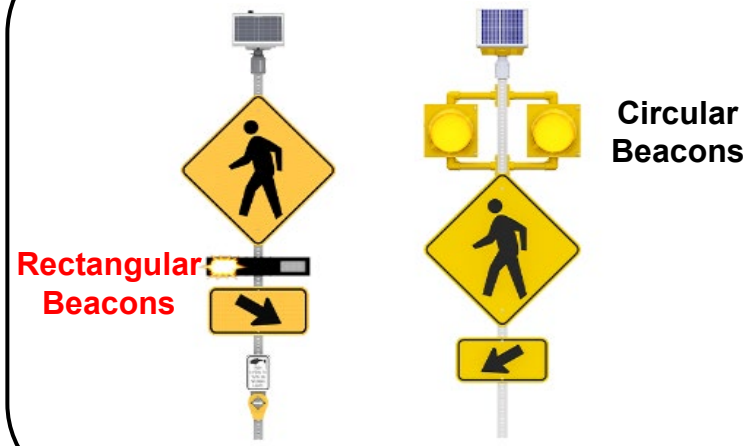
※2 The experimental site in this study meets these criteria

【Source】
Derived from the FHWA guidelines via the Carmanah Technologies RRFB Application Guide

Operational Criteria: In the U.S., RRFB application levels (Recommended, To be considered, or Engineering Judgment) are categorized based on road conditions such as the number of lanes, traffic volume, and posted speed limits

RRFB Design Elements and Effectiveness

Beacon (Light) Shapes



Evaluation of effectiveness based on beacon shape (Fitzpatrick, 2016)

Beacon Placement

Evaluation of effectiveness based on the relative position of the beacon and the sign (Fitzpatrick, 2016)

パターン	2-5		Blocks		WW+S	
累積時間 [ms]	左ビーコン [ms]	右ビーコン [ms]	左ビーコン [ms]	右ビーコン [ms]	左ビーコン [ms]	右ビーコン [ms]
25	25		25		25	
50	25		25		25	
75	25		25			
100	25		25	25		
125	25		25	25		25
150			25	25		25
175			25			
200			25			
225	25		25		25	
250	25				25	
275	25					
300	25					
325	25			25		25
350				25		25
375				25		
400			25	25		
425		25	25	25	25	25
450			25	25	25	25
475		25		25		
500				25		
525		25		25	25	25
550					25	25
575		25				
600						
625		25				
650		25				
675		25				
700		25				
725		25				
750		25				
775		25				
800		25				
点灯時間 [ms]	250	300	300	300	200	200
点灯比率	69%		56%		37%	
消灯比率	31%		44%		63%	

オレンジのセル：ビーコン点灯
グレーのセル：ビーコン消灯

点灯比率：1周期（800ms）のうち、少なくとも1つのビーコンが点灯している割合
消灯比率：1周期（800ms）のうち、少なくとも1つのビーコンが消灯している割合

Evaluation of effectiveness based on different flash patterns (FHWA, 2016)

Specific design elements (shape, placement, and flash pattern) have a **limited influence** on the overall effectiveness of RRFBs

In the United States, the standard configuration consists of **rectangular beacons**, **bottom-mounted placement**, and the **WW+S (Wig-Wag + Simultaneous) flash pattern**. This experiment adopts the standard U.S. specifications as the baseline

RRFB Implementation in Vancouver (Observational Case Study)

Field Observations of Operational Specifications
Beacon: Rectangular type
Placement: Mounted above the sign
Flash Pattern: Wig-Wag + Simultaneous (WW+S)
Duration: 17-second flash cycle
Location: Mid-block pedestrian crossing
Speed Limit: 50 km/h

Social Experiment Timeline and Installation Process

	Apr–Jun 2024	Jul-Sep 2024	Oct-Dec 2024	Jan-Mar 2025	Apr-Jun 2025	Jul-Aug 2025	Oct-Dec 2025	Jun-Mar 2025
Chiba Prefectural Police	Consultations→ Conditional Informal Consent	Experiment Approval	Permits Agreements Road Use Permit	Begin Experiment				Experiment Finish
Chiba Prefectural Civil Engineering Office		Consultations→ Conditional Approval Consultations→ Informal Approval	Application Road Occupation Permit					
Construction Company		Cost Estimation	Contract	Construction				
City Hall			Preliminary Briefing					
Bus Companies			Preliminary Briefing					
Local Business Association			Baseline Survey	1-Month Follow Up	3-Month Follow Up	6-Month Follow Up	9-Month Follow Up	1-Year Follow Up
Observational Survey								

Traffic Control

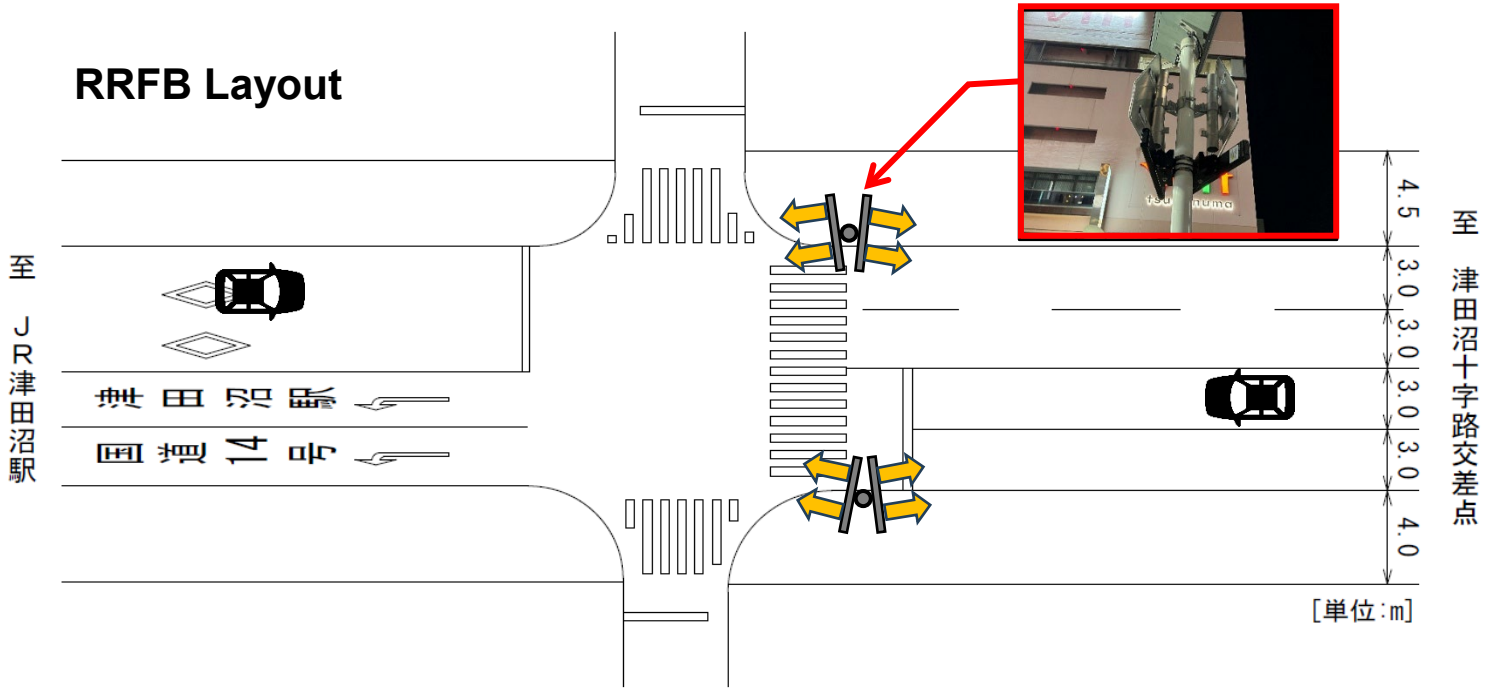
Foundation Work

Pole Mounting

Completion

Device Specifications and Experimental Layout

RRFB Layout



Push-button activates the RRFB

Technical Configuration

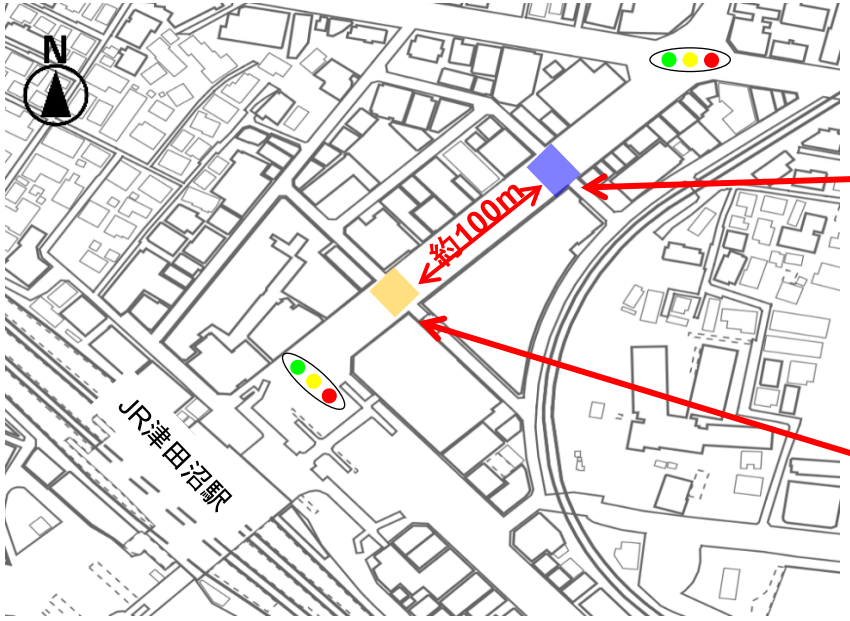
Items	Content
Signage	High-intensity reflective "School Zone" (407-B) sign
LED Light Bars	Dual LED units per pole
Height	Approx. 2.7m above ground
Power Source	Solar panel integrated with battery
Communication	Wireless synchronization between units
Actuation	Manual push-bottom
Extension Feature Upon Re-Press	None

Light Specification

Items	Content
Flashing pattern	Wig-Wag + Simultaneous (WW+S)
Cycle	0.8 Seconds
Visibility	Approx. 200m
Color	High-intensity Amber
Duration	10 Seconds

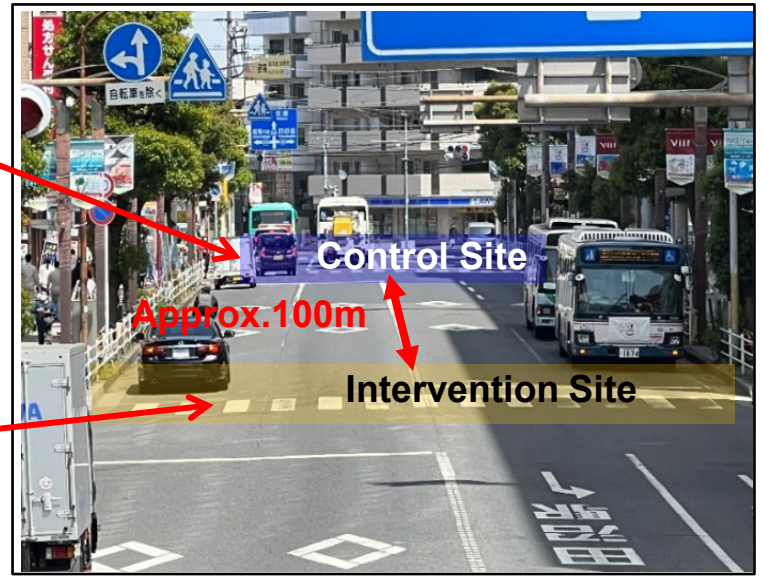
Study Sites and Research Design (Comparison between Intervention and Control Sites)

Items	Content
Location	2-19-1 Maebara-nishi, Funabashi City, Chiba Prefecture
Study Period	January 9, 2025 – January 20, 2026 (1 year)
Road Geometry	Intersection / 4-lane undivided highway
Road Classification	Arterial road
Crossing Distance	13.0m
Speed Limit	40km/h
Observation Timeline	Pre-installation, and 1, 3, 6, 9, and 12 months post-installation
Observation Hours	Weekdays, 10:00 AM to 10:00 AM the following day (24-hour periods)



Non-RRFB Site (Control Site)

RRFB Crosswalk (Intervention Site)



Study Overview (Observation Schedule and Methodology)

Observation Sites and Time, Weather Conditions）

Observation Sites	Intervention Points (RRFB) ：Crosswalk near 2-18 Maebara-nishi, Funabashi City Control Sites (Non-RRFB) ：Crosswalk near 2-21 Maebara-nishi, Funabashi City
Study Dates & Weather Conditions	Pre-Install ：Dec 16 (Mon) 10:00 – Dec 17 (Tue) 10:00, 2024 Weather: Clear / Sunny ※1 1-month Post ：Feb 10 (Mon) 10:00 – Feb 11 (Tue) 10:00, 2025 Weather: Clear / Sunny 3-month Post ：Apr 14 (Mon) 10:00 – Apr 15 (Tue) 10:00, 2025 Weather: Mostly sunny with occasional rain 6-month Post ：Jul 28 (Mon) 10:00 – Jul 29 (Tue) 10:00, 2025 Weather: Rain followed by clear skies 9-month Post ：Oct 6 (Mon) 10:00 – Oct 7 (Tue) 10:00, 2025 Weather: Cloudy followed by clear skies 12-month Post ：Jan 19 (Mon) 10:00 – Jan 20 (Tue) 10:00, 2026 Weather: Cloudy followed by clear skies

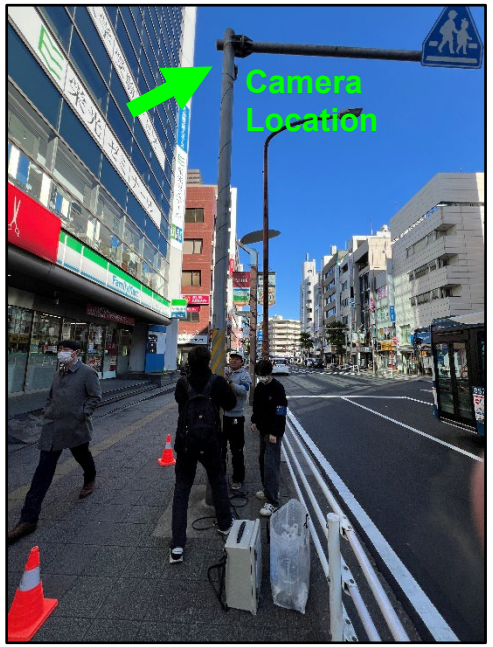
※1 Recording was suspended for approximately 30 minutes between 20:00 and 21:00 due to equipment malfunction
※2 February 11 (Tue) was a public holiday

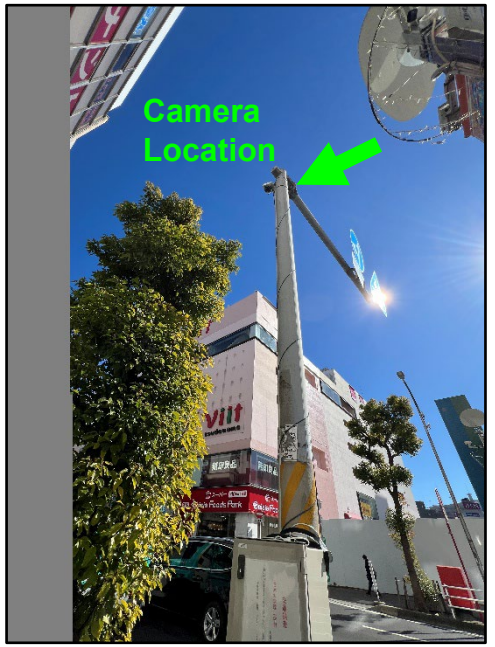
Observation Methodology

Three cameras installed at each of the two sites for a total of six 24-hour observation sessions.※3
Collection of longitudinal data (long-term pre- and post-installation analysis).

※3 Recording was briefly suspended twice for a few minutes for battery replacement

In cooperation with the Chiba Prefectural Police, video cameras were mounted on overhead pedestrian crossing sign poles.

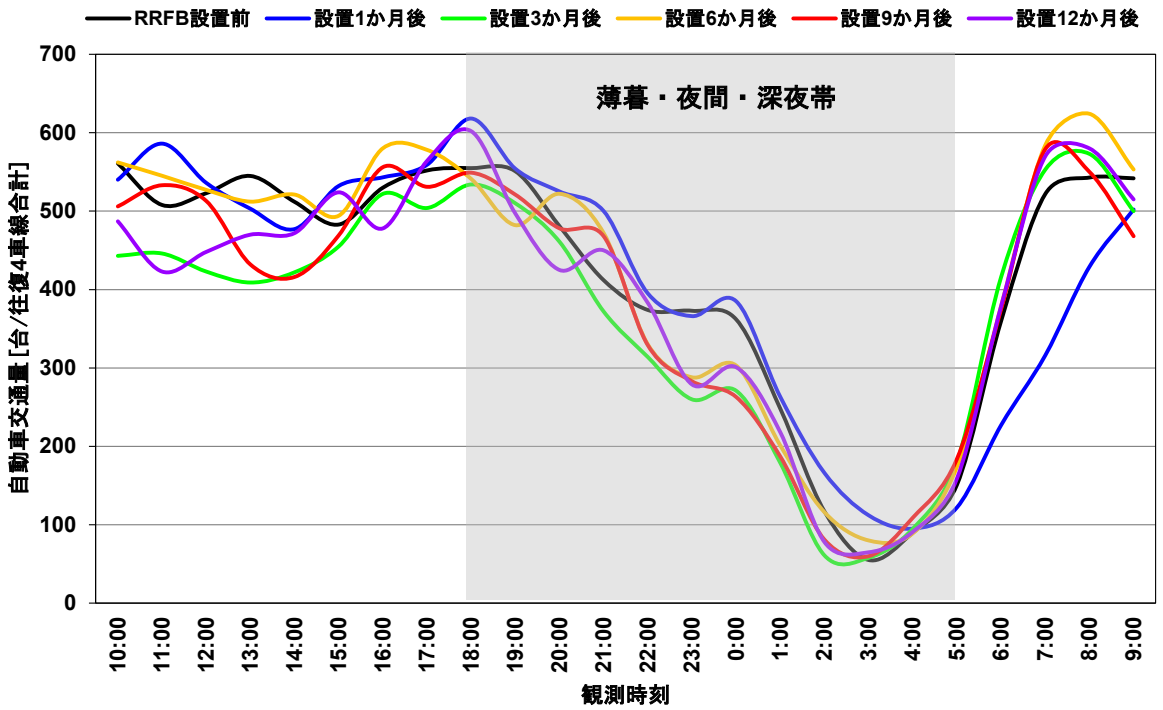




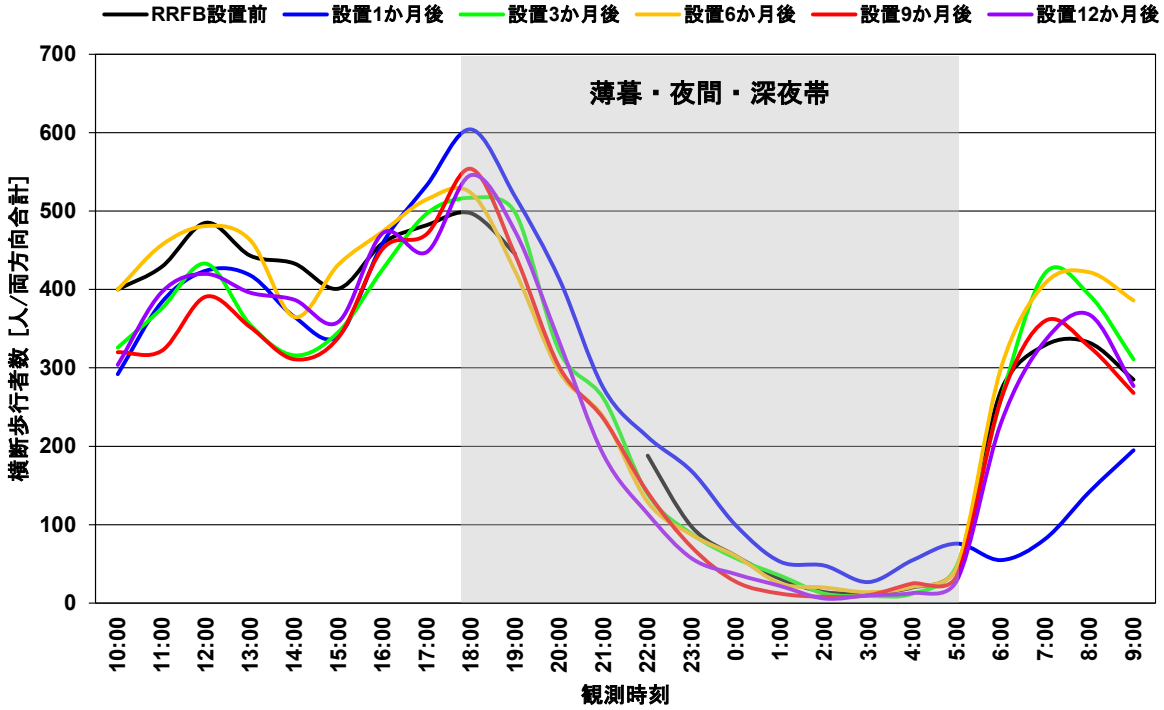
Installation of RRFB at JR Tsudanuma Station (North Exit)

Captured from the pedestrian deck of JR Tsudanuma Station

Traffic Conditions at the Intervention Site (Volume of Motor Vehicles and Pedestrians)



Average Daily Traffic (ADT)
9,659 vehicles/day
(4-lane undivided road)

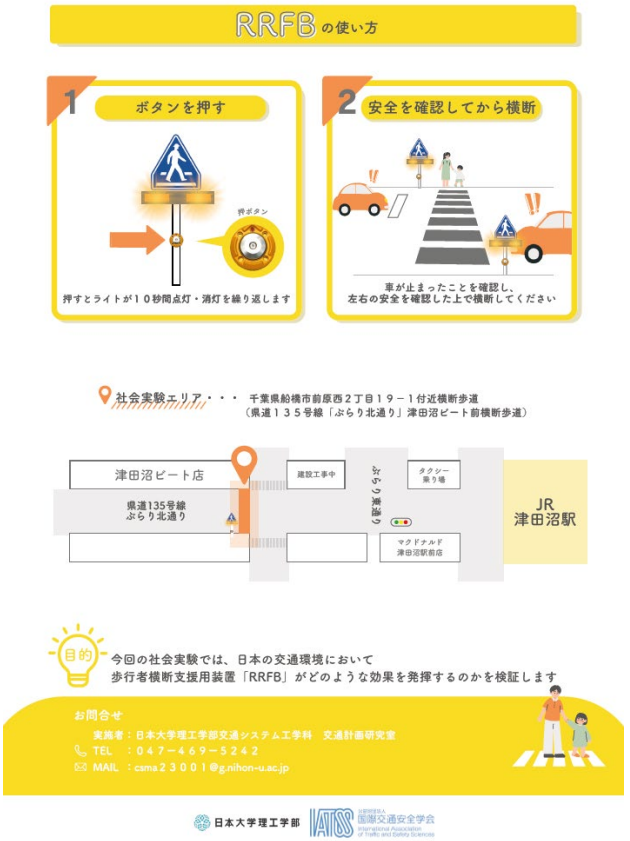


Average Daily Pedestrians
5,699 people/day
※ Data excludes mid-block crossings (jaywalking)

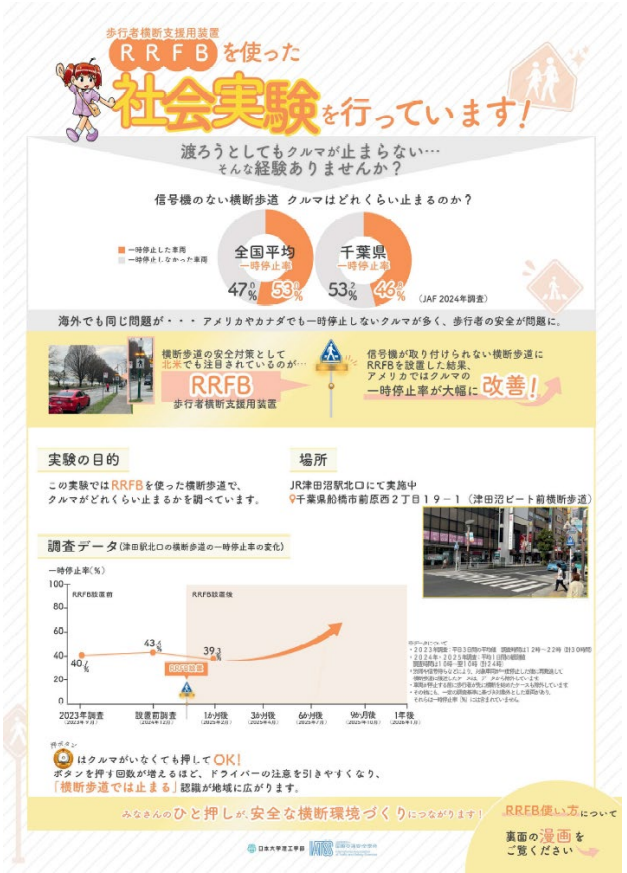
Public Awareness Campaign for Social Implementation (Flyers)

- Objectives： To improve public awareness of RRFBs and encourage proper usage
- Target Audience： Local residents, facilities near the station, business associations, etc.
- Total Distribution ： Approx. 8,300 copies (February – September 2025)

1st Campaign Flyer: (Front)



1st Campaign Flyer: (Back)



2nd Campaign Flyer: (Front)

2nd Campaign Flyer: (Back)

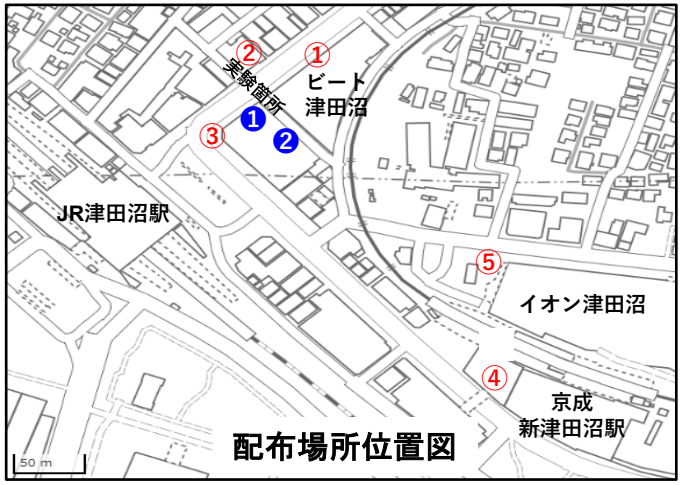
Outreach Activities (Flyer Distribution & Poster Display)

Flyer Distribution

・ Goal: Direct outreach to pedestrians (see map for distribution points)

※ Conducted in accordance with the Road Use Permit

・ Dates / Volume: June 24 and July 1, 2025 / 802 copies total (2-day period)



配布場所位置図


① Front of Tsudanuma Viit


② Front of Chiba Kogyo Bank

Poster Display

- **Locations: 2 designated sites**
- **Duration：**
  Sep 2025 – Jan 2026

※ Posted following review under the Funabashi City Outdoor Advertising Ordinance


❶ Near the crosswalk


❷ Side streets/Narrow alleys

Poster

Media Coverage

千葉日報（日刊） 2025年（令和7年）7月2日（水曜日）

信号ない横断歩道の安全対策

ライト点滅 運転者に注意促す

津田沼駅北口で社会実験

JR津田沼駅北口近くの信号機のない横断歩道で、歩行者横断支援用装置（RRFB）の社会実験が行われている。RRFBは歩行者が横断する際にボタンを押すと、ライトが点滅してドライバーに歩行者の存在を視覚的に知らせる。横断歩道の交通安全対策として北米で整備が進んでおり、国内でも愛知県豊田市が積極的に導入し、横断歩道前での車の一時停止率向上がみられている。今回の実験でも効果が表れ始めている一方、利用する歩行者が少ないことが効果を検証する上での課題になっている。（藤田泰彰）

県内で初めてとなる今回のRRFB設置の社会実験は国際交通安全学会のプロジェクトで、県警の支援を受けて今年1月から1年間実施。実験場所に選んだ商業施設「津田沼ビート」前の信号機のない横断歩道（船橋市前原西2）は、交通事故が多く、地元が信号機設置を要望しているものの、近くに信号機があるため設置が難しいという。

実験では、片側2車線の道路の左右歩道で横断歩道の標識と同じ支柱にライトを設置。歩行者が支柱のボタンを押すことで左右両側のライトが10秒間点滅し、ドライバーに注意を促す。左右は無線通信で結ばれ、太陽光発電で電源を確保している。

社会実験の中心メンバーで日大大学院理工学研究科の吉村暢洋さん（45）による通標識の補助的な設備にと、車の一時停止率は設置1カ月後の2月に行った調査で約39％だったのに対し、同3カ月後の4月は約46％に上昇。近くにある未設置の横断歩道に比べて、2月の一時停止率はほぼ同じだったが、4月は5・2ポイント高くなった。ドライバーから「まぶしい」などのクレームも寄せられていない。

吉村さんは「効果が見え始めている」と言及。2022年に仙台市青葉区で行った社会実験では4カ月間で一時停止率が約15ポイントアップしており、今回の実験も3カ月単位で調査を続け効果を確認する。

RRFBは米国やカナダで2000年代後半から採用され、信号機と同じ効力を持つ。国内では現在、交通標識の設置位置が設けられており、道路を管理する行政が設置可能とされる。実際に豊田市は独自に19年8月から整備を始め、計17カ所に設置した。

整備コストも信号機に比べて低いRRFBだが、認知度の低さが課題。今回の実験でボタンが押された1日当たりの回数は2月の調査で3回、4月の調査でも9回にとどまった。

認知度の向上へ、地元の船橋市前原商店会は利用方法のイラストを入れたチラシを作成し、近くの小学校や商業施設などに配布。6月23日に続き、1日も同大学の学生らが実験場所近くなどでチラシを配り、ボタンを押す回数が増えるほど、ドライバーの注意を引きやすくなり「横断歩道では止まる」認識が地域に広がる。皆さんの一押しが安全な横断環境づくりにつながる」とアピールした。

◇

道交法は、横断歩道は歩行者優先と定めており、歩行者らが横断している時や横断しようとしている時、車両は一時停止をして歩行者らに道を譲らなければならない。

津田沼ビート前の横断歩道に社会実験として設置された歩行者横断支援用装置（RRFB）＝船橋市

船橋市前原商店会が作成したチラシ

July 2, 2025
Chiba Nippo

横断歩道 光でアピール

日大など 津田沼駅前で社会実験

信号ない箇所

日大理工学部と国際交通安全学会（東京都）は、船橋市前原商店会と協力し、JR津田沼駅北口近くの信号機がない横断歩道で、「歩行者横断支援用装置（RRFB）」を活用した社会実験を行っている。横断歩行者の安全を守る装置で、県内初の試み。来年1月末まで社会実験を行い、効果を検証する。（大和太郎）

RRFBが設置された横断歩道標識。支柱のボタンを押すと横断の下のライトが光る（6月27日、船橋市前原西で）

協力：船橋市前原商店会

横断歩道の手前に立つ「横断歩道標識」の支柱に取り付けられたボタンを押すと、車道に向かって支柱上部のライトが10秒間点滅する。夜間はもちろん、昼間もはっきりとした閃光を放ち、横断歩行者の存在をドライバーに知らせる。

電源は支柱上部に設置した太陽光発電パネルで確保している。横断歩道の反対側の支柱にもパネルを設置しており、反対車線の車に向かっても同時にライトが点滅する仕組みだ。

実験を主導するNPO法人交通システムを専攻する吉村暢洋さん（45）によると、RRFBは、開発された米国や、カナダで導入が進んでいる装置。閃光で歩行者の存在を知らせることで、車が一時停止する確率が大幅に上がったと報告されている。国内では愛知県豊田市などで導入例がある。

背景に、維持費がかかる信号機の設置が難しくなっている。人口減少を地方を中心とした今後の信号機の減少を懸念する声もある。

また日本自動車連盟（JAF）の昨年の調査で、信号機のない横断歩道で一時停止する車の割合をみると、全国平均は33・0％にとどまり、千葉県は46・8％とさらに低い。

RRFBは整備コストが信号機と比べて低い。横断歩行者の安全を守る装置として、信号機の代替的な役割を果たす可能性があるという。

◇

社会実験は県警の許可を得て、船橋市前原西の片側2車線の県道で1月に始まった。日本の交通環境でも装置が効果を発揮するかを確認するのが目的だ。

千葉興業銀行と商業施設「津田沼ビート」前を結ぶ横断歩道の標識に装置を設置した。交通事故が多く、地元が信号機の設置を要望している場所という。

社会実験ではボタンが押された際に車両が一時停止したかなどを映像で記録し、効果を調べる。

ボタンが押される回数は2月は1日あたり37回だったが、4月には同94回、7月（14～15日）には187回（速報値）と倍増した。一時停止率も4月は46・1％、7月は53・7％（同）と、設置前と比べて約10ポイント上昇している。

吉村さんがかつて仙台市で行った実験では導入4カ月で一時停止率が約15ポイントアップしたというデータもある。

ただ、船橋市と仙台市の実験はいずれも装置を利用した横断歩行者が依然少ない。

認知されるのに7年かかったと言われている。現状の横断歩道には信号があるか、何もないかの二択しかない。その中間的なものをうまく組み入れて通行の安全を確保したい」と話している。

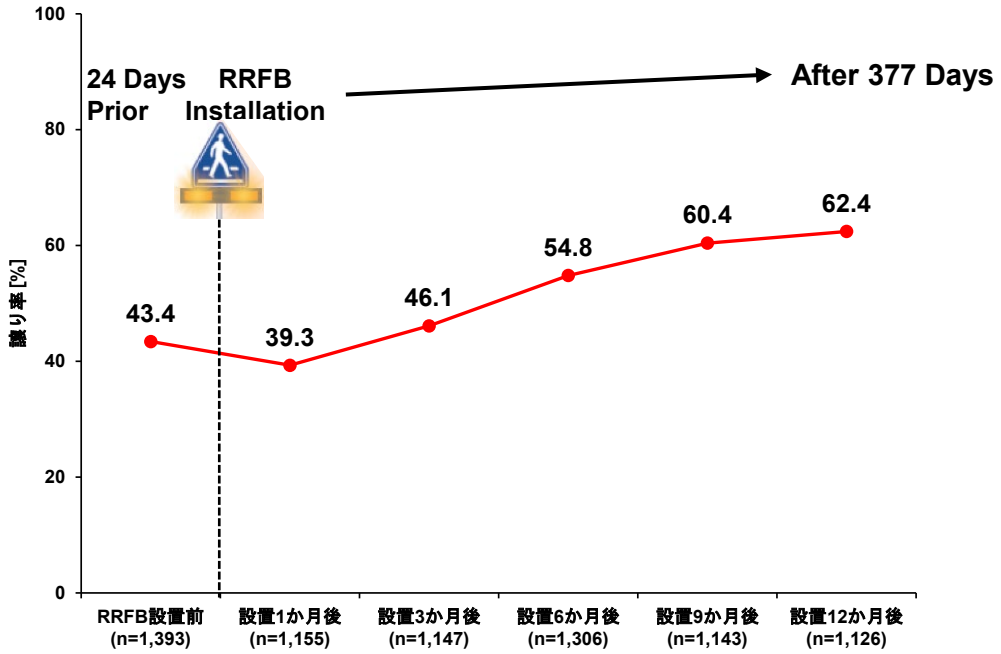
課題となっている。

日大理工学部の学生らは6月中旬から今月上旬にかけ、装置の存在を周知するために前原商店会が協力して作ったチラシを通行人らに配り、取り組みをPR。

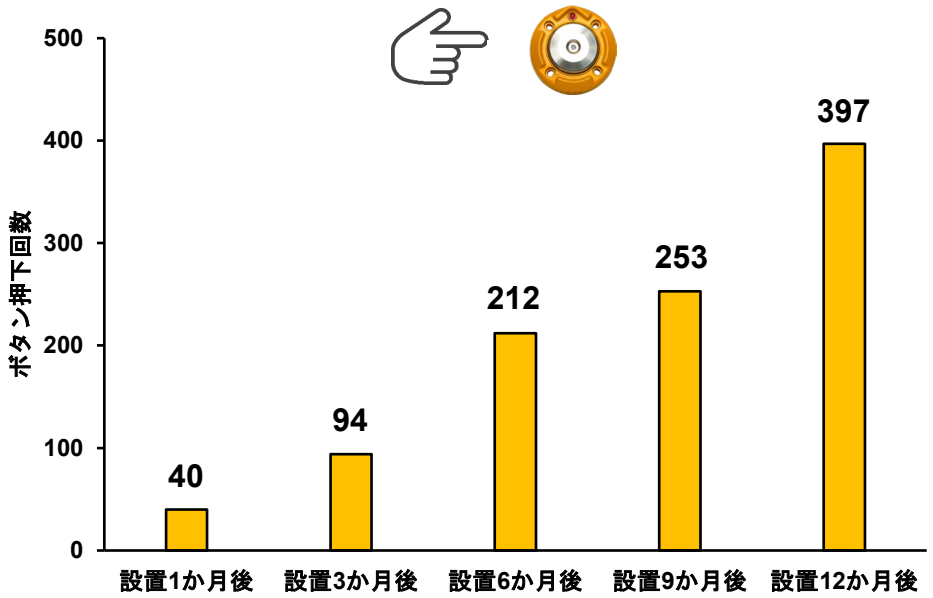
July 29, 2025
The Yomiuri Shimbun
(Chiba Edition)

Trends in Driver Yielding Rates and Button Activation

Combined trend for both flashing and non-flashing states



Trends in the frequency of button use



※1 Push-button activations represent the total 24-hour count for each observation date
※2 Includes all recorded activations, regardless of whether a vehicle was approaching

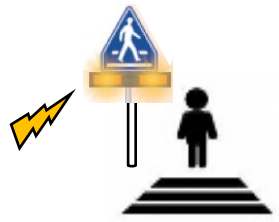
Observation Results

- **Driver Yielding Rate**: Increased from 43.4% (Pre-installation) to 62.4% (12-month post), representing a +19.0 percentage point improvement
- **Push-button Activations**: Increased from 40 times (1-month post) to 397 times (12-month post)

Analysis of RRFB Effectiveness and Temporal Sustainability

When Light is Flashing

1-Month Post n=26
3-Months Post n=70
6-Months Post n=121
9-Months Post n=128
12-Months Post n=166



※n :Number of vehicles approaching while the button was pressed

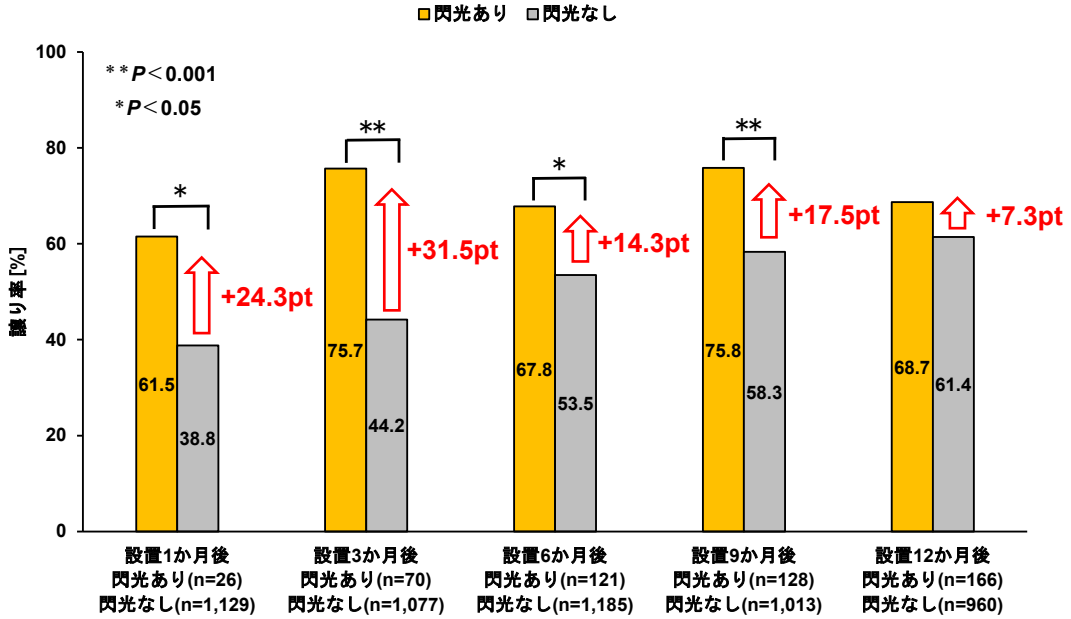
Comparison

When Light is not Flashing

1-Months Post n=1,129
3-Months Post n=1,077
6-Months Post n=1,185
9-Months Post n=1,013
12-Months Post n=960

※n: Number of vehicles approaching while the button was NOT pressed

Simple Comparison（χ²Test）



・ 1 to 9 Months Post-Installation: Yielding rates during flashing periods were significantly higher
・ 12 Months Post-Installation: No statistically significant difference was observed

Interpretation Challenges

・ Yielding rates during non-flashing periods also showed an upward trend over time
・ Simple comparisons fail to account for these underlying temporal trends (longitudinal changes)

Logistic Regression Analysis (Accounting for Temporal Shifts)

説明変数	偏回帰係数	P値
定数項	0.037	0.18
閃光の有無（1＝閃光あり、0＝閃光なし）	0.852	<0.001 ***
観測月（設置後月数；6か月基準で中心化した連続変数）	0.086	<0.001 ***
閃光あり×観測月	-0.087	0.002 **
サンプル数	5,875	
McFadden R^2	0.028	

注）目的変数は譲りの有無（1＝譲った、0＝譲らなかった）を目的変数とした。
*** p<0.001, ** p<0.01

While the flashing effect remains statistically significant, the magnitude of this effect tends to diminish over time

Comparison of Yielding Behavior (Intervention Site vs. Control Site)

Intervention Site (Non-flashing state)

Prior to Post n=1,393
1-Month Post n=1,129
3-Months Post n=1,077
6-Months Post n=1,185
9-Months Post n=1,013
12-Months Post n=960

※n: Number of vehicles approaching while the button was NOT pressed

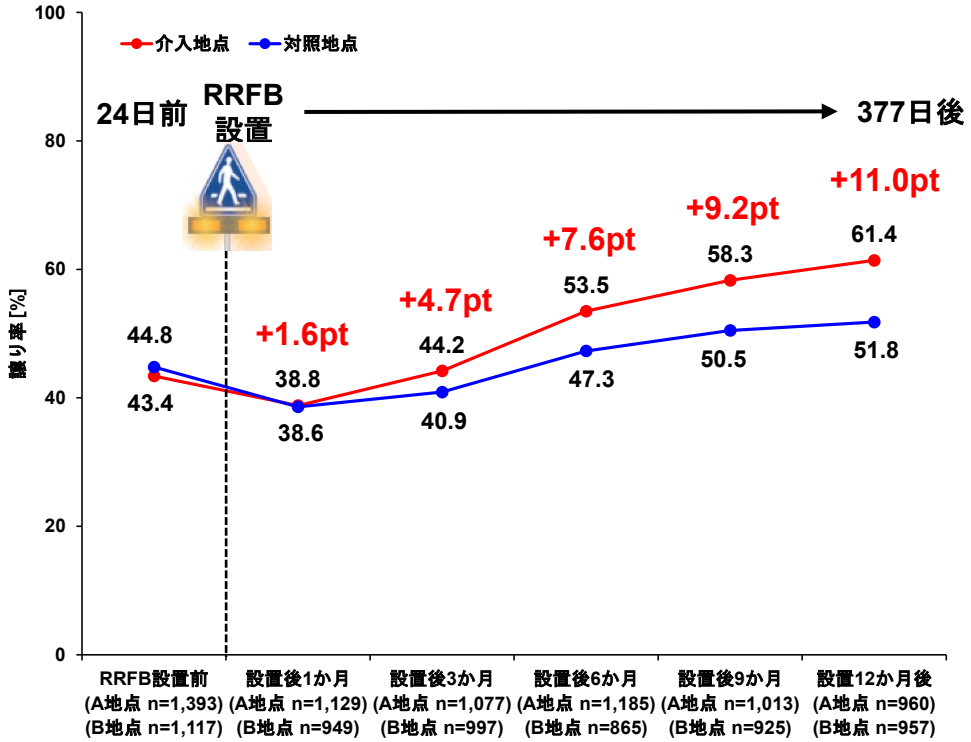
Validation via DiD Analysis

Control Site (Adjustment Unsignalized Crosswalk)

Prior to Post n=1,117
1-Month Post n=949
3-Months Post n=997
6-Months Post n=865
9-Months Post n=925
12-Months Post n=957

※n: Number of vehicles approaching while a pedestrian was waiting to cross

Methodology： Point-in-time comparisons cannot isolate the effects of RRFB installation from general temporal trends common to both sites
To address this, we employed a Difference-in-Differences (DiD) analysis to compare the relative changes between the two sites



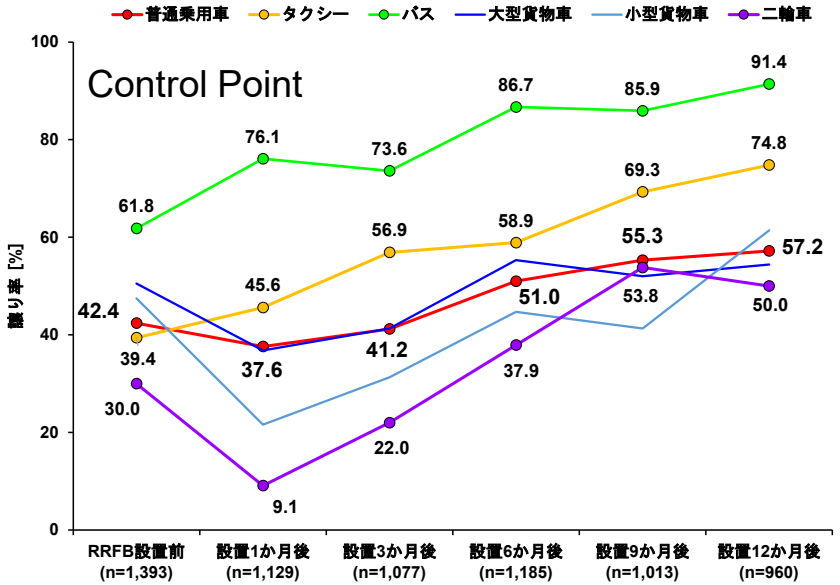
Key Findings

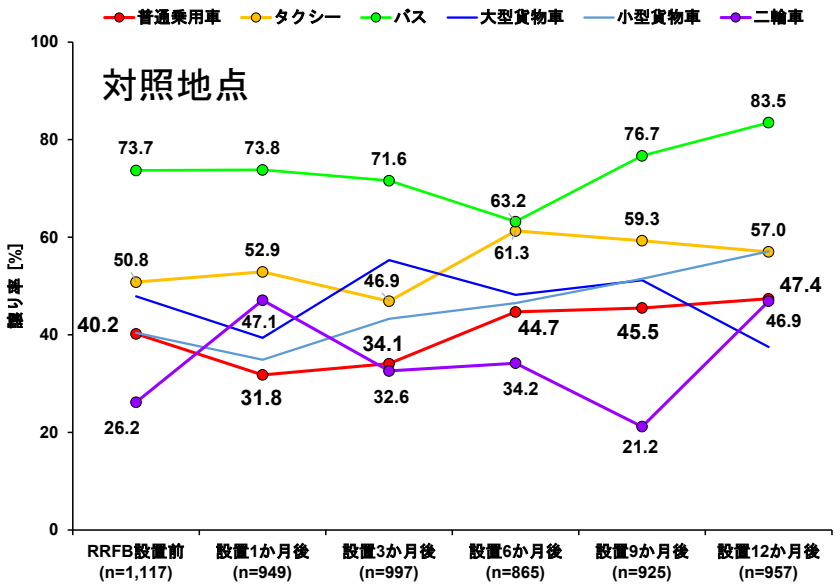
- Prior to installation, the difference in yielding rates between the two sites was minimal
- Post-installation, the yielding rate at the intervention site showed a relative increase compared to the control site.
- 12-Month Difference-in-Differences (DiD):
  (61.4 - 43.4) - (51.8 - 44.8) = 11.0

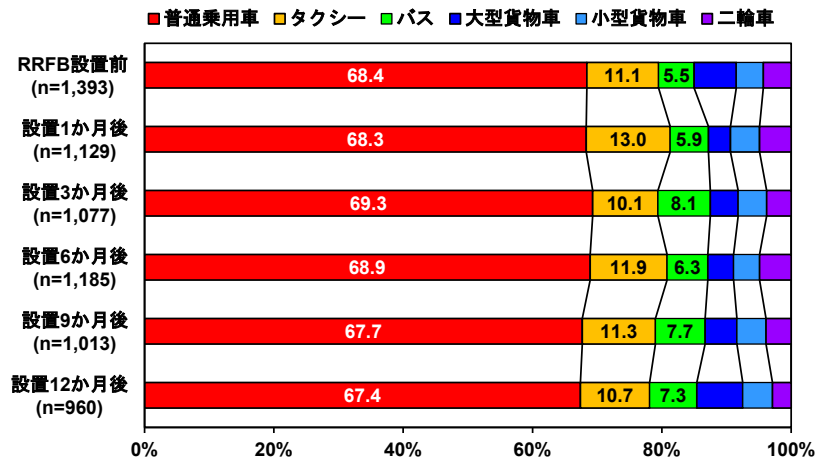
→ Following RRFB implementation, driver yielding rates increased even during non-flashing states.
This increase significantly outperformed the natural trend observed at the control site.

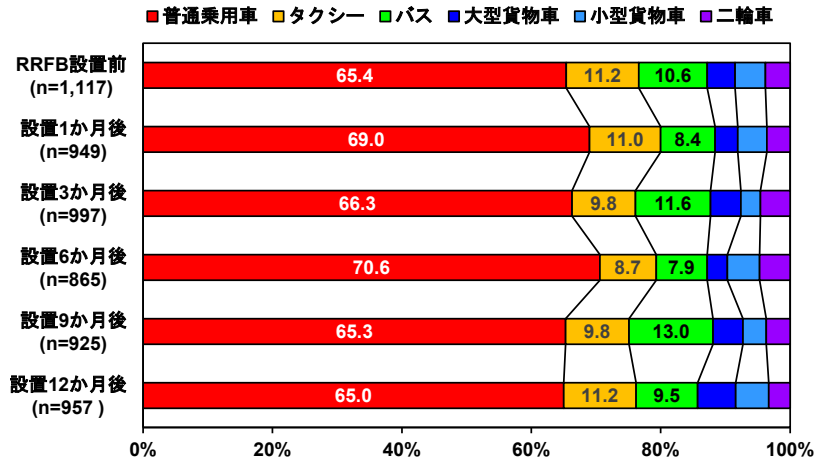
Yielding Trends by Vehicle Type and Time of Day (Non-Flashing)

Examined the breakdown of the increased yielding rate during non-flashing states by vehicle category





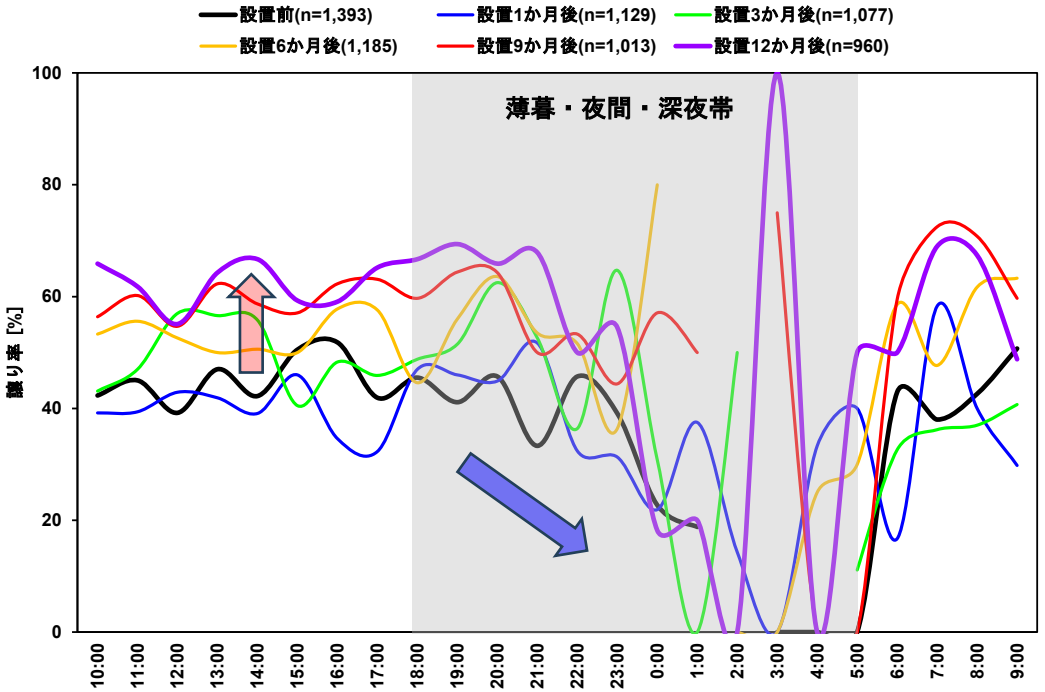




At the intervention site, although baseline yielding levels vary by vehicle type, an upward trend was confirmed across multiple categories

Analysis of Yielding Rates by Time of Day (Non-Flashing State)

Examined the breakdown of the increased yielding rate during non-flashing states by vehicle category



Key Findings

・Daylight and Twilight Hours: Yielding rates during non-flashing states showed an upward trend compared to pre-installation levels (represented by the black line)

・ Nighttime and Late-Night Hours: Changes in yielding rates were limited

・ Across all observation periods, yielding rates consistently remained lower during nighttime compared to daylight hours

※ Large variances in late-night estimates are due to the small sample size of vehicles in this time bracket

〈 Yielding Behavior During Non-Flashing States 〉

Integrating the results by site, vehicle type, and time of day suggests that the physical presence of the RRFB unit itself—independent of the flashing effect—may positively influence driver yielding behavior.

※ The specific factors contributing to this "presence effect" remain a subject for future research

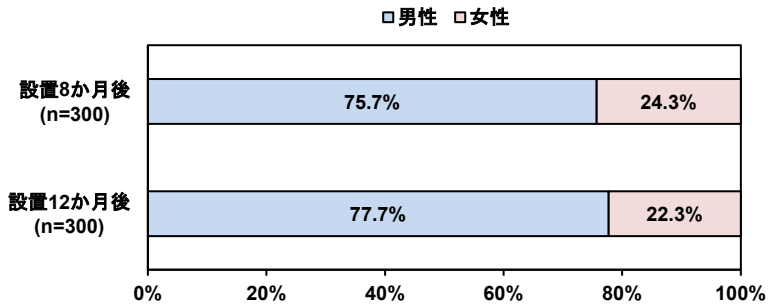
Driver Survey: Respondent Attributes and RRFB Experience

【 Survey Methodology & Timeline】

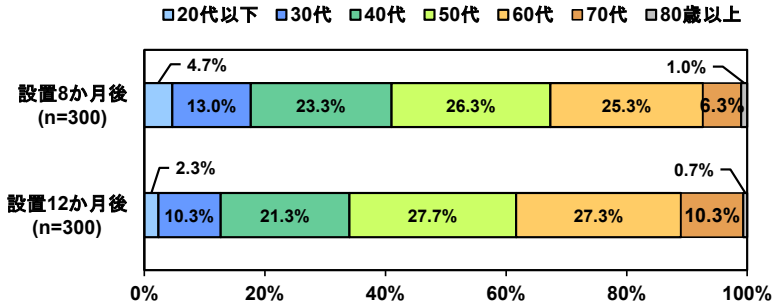
- 10-question Web-based survey (via Rakuten Insight)
- 1st Phase: 8 months post-installation
  Sep 18 – Sep 22, 2025
- 2nd Phase: 12 months post-installation
  Jan 26 – Feb 2, 2026

【 Target Criteria (Screening) 】

- Residents of Funabashi City or Narashino City
- Drove through the study site within the past year
- Aware of the RRFB system
- Sample Size: 300

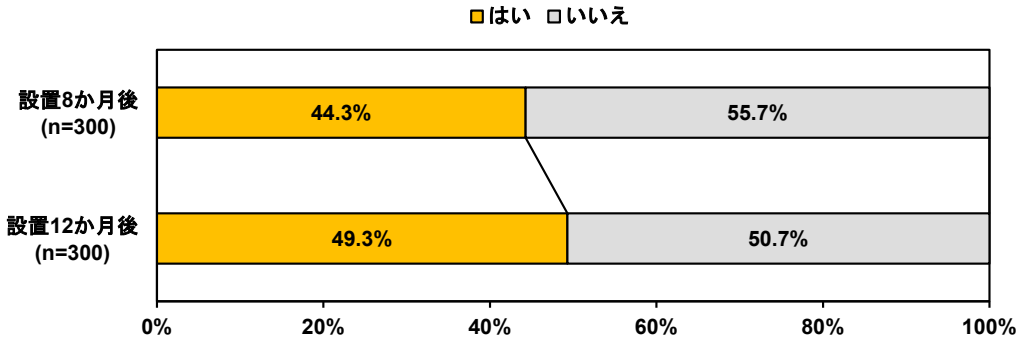


Gender Distribution of Respondents



Age Distribution of Respondents

Experience with Flashing Beacons: "Have you ever driven through this crosswalk while the lights were flashing?"

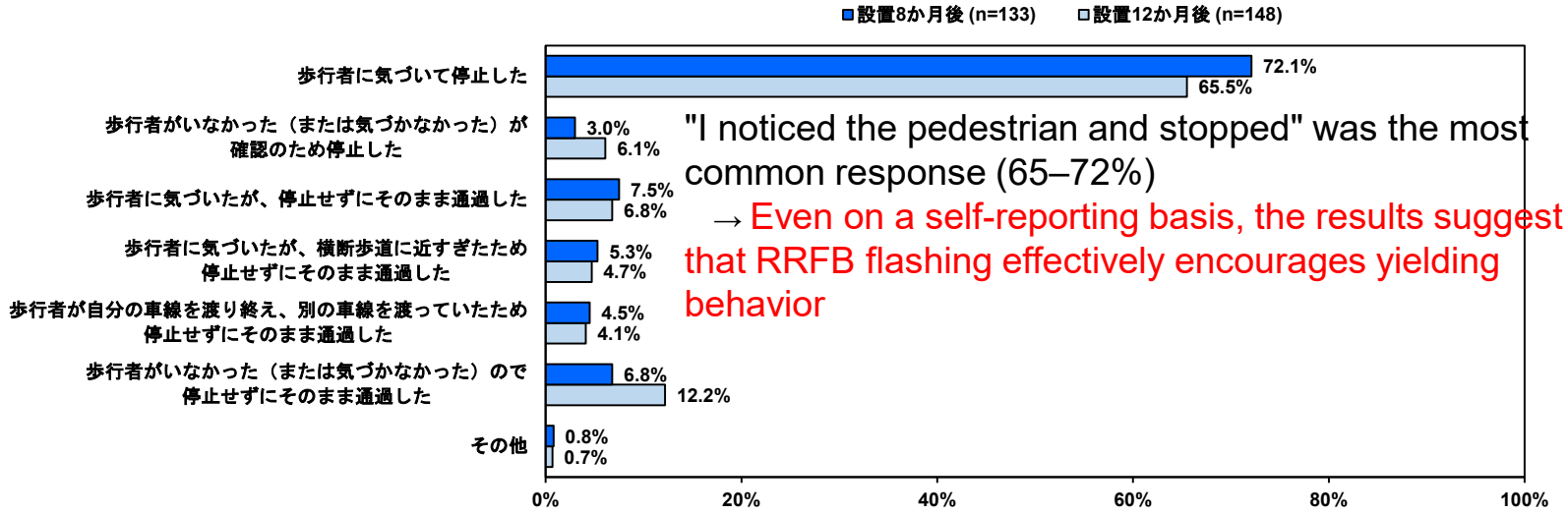


- 8-Month Post: 44.3% (n=133)
- 12-Month Post: 49.3% (n=148)

→ Approximately half of the respondents had experienced driving through the site during a flashing event

Driver Survey: Driving Behavior and Perception of Flashing

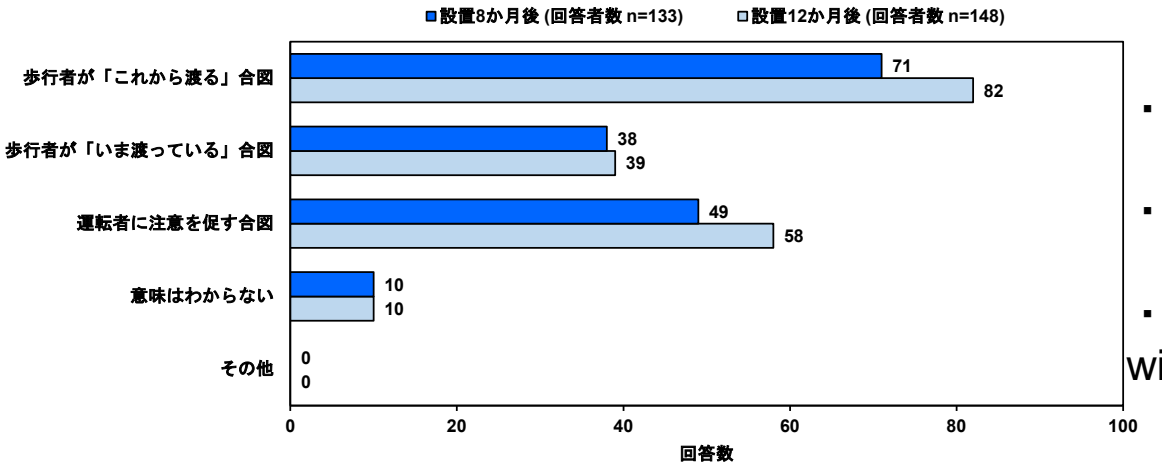
Driving Behavior during Flashing Events: "What action did you take when the lights were flashing?“ (Select one) (n=133・n=148)



"I noticed the pedestrian and stopped" was the most common response (65–72%)

→ Even on a self-reporting basis, the results suggest that RRFB flashing effectively encourages yielding behavior

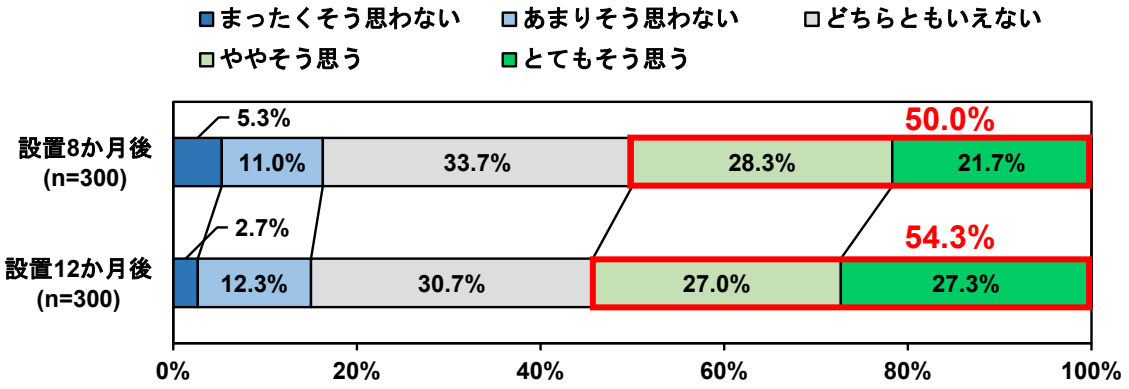
Perceived Meaning of the Flashing Light: "What do you believe the flashing amber light signifies? (Multiple responses allowed)"



- Most Frequent: A signal that a pedestrian is about to cross (8-month: 71; 12-month: 82)
- Second Most Frequent: A signal to alert drivers to be cautious (8-month: 49; 12-month: 58)
- Others: Very few respondents answered "I don't know the meaning," with figures remaining consistent across both periods

Driver Survey: Awareness and Public Acceptance

Yielding Awareness During Non-Flashing States: "When approaching the crosswalk, even if the lights are not flashing, do you feel you are more inclined to stop for pedestrians than before?" (n=300)



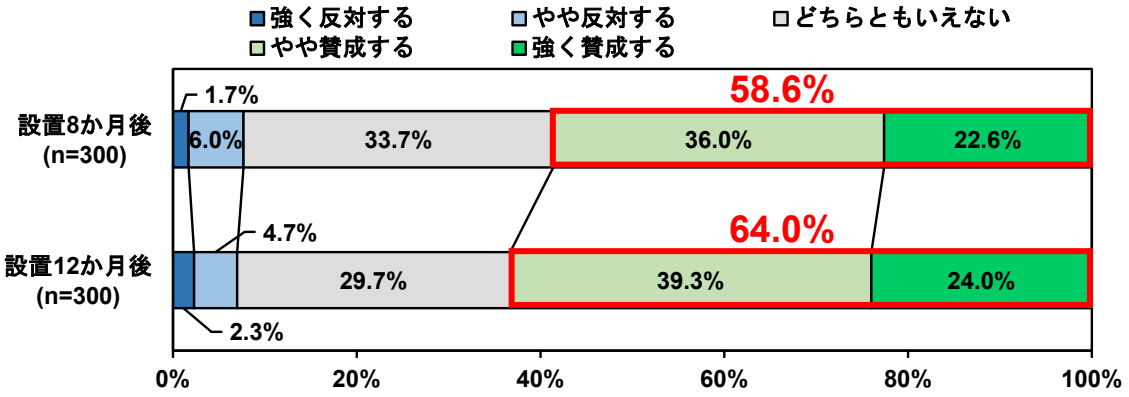
Positive Response (Somewhat + Strongly Agree)

50.0% → 54.3%

→ Approximately half of the respondents reported an increase in yielding behavior

→ Slight upward trend observed at the 12-month mark

Public Acceptance: "To what extent do you support the installation and operation of amber flashing lights as a safety measure for unsignalized crosswalks?" (n=300)



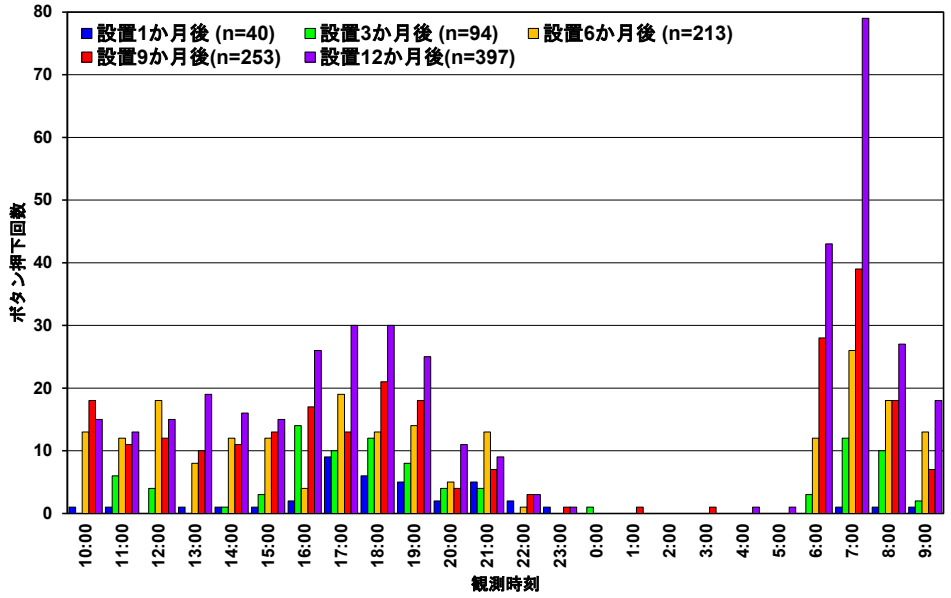
Positive Response (Somewhat + Strongly Agree)

58.6% → 64.0%

→ Approval rose by 5.4 percentage points

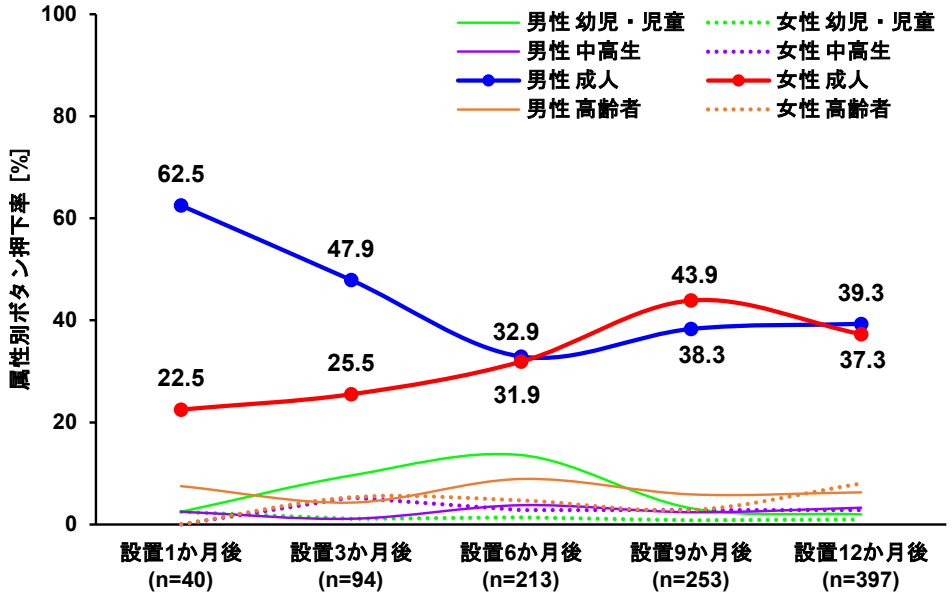
→ Steady and growing support for the system

Pedestrian Usage Patterns (Time of Day & Demographics)



Trends by Time of Day

- Button activations are concentrated during peak hours: 6:00–8:00 AM and 4:00–7:00 PM
- Usage during morning hours increased over the study period
- Nighttime usage remained limited



Demographic Trend

- Adults (Commuters): The primary user group
- Initially dominated by male adults
- Proportion of female adult users increased over time
- Younger Demographic: Consistently low usage rates
- Partially attributed to the overall low volume of young pedestrians at this site

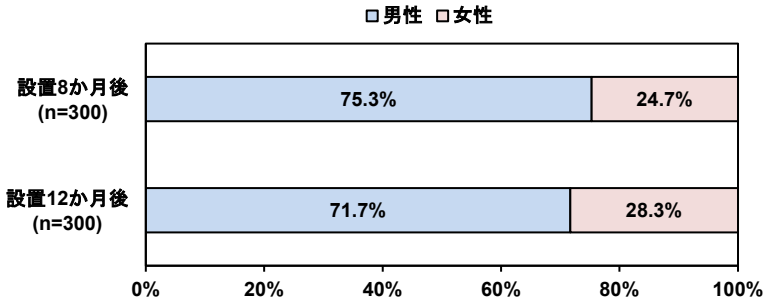
Pedestrian Survey: Respondent Profile, Traffic Frequency, and Usage Experience

【 Methodology and Timeline 】

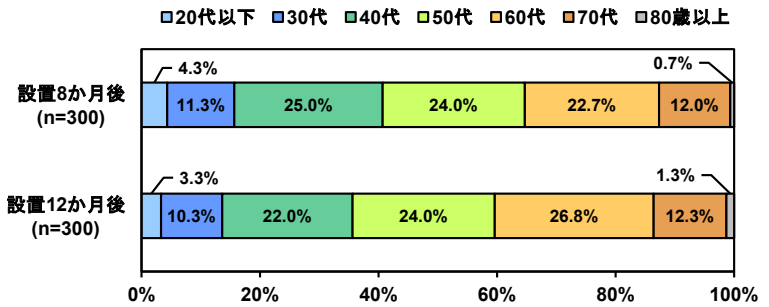
- 10-question web-based survey (via Rakuten Insight)
- First Survey: 8 months post-installation
  Sept 18 – Sept 22, 2025
- Second Survey: 12 months post-installation
  Jan 26 – Feb 2, 2026

【 Screening Criteria 】

- Residents of Funabashi City or Narashino City
- Have crossed the experimental site within the past year
- Must be aware of the RRFB
- Sample Size: 300 respondents

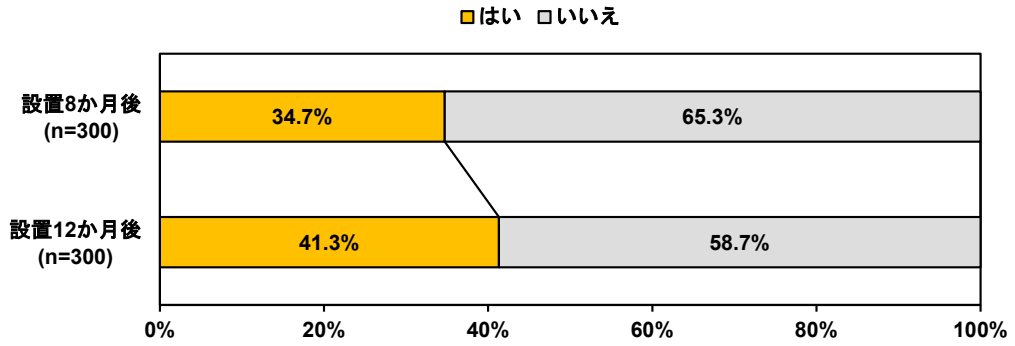


回答者の性別構成



回答者の年代構成

Usage Experience: Have you ever pushed the button to activate the flashing yellow lights when crossing the street?



RRFB Usage Experience

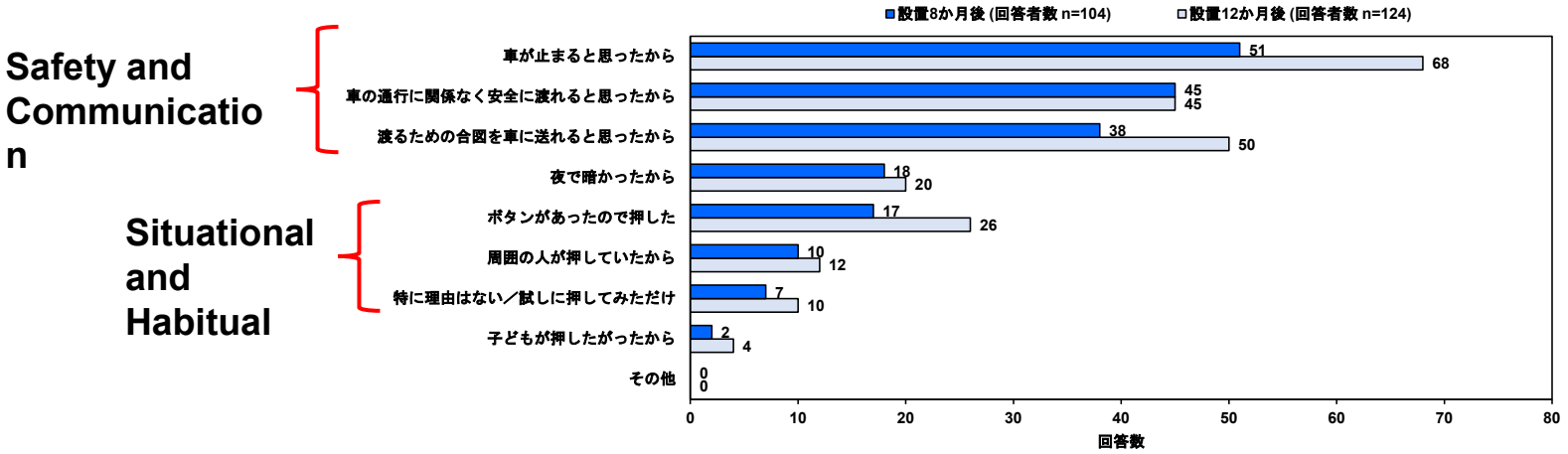
- 8 Months Post-Installation: 34.7% (n=104)

12 Months Post-Installation: 41.3% (n=124)

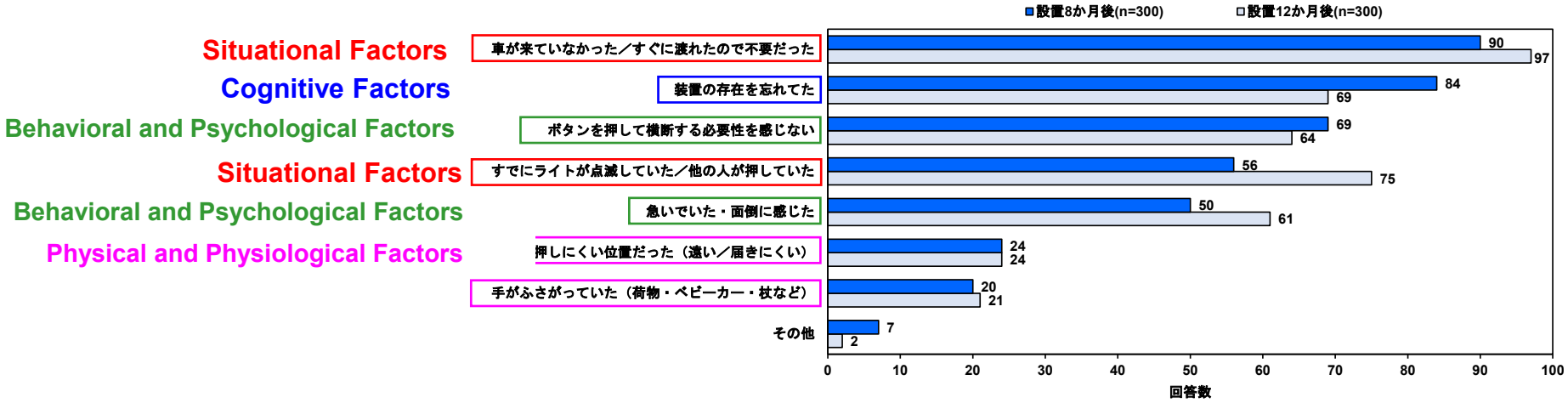
→ Approximately 30–40% of respondents have prior experience using the RRFB

Pedestrian Survey: Reasons for Use and Non-Use of RRFB

Reasons for Use: "Select all reasons why you chose to use the flashing beacon device." (n=104 / n=124; Multiple responses allowed)

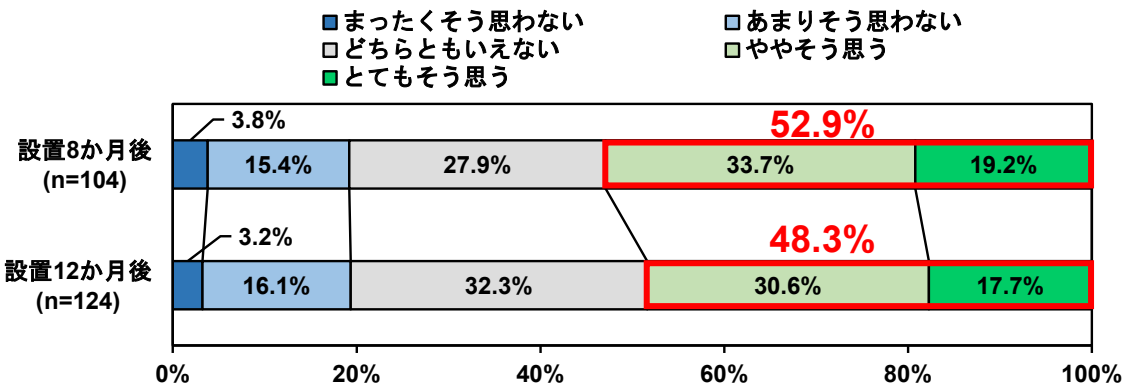


Reasons for Non-Use: "Select all reasons why you may have chosen NOT to press the button when crossing." (n=300; Multiple responses allowed)



Pedestrian Survey: Perceived Effectiveness and Public Acceptance

Perceived Effectiveness of RRFB: "When you pressed the button and the lights were flashing, did you feel that vehicles were more likely to stop for you?" (n=104 / 124)



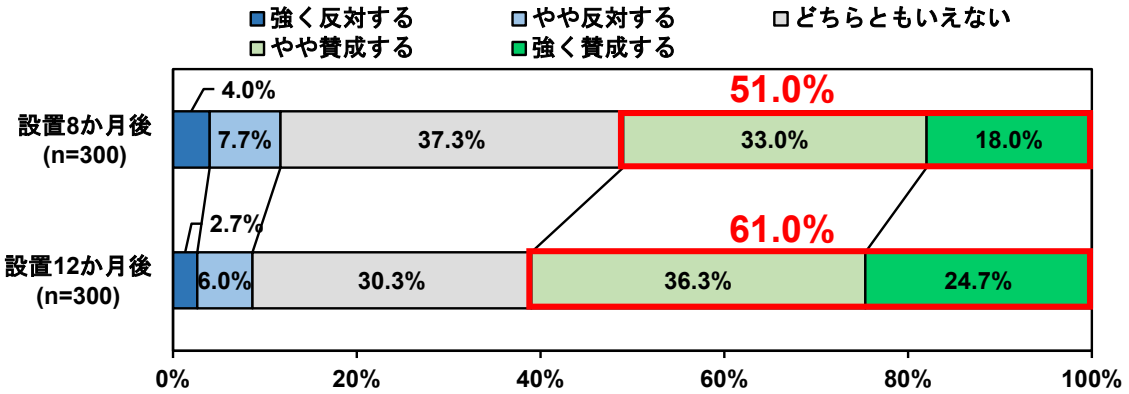
Positive Response (Somewhat + Strongly Agree)

52.9% → 48.3%

→ A slight decrease in positive perception was observed

→ This suggests that as users became more experienced with the system, their evaluations may have become more cautious and realistic

Public Acceptance: "To what extent do you support the installation and operation of amber flashing lights as a safety measure for unsignalized crosswalks?" (n=300)



Positive Response (Somewhat + Strongly Agree)

51.0% → 61.0%

→ Approval among pedestrians rose by 10 percentage points, showing a more significant shift in attitude compared to drivers

Summary of the RRFB Social Experiment at Unsignalized Crosswalks

① Effectiveness and Sustainability of Flashing Beacons

Vehicle yielding rates during flashing periods improved significantly ($p < 0.001$).

→ The RRFB is highly effective when positioned as an "activation-based device" (as seen in North America) to prompt immediate driver response

② Impact on Yielding Behavior During Non-Flashing States

The yielding rate during non-flashing states at the intervention site rose from 43.4% to 61.4%, outperforming the natural trend at the control site.

→ This suggests that the mere presence of the RRFB installation may contribute to a baseline improvement in yielding behavior.

③ Pedestrian Usage and Evaluation

Push-button Activations: Increased approximately 10-fold.

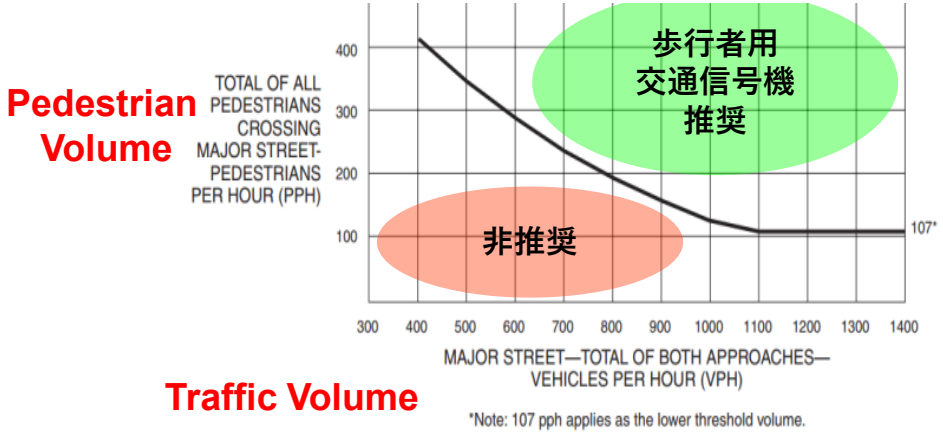
→ Public Support: Approval rose from 51.0% to 61.0% (+10 pts)

〈Conclusion〉

Unlike traffic signals that rely on legal regulations, RRFBs encourage behavioral changes in drivers by visualizing the pedestrian's intent to cross. Continuous monitoring and further verification will be essential to evaluate their long-term effectiveness

Institutional Challenges for Social Implementation (Part 1)

USA
FHWA STEP Guide (Safe System Approach for Intersections and Crossings)



FHWA STEP Guide: Selection Guidelines for Crosswalk Improvements (Including measures other than traffic signals)

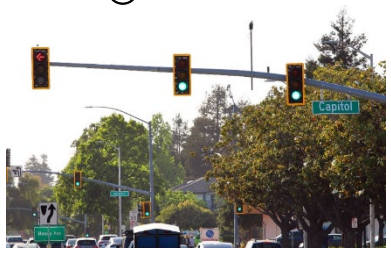
Number of lanes and presence of pedestrian refuge islands

Annual Average Daily Traffic

Regulation

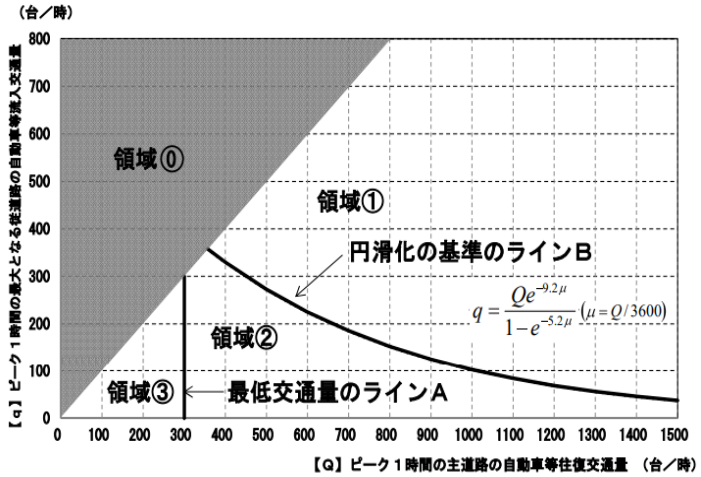
Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	❶ 2 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6	❶ 5 6 7 9	① 5 6 ❼ ❾	❶ 4 5 6 7 9	① 5 6 7 9	① 5 6 ❾
3 lanes with raised median (1 lane in each direction)	❶ 2 3 4 5	❶ ❸ 5 7 9	① ❸ 5 ❼ ❾	① 3 4 5 7 9	① ❸ 5 ❼ ❾	① ❸ 5 ❼ ❾	① ❸ 4 5 7 9	① ❸ 5 ❼ ❾	① ❸ 5 ❾
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	❶ 2 3 4 5 6 7 9	❶ ❸ 5 6 7 9	① ❸ 5 6 ❾	① 3 4 5 6 7 9	① ❸ 5 6 ❼ ❾	① ❸ 5 6 ❾	① ❸ 4 5 6 7 9	① ❸ 5 6 ❾	① ❸ 5 6 ❾
4+ lanes with raised median (2 or more lanes in each direction)	❶ ❸ 5 7 8 9	❶ ❸ 5 7 8 9	① ❸ 5 8 ❾	① ❸ 5 7 8 9	① ❸ 5 ❼ 8 ❾	① ❸ 5 8 ❾	① ❸ 5 ❼ 8 ❾	① ❸ 5 8 ❾	① ❸ 5 8 ❾
4+ lanes w/o raised median (2 or more lanes in each direction)	❶ ❸ 5 6 7 8 9	① ❸ 5 6 7 8 9	① ❸ 5 6 8 ❾	① ❸ 5 6 7 8 9	① ❸ 5 6 ❼ 8 ❾	① ❸ 5 6 8 ❾	① ❸ 5 6 ❼ 8 ❾	① ❸ 5 6 8 ❾	① ❸ 5 6 8 ❾

⑦＝RRFB



⑨＝交通信号機

Japan
National Police Agency Guidelines (Criteria for Installation and Removal of Traffic Signals)



・Standards for determining traffic signal installation are based on vehicle traffic volumes on major and minor streets※

・While guidelines for non-statutory road markings exist, a systematic framework for the step-by-step selection of pedestrian crossing countermeasures is not clearly defined ※ Other requirements, such as minimum spacing between signals, also apply

〈Challenges It is necessary to clarify the regulatory status and positioning of pedestrian crossing countermeasures other than traffic signals

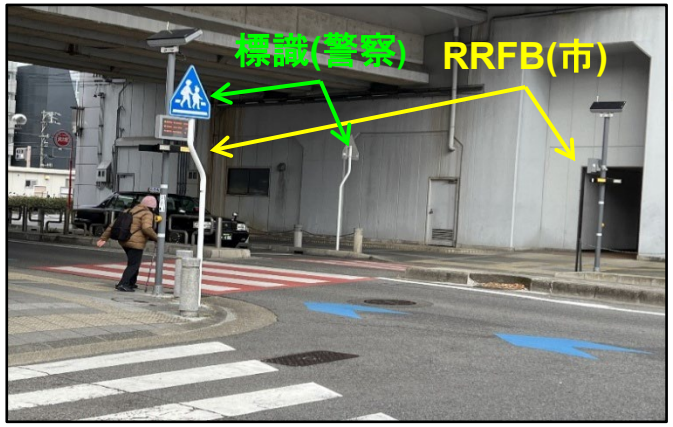
Numbers in the cells indicate the type of candidate countermeasures; ● indicates "Strongly Recommended," and ○ indicates "Possible for Consideration."

Institutional Challenges for the Social Implementation of RRFB (Part 2)

Administrative & Regulatory Framework

・Unlike traffic signals, RRFBs do not directly impose a legal obligation to stop
→ Their official positioning within the current Japanese regulatory framework remains undefined

・It is necessary to clarify the division of roles and strengthen cooperation between Road Authorities (National/Municipal) and Traffic Managers (Police)



RRFB-equipped crosswalk in Toyota City, Aichi Prefecture

Technical & Operational Standards

Although similar devices have been introduced in some municipalities, specifications and operational methods are not yet standardized

Activation: Push-button vs. Sensor-based

RRFB push-button (Vancouver)


Sensor-based warning sign (Tokyo)

Warning Method: Flashing Beacons vs. LED Message Displays


RRFB beacon (Funabashi)


LED display board (Tokyo)

Cost

While recognized as a low-cost solution in North America, domestic cost-benefit data remains limited due to the small number of installations in Japan

〈Recommendation〉 To evaluate the feasibility of RRFB implementation, it is essential to systematically address institutional, technical, and financial challenges in addition to verifying its effectiveness

公益財団法人 国際交通安全学会

International Association of Traffic and Safety Sciences