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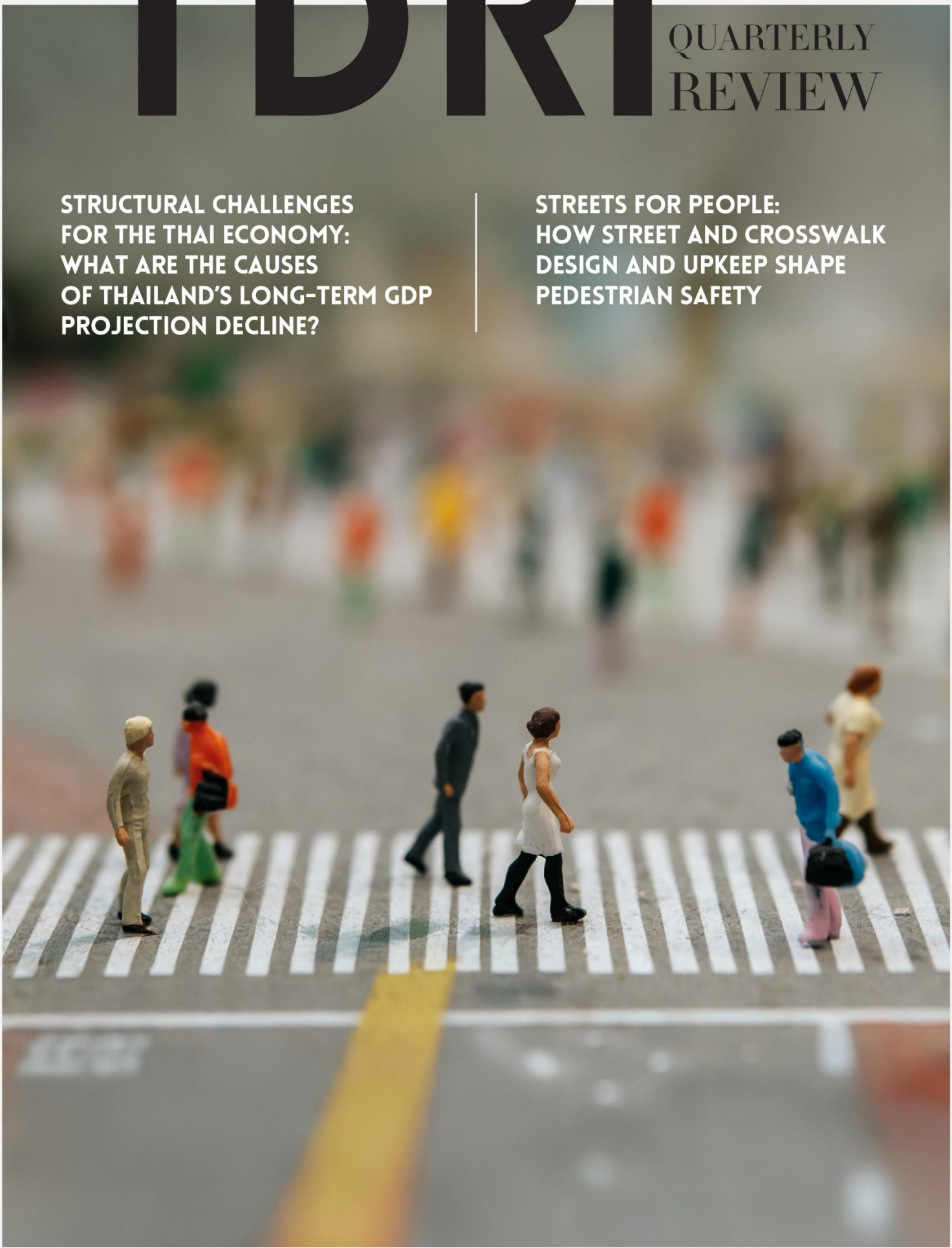
STREETS FOR PEOPLE: HOW STREET AND CROSSWALK DESIGN AND UPKEEP SHAPE PEDESTRIAN SAFETY



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STRUCTURAL CHALLENGES FOR THE THAI ECONOMY: WHAT ARE THE CAUSES OF THAILAND'S LONG-TERM GDP PROJECTION DECLINE?

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ABSTRACT

Thailand's post–COVID-19 economic recovery has been characterized by persistently weak growth, averaging only 2.3 percent during 2022–2024—well below its pre-pandemic performance and far from its historical peaks. This paper argues that the slowdown reflects not a temporary cyclical shock, but a deepening structural deterioration in Thailand's long-term growth potential. As the second installment in a three-part analytical series, the study focuses on diagnosing the key structural constraints that have contributed to Thailand's sustained deceleration in growth relative to regional peers.

Using a combination of quantitative indicators and qualitative policy analysis, the paper examines ten core structural factors shaping Thailand's growth dynamics: labor, capital, total factor productivity, fiscal sustainability, household debt, the goods-exporting sector, foreign direct investment, tourism, the services-importing sector, and external threats. The analysis reveals that weaknesses are broad-based and mutually reinforcing. Demographic aging, early labor-force exit, and declining education quality are constraining labor supply and productivity. Sluggish investment and slowing total factor productivity signal weakening growth fundamentals. At the same time, high household debt, limited fiscal space, declining export competitiveness, changing patterns of foreign direct investment, a stagnating tourism model, and a widening deficit in services trade further undermine economic momentum. These challenges are compounded by rising exposure to global trade fragmentation and climate-related risks.

Taken together, the findings suggest that Thailand's growth engine is impaired across multiple components rather than hindered by a single binding constraint. Each structural area requires targeted policy interventions to stabilize and, collectively, revive Thailand's long-term growth trajectory.

Keywords: GDP projection, Thai economy, structural challenges, policy intervention

1. INTRODUCTION

In the aftermath of the COVID-19 pandemic, Thailand's economic growth during the period 2022–2024 averaged only around 2.3 percent, representing a marked slowdown compared with the pre-COVID period (2010–2019), when average growth stood at approximately 3.2 percent. This deceleration should not be interpreted as a temporary cyclical weakness. Rather, it reflects a deeper and more persistent deterioration in Thailand's long-term growth prospects. Historically, Thailand's GDP growth peaked at an average of 7.3 percent during 1993–1996, before declining to around 5.3 percent during 1999–2007, and subsequently falling further in the pre-COVID decade. Looking ahead, long-term projections suggest that Thailand's growth rate will continue to decline steadily, period by period, at least until 2080 (Bisonyabut & Tantisan, 2025).

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The downward revision of Thailand's GDP growth trajectory is therefore not unexpected when viewed against the backdrop of the country's accumulated structural challenges and the limited success of past efforts to address them. What is striking, however, is not merely the presence of these challenges, but their breadth and persistence. Multiple structural weaknesses continue to weigh on economic performance, collectively signaling a broad erosion of competitiveness. Thailand's growth engine increasingly resembles an economic system suffering from failures across multiple components, rather than a single malfunctioning part.

This paper constitutes the second installment in a three-part series examining Thailand's prolonged economic slowdown through three complementary analytical lenses. The first paper, published earlier, traced Thailand's growth trajectory from its historical peak to the present, demonstrating that the observed slowdown is fundamentally structural and long-term in nature, with potentially severe consequences if left unaddressed. Building on that foundation, this paper focuses on identifying the key structural challenges that have contributed to Thailand's persistently weak growth relative to its regional peers. The third paper, forthcoming, will examine institutional constraints that have hindered effective reform, helping to explain why well-known policy proposals have repeatedly failed to translate into meaningful and sustained progress.

2. UNTANGLING STRUCTURAL CHALLENGES

To identify the underlying causes of Thailand's long-term GDP projection decline, this paper examines a set of core macroeconomic structural factors that together form the backbone of the Thai economy. These include:

1. labor,
2. capital,
3. total factor productivity,
4. fiscal sustainability,
5. household debt,
6. goods exporting sector,
7. foreign direct investment (FDI) sector,
8. tourism sector,
9. import services sector, and
10. external threats.

These structural components encompass both the supply side and the demand side of the economy and represent the primary channels through which economic growth is generated in Thailand. Weaknesses in any one of these areas can constrain growth; however, when multiple factors deteriorate simultaneously, their combined effects can substantially depress long-term GDP performance.

For each structural factor, this study employs quantitative and/or qualitative analyses to evaluate the extent to which it has supported or constrained Thailand's economic growth over time. Where appropriate, empirical evidence is complemented by institutional and policy analysis to capture mechanisms that may not be fully observable in aggregate data. Based on these assessments, policy recommendations are proposed for each factor with the aim of mitigating structural constraints and improving Thailand's long-term growth potential.

3. FINDINGS

This section presents a detailed analysis of each structural factor, along with corresponding policy recommendations aimed at addressing identified weaknesses and enhancing Thailand's long-term economic performance.

3.1 Labor

Labor employed in the agricultural, manufacturing, or service sectors directly contributes to GDP by producing goods and services that add value to the economy. A key challenge for this growth factor is demographic aging: as the population ages, the labor force both shrinks and becomes older, thereby limiting its contribution to GDP growth. Thailand currently faces several challenges related to this factor.

High-income economies typically counter labor-force shrinkage by extending the retirement age. As shown in Figure 1, most high-income economies have an official retirement age of around 65, while developing economies tend to maintain an official retirement age closer to 60.

In Thailand, there is no formal retirement age for most workers, except for civil servants, whose mandatory retirement age is 60. However, in practice, many workers retire earlier—often around age 55—

which coincides with the age at which individuals become eligible to leave their jobs and receive pension benefits. More concerningly, labor-force statistics (Figure 2) indicate that a significant number of workers exit the labor market as early as their early 50s (TDRI, 2025a).

In addition, Thailand loses part of its labor force through channels that are largely avoidable. Three notable examples include:

1. Mandatory military conscription among young workers (Prachathai, 2019);
2. loss of life due to road accidents (approximately 16,000–20,000 fatalities per year, TDRI, 2025b); and
3. premature deaths related to climate-related incidents, including natural disasters (Kosako, 2025) and prolonged exposure to PM2.5 pollution (Hermayurisca & Taneepanichskul, 2023).

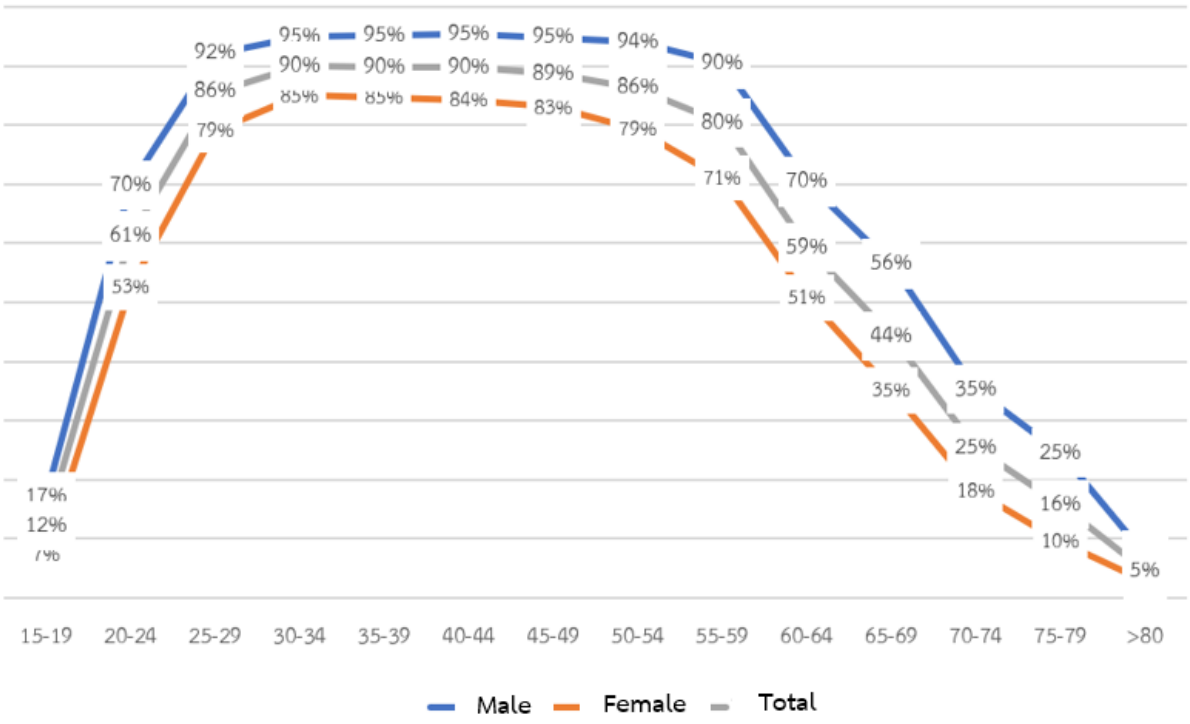
Qualitative aspects further exacerbate the problem. Recent PISA test results (PISA, 2022) show that Thailand's scores are below the OECD average and below those of peer economies such as China, Malaysia, and Vietnam. More importantly, the trend in Thailand's educational performance has been declining over time.

In summary, population aging and labor-force shrinkage constitute major constraints on GDP growth. These challenges are compounded by both quantitative losses of labor and declining labor quality. Government policy should therefore focus on extending working lives by raising the effective retirement age and keeping workers in the labor market for as long as possible. At the same time, it should address labor leakage through mechanisms such as military conscription and preventable premature deaths, while placing greater emphasis on improving labor quality.

Figure 1
Retirement Age by Country

Note. From TDRI (2025a).

Figure 2
Labor Force Participation of Thailand



Note. From TDRI (2025a).

3.2 Capital

Capital refers to machinery and equipment used in the production of goods and services. In Thailand, capital investment indicators have remained sluggish following the COVID-19 pandemic. According to the Bank of Thailand's database, Business loan growth declined from an average of 4.3% during 2015–2019 (pre-COVID) to just 2.3% between 2021–2024. Similarly, according to NESDC's database, investment as a share of GDP has grown more slowly, falling from an average growth rate of 2.9% to 1.7% over the same period. Notably, a strong investment cycle is typically characterized by growth rates of around 3.5%–7% per year.

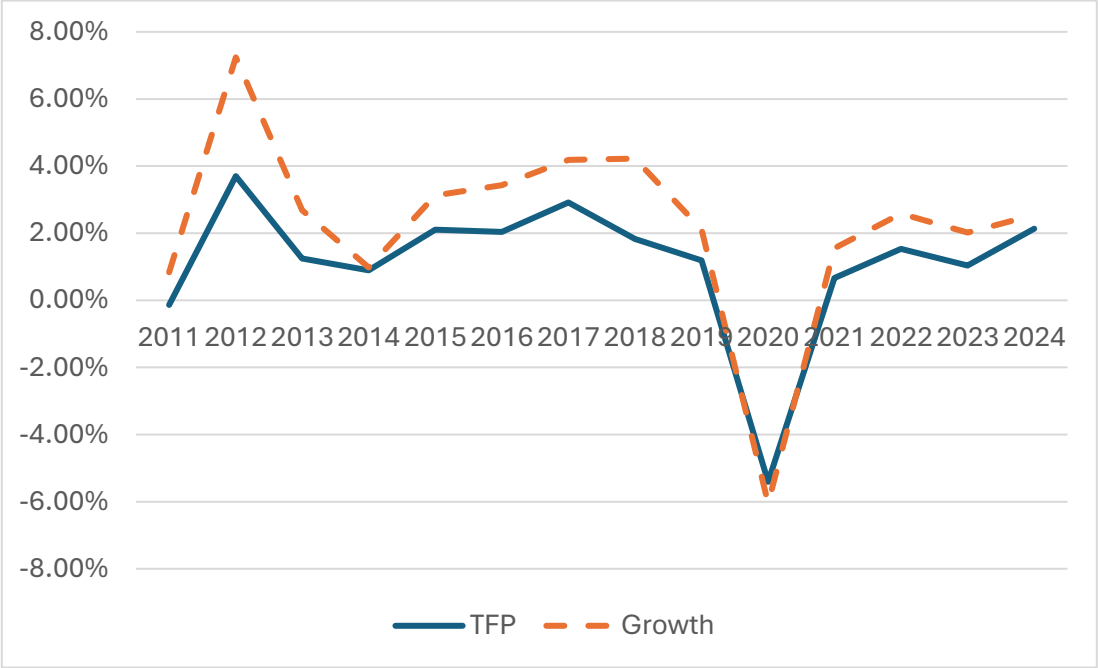
However, the decline in investment indicators should not be viewed as a standalone problem to be addressed directly. Rather, it reflects deeper structural weaknesses, particularly in foreign direct investment (FDI) and export performance, which will be discussed in subsequent sections.

3.3 Total Factor Productivity

Total factor productivity (TFP) measures how efficiently an economy transforms labor and capital into output, capturing gains from technology, innovation, skills, and organizational improvements beyond the mere accumulation of labor and capital. Based on NESDC analysis, TFP accounted for approximately 50% of Thailand's GDP growth during 2011–2024. However, a clear slowdown in TFP growth has been observed in the post-COVID period. During 2015–2019, TFP growth averaged around 2.0% per year, but following the COVID-19 shock, it declined to just 1.34% per year, signaling increasing constraints on Thailand's future growth potential (NESDC, 2025).

This trend underscores the urgent need to strengthen Thailand's technology and innovation system, including policies that support technological upgrading, technology transfer, and the effective adoption of new technologies across firms and sectors.

Figure 3
Thailand's TFP Growth



Note. From NESDC (2025).

3.4 Fiscal Sustainability

Thailand's post–COVID-19 GDP growth slowdown is very pronounced, but less widely recognized is the fact that fiscal policy has already been stretched in supporting the economy. The public debt-to-GDP ratio rose from an average of 41.8% during 2015–2019 to 61.1% in the post-COVID period (2021–2024), and the current medium-term fiscal framework (Cabinet, 2025) projects the ratio to approach its statutory ceiling of 70%. The IMF and international credit rating agencies have warned that Thailand faces an increased risk of a sovereign credit downgrade, which would raise borrowing costs for both the public and private sectors. This situation is not surprising, as the government has operated under persistent fiscal deficits for more than two decades, with the deficit widening from an average of −2.6% of GDP per year during 2015–2019 to −4.1% per year in the post-COVID period (2021–2024).

Looking ahead, the country faces heightened political risks arising from competition between populist policy agendas and expanding welfare-state commitments, which could further undermine fiscal discipline. Comprehensive fiscal reform is therefore essential to safeguard Thailand's long-term macroeconomic stability.

3.5 Household Debt

Thailand is one of the countries with very high household debt. Notably, many countries with high household debt are high-income economies (Ishak, 2026), such as Switzerland (125% of GDP), Australia (112% of GDP), Canada (100% of GDP), and the Netherlands (94% of GDP). In contrast, Thailand's household-debt-to-GDP ratio is unusually high for a developing economy, standing at around 84% of GDP before COVID-19 and rising to around 90% after COVID-19. Among developing peers, Malaysia is the closest comparator, with household debt of around 70% of GDP, which is still significantly lower than Thailand's level.

High household debt constrains economic growth through the consumption channel. Highly indebted households must allocate a large share of their income to debt repayment before consumption, reducing aggregate demand. In addition, high debt burdens can prevent households from expanding economic activities or investing to increase future income, trapping some households in persistent vulnerability or poverty.

Household debt can be reduced gradually over time through economic growth (base-effect reduction) and debt-restructuring or relief programs,

typically offered by lenders, the Bank of Thailand, and the government. However, such adjustment processes often take a long time. Even so, targeted debt-support programs can generate positive macroeconomic effects, as they help revive consumption and create multiplier effects throughout the economy.

3.6 Goods-Exporting Sector

Before this point, the factors discussed are primarily internal factors that serve as the backbone of the economy. The remaining factors are external factors that inject income into the system, among which the goods-exporting sector plays a central role. Based on Trademap database, during 2015–2019, Thailand accounted for roughly 1.3% of global exports. After COVID-19, this share declined slightly to 1.2% during 2021–2024.

Looking ahead, however, the global trade environment has changed markedly. The United States has introduced reciprocal tariff measures that apply to a broad range of imported goods, under which Thailand faces a tariff rate of 19% (USTR, 2025). Although this rate is broadly comparable to those imposed on competing exporting countries, the tariffs nonetheless impose significant cost pressures that cannot be easily passed on to U.S. consumers.

Moreover, the emerging trade regime is increasingly shaped by strategic competition between the United States and China, placing Thailand in a vulnerable intermediary position. According to Trademap database, Thailand's combined export share to the U.S. and China increased from 23.2% during 2015–2019 to 29.3% during 2021–2024, while imports from these two countries rose from 27.3% to 30.8% over the same period. This rising dependence heightens Thailand's exposure to economic shocks arising from bilateral trade conflicts.

A clear example of this vulnerability is Thailand's role as a transshipment hub for Chinese products. In 2025, the United States imposed final tariff rates on solar panels and components originating from Thailand, ranging from approximately 375% to 972%, significantly increasing the cost of Thai exports to the U.S. market.

A new export enhancing strategy is therefore needed to protect the country under this new global trade order and to guide the goods-exporting sector forward.

3.7 Foreign Direct Investment

Foreign direct investment (FDI) has long served as a foreign-driven engine of investment and growth for Thailand. Notably, Japanese investment in major industries—including automotive, electrical appliances, and electronics—has not only generated large-scale employment (including jobs in related and upstream industries) but has also supported the development of local supply chains and contributed significantly to the broader local economy.

In the post–COVID-19 period, however, the composition of FDI has begun to shift (Suleesathira, 2025). Thailand has transitioned from an investment landscape dominated by Japanese firms toward one increasingly shaped by Chinese conglomerates and data center investments. These new forms of investment differ substantially from earlier FDI patterns. First, Chinese firms tend to rely more heavily on their own workers and supply chains, limiting spillovers to local labor and suppliers. Second, data center investments fewer opportunities for local supply chain development.

As a result, although headline FDI inflows have continued to rise and recently reached new record levels, it is unclear whether Thailand's economy will benefit to a similar extent as in the past. In practice, the primary beneficiaries may instead be industrial estate developers and utility providers servicing these investments. Moreover, growing competition for limited resources—particularly utilities—has emerged as an additional concern, as new FDI projects may crowd out more labor-intensive and supply-chain-rich forms of investment that have traditionally generated broader economic benefits.

A balanced approach is therefore required—one that carefully weighs the gains from both traditional and new forms of FDI, while ensuring that Thai workers and local supply chains remain integral parts of the investment equation.

3.8 Tourism Sector

The tourism sector is a major contributor to Thailand's GDP. At its peak in 2019, Thailand welcomed nearly 40 million international visitors, with tourism contributing around 10% of GDP (World Travel and Tourism Council, 2024).

However, even in 2025, the number of international visitors has not yet returned to its 2019 level. Estimated arrivals remain at around 33–34 million visitors. Two developments are particularly concerning.

First, Thailand continues to rely heavily on traditional tourism assets, including mountains, beaches, sunshine, and cultural heritage sites. These strengths have long positioned Thailand as one of the world's most visited destinations. Nevertheless, after decades of offering largely similar experiences, many destinations now face overcrowding, rising prices, environmental degradation, tourist scams, and "tourist traps." Policy choices have also contributed to these challenges, including the legalization of cannabis, which has affected Thailand's tourism image in some markets.

Second, regional competitors have not remained static. Countries such as China, Japan, and Vietnam have actively upgraded and promoted their tourism sectors by introducing new attractions and differentiated experiences. Compounding these pressures, the strength of the Thai baht has placed Thailand at a cost disadvantage, making travel expenses approximately 4–10% higher than those of peer destinations.

To revitalize the tourism sector, it is imperative to reinvigorate the visitor experience. Thailand must preserve the qualities that once defined its appeal—friendliness, hospitality, local character, and a sense of joy—while simultaneously developing new sources of excitement, including well-designed man-made destinations, to compete more effectively with regional peers.

3.9 Services-Importing Sector

The services-importing sector functions as a leakage from the economy, capturing expenditures by local residents on services provided outside the Thai economy. It includes travel services, business services (trade-related, professional, and management consulting), transport, financial services, government goods and services, telecommunications, computer and information services, the use of intellectual property, construction services, and insurance and pension services.

In analyzing the external services sector, it is useful to compare services imports with services exports (Tables 1 and 2). During the periods 2015–2019 and 2021–2024, a sharp contrast emerged between these two sectors. While the services-exporting sector declined from an average of USD 70,297 million to USD 48,282 million, the services-importing sector increased from an average of USD 48,898 million to USD 64,847 million.

As a result, Thailand has shifted into a negative external services balance vis-à-vis the rest of the world. More disaggregated statistics show that Thailand's major service exports are concentrated in travel, business services (primarily trade-related), and transport, which together account for approximately 95 percent of total service exports. In contrast, service payments have been rising in transport, business services, intellectual property rights, insurance and pension services, financial services, telecommunications, computer and information services, and personal, cultural, and recreational services.

Looking ahead, the services-exporting sector remains heavily dependent on relatively stagnant activities, namely travel (linked to tourism), business services (linked to goods exports), and transport (linked to both tourism and goods exports)—all of which face limited growth prospects. Meanwhile, services-importing sectors are growing rapidly in popularity among Thai consumers and businesses, particularly in ride-hailing and food delivery, accommodation platforms, e-commerce marketplaces, mobile app stores, streaming and digital content services, and cloud and IT services. Without policy intervention, the negative balance in services trade is likely to widen further.

Table 1
Thailand's Services-importing sector (unit: Mil. USD)

Services-importing sector	2024	Share	2015–19	Share	2021–24	Share	Growth
All services	73,644	100.0%	48,898	100.0%	64,847	100.0%	5.3%
Transport	23,011	31.2%	17,076	34.9%	24,982	38.5%	7.2%
Other business services	21,118	28.7%	12,611	25.8%	18,012	27.8%	6.7%
Travel	15,704	21.3%	10,347	21.2%	9,426	14.5%	-1.7%
Charges for the use of intellectual property	6,498	8.8%	4,594	9.4%	5,911	9.1%	4.7%
Insurance and pension services	2,876	3.9%	1,884	3.9%	2,495	3.8%	5.2%
Financial services	2,103	2.9%	926	1.9%	1,799	2.8%	12.8%
Telecommunications, computer, and information services	1,217	1.7%	663	1.4%	1,114	1.7%	9.9%
Personal, cultural, and recreational services	547	0.7%	35	0.1%	474	0.7%	60.2%
Government goods and services	313	0.4%	296	0.6%	278	0.4%	-1.2%
Construction	255	0.3%	465	1.0%	356	0.5%	-4.7%

Note. From Trademap database.

Table 2
Thailand's Services-exporting sector (unit: Mil. USD)

Sectors-exporting sector	2024	Share	2015-19	Share	2021-24	Share	Growth
All services	72,142	100.0%	70,297	100.0%	48,282	100.0%	-6.6%
Travel	42,691	59.2%	50,917	72.4%	23,102	47.8%	-13.4%
Other business services	18,442	25.6%	10,466	14.9%	16,295	33.7%	8.4%
Transport	7,583	10.5%	6,646	9.5%	6,140	12.7%	-1.4%
Financial services	894	1.2%	712	1.0%	805	1.7%	2.2%
Government goods and services	787	1.1%	333	0.5%	519	1.1%	8.4%
Telecommunications, computer, and information services	512	0.7%	531	0.8%	425	0.9%	-4.0%
Charges for the use of intellectual property	384	0.5%	123	0.2%	313	0.6%	18.5%
Construction	345	0.5%	377	0.5%	241	0.5%	-7.8%
Personal, cultural, and recreational services	259	0.4%	88	0.1%	214	0.4%	17.4%
Insurance and pension services	245	0.3%	103	0.1%	229	0.5%	15.7%

Note. From Trademap database.

3.10 External Threats

Last but not least, looking ahead, several external threats could have a significant impact on the economy and overall GDP. One such threat is global warming. Climate-related disasters not only cause premature deaths but also generate substantial economic losses. In recent years, Thailand has experienced an increasing number of extreme events, many of which have set new records. For example, the severe flooding in Hat Yai was caused by an unprecedented rainstorm, the heaviest in more than 300 years (Pasutan, 2025). Similarly, the earthquake in 2025, which was clearly felt in Bangkok. It is a once in a lifetime for most Bangkok's residents.

Other catastrophic events, whether natural or man-made, cannot be ruled out in the future. Countries that are well prepared for such shocks are better positioned to preserve economic stability and protect their citizens from the unforeseen hardships these events may impose.

4. CONCLUSION

This article compiles empirical evidence and statistical data to diagnose Thailand's economic growth slowdown. The findings suggest that the deceleration is not driven by a single factor, but rather by simultaneous deterioration across ten structural dimensions, collectively producing a systemic weakness. This dynamic can be likened to the human body, which may withstand isolated health issues to some extent, but becomes critically ill when multiple conditions occur concurrently.

The article also outlines broad policy directions for addressing each structural challenge, emphasizing that problem recognition and appropriate strategic orientation are essential first steps toward effective reform. However, given space limitations, the article does not provide detailed policy prescriptions for each area. More comprehensive solutions are discussed in the referenced literature, alongside additional policy proposals that have long been debated within academic and policy circles.

REFERENCES

Bisonyabut, N., & Tantisan, W. (2025). Tracking Thailand's economic growth: Past, present and future. *TDRI Quarterly Review, 40*(3), 2–9.

Cabinet. (2025). *Revised Medium Term Fiscal Framework (MTFF).*

Hermayurisca, F., & Taneepanichskul, N. (2023). Estimation of premature death attributed to short- and long-term PM2.5 exposure in Thailand. *Environmental Monitoring and Assessment, 195*(10), 1176. https://doi.org/10.1007/s10661-023-11807-4

Ishak, I. (2026, January 30). *Ranked: The 35 countries with the highest household debt*. Visual Capitalist. https://www.visualcapitalist.com/cp/35-countries-with-highest-household-debt/

Kosako, J. (2025, December 23). *Voices from Hat Yai in the wake of the flood crisis* [เสียงจากหาดใหญ่หลังวิกฤตน้ำท่วม]. Business Voices, No. 2. https://www.bot.or.th/th/research-and-publications/research/business-voices/business-voices-2025-12.html

National Economic and Social Development Council. (2025). *Capital stock of Thailand, 2024 edition.*

Pasutan, P. (2025, November 24). *What does Hat Yai's "heaviest rainfall in 300 years" actually mean?* [ฝนตกหาดใหญ่ “หนักสุดในรอบ 300 ปี” หมายความว่าอย่างไร?] ThaiPBS. https://www.thaipbs.or.th/now/content/3403

PISA. (2022). *Press conference: results of the PISA 2022 Assessment* [การแถลงข่าวผลการประเมิน PISA 2022]. https://pisathailand.ipst.ac.th/news-21/

Prachatai. (2019). *TDRI recommends strategies to cope with an aging society: invest in human resources, reduce military service requirements, increase automation, and develop cities*. [TDRI แนะรับมือ ‘สังคมอายุยืน’ ลงทุนมนุษย์-ลดเกณฑ์ทหาร-เพิ่มระบบอัตโนมัติ-พัฒนาเมือง]. https://prachatai.com/journal/2019/05/82475

Suleesathira, P. (2025, September 16). *In-depth analysis: Why investment in the Eastern region fails to improve the lives of local people* [เจาะลึก: ทำไมเม็ดเงินลงทุนภาคตะวันออกไม่ทำให้คนในพื้นที่ดีขึ้น] Bangkokbiznews. https://www.bangkokbiznews.com/business/economic/1198863

Thailand Development Research Institute. (2025a). *Silver economy*.

Thailand Development Research Institute. (2025b). *Reimagining Thailand's development's model*. https://tdri.or.th/2025/09/tdri-annual-public-conference-2025/

United States Trade Representative. (2025). *Fact sheet: The United States and Thailand reach a framework for an agreement on reciprocal trade*. https://ustr.gov/about/policy-offices/press-office/fact-sheets/2025/october/fact-sheet-united-states-and-thailand-reach-framework-agreement-reciprocal-trade

World Travel and Tourism Council. (2004). *Travel & tourism economic impact research (EIR)*. https://wttc.org/research/economic-impact/

STREETS FOR PEOPLE: HOW STREET AND CROSSWALK DESIGN AND UPKEEP SHAPE PEDESTRIAN SAFETY*

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ABSTRACT

Thailand continues to record one of the world's highest road-traffic fatality rates, and pedestrians remain disproportionately exposed—often at crosswalks intended to protect them. This article examines how crosswalk design and upkeep shape pedestrian safety in Thailand through an integrated lens combining (i) the Safe-System approach and human vulnerability, (ii) international crosswalk typologies and warrant-based guidance (with examples from the United Kingdom, the United States, Australia, and New Zealand), and (iii) field evidence from observed crossings in Bangkok and Chiang Mai. Synthesizing these perspectives, the analysis finds that Thailand's crosswalks frequently underperform on three core safety functions emphasized across global standards: visibility (e.g., faded markings, inadequate lighting, obstructed sightlines), speed management (high approach speeds and limited traffic calming), and conflict reduction (multilane "multiple-threat" conditions, insufficient refuge provision, and poor stop-line placement). These infrastructure gaps are reinforced by fragmented governance, inconsistent universal-design implementation, weak maintenance regimes, and limited enforcement capacity. The article concludes that improving pedestrian safety requires not merely importing foreign models, but institutionalizing context-sensitive reforms: unified national guidance with clear crossing warrants, 30 km/h priority zones in pedestrian-dense areas, systematic accessibility upgrades, routine safety audits and maintenance budgets, and expanded automated enforcement and adaptive technologies.

Keywords: pedestrian safety, crosswalk design, speed management, safe system approach, Thailand

1. INTRODUCTION

Thailand continues to experience one of the highest road traffic fatality rates in the world. The *Global Status Report on Road Safety 2018* by the World Health Organization (WHO, 2018) recorded **32.7 deaths per 100,000 population**, equivalent to **22,491 lives lost annually**. Within this broader crisis, pedestrians face particular risks. Data from the Department of Disease Control's Integrated Road Traffic Injury Surveillance System show that between 2011 and 2021, pedestrian fatalities averaged **approximately 645 per year**, representing **2–4 percent of all road traffic deaths (**Department of Disease Control, 2022). A substantial share of these cases occurred directly at crosswalks, spaces that, in principle, are intended to safeguard pedestrians.

* This article is based on the Report on Project to formulate principles for implementation of safe pedestrian crossings to improve road safety.

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The scale of these losses underscores the vulnerability of pedestrians in Thailand's transport environment. Vehicle occupants benefit from advances in safety technologies, yet those outside vehicles remain largely unprotected. The risks intensify as speed and vehicle mass increase, both of which characterize Thailand's road network. In recent years, highly publicized pedestrian deaths at zebra crossings have further exposed systemic shortcomings in street design, maintenance, and enforcement, sparking national concern over pedestrian safety.

Crosswalks represent the most acute points of conflict between vehicles and foot traffic. In Thailand, however, many are compromised by faded markings, obstructed sightlines, insufficient lighting, or absent accessibility features. Such deficiencies not only heighten the likelihood of crashes but also reflect a broader neglect of those who walk, whether by necessity or choice. Improving the safety of pedestrian crossings is therefore both a technical requirement—to prevent avoidable deaths and serious injuries—and a moral imperative, signaling that pedestrian lives are valued.

In response, this article examines Thailand's pedestrian crossing safety through four complementary perspectives. Section 2 outlines the theoretical principles of pedestrian safety, focusing on the Safe-System approach and its implications for crosswalk design. Section 3 reviews international guidelines and crosswalk typologies, highlighting design warrants and safety criteria applied in countries such as the United Kingdom, the United States, Australia, and New Zealand. Section 4 assesses Thailand's current pedestrian landscape, including both gaps in design standards and field evidence from Bangkok and Chiang Mai. Finally, Section 5 aligns global lessons with Thai realities, identifying areas of convergence, divergence, and opportunities for reform. Together, these perspectives provide a comprehensive assessment of Thailand's crosswalk challenges and inform pathways for evidence-based, context-sensitive solutions.

2. UNDERSTANDING CROSSWALK SAFETY PRINCIPLES

Designing streets for people requires both a philosophical foundation and technical guidance. The Safe-System approach provides this foundation by recognizing that humans make mistakes and are vulnerable to crash forces. Physical design must then translate these principles into concrete measures that anticipate errors and minimize harm. Together, these concepts form a framework for analyzing and improving pedestrian crossings.

2.1 Safe-System Approach and Human Vulnerability

The Safe-System approach is grounded in two premises: humans are fallible, and the human body has limited tolerance to crash forces. Accordingly, road safety must be achieved not by expecting perfect behavior, but by designing systems that anticipate mistakes and prevent them from resulting in death or serious injury. Central to this framework is the principle of shared responsibility, which distributes accountability across all stakeholders—designers, operators, policymakers, and road users (United States Department of Transportation [USDOT], 2024).

The approach is underpinned by six guiding principles:

- Deaths and serious injuries are unacceptable.
- Humans make mistakes.
- Humans are vulnerable.
- Response is shared.
- Safety must be proactive.
- Redundancy is essential.

These principles are operationalized through five interdependent elements: safe road users, safe vehicles, safe speeds, safe roads, and effective post-crash care. Special attention is given to vulnerable users such as pedestrians and cyclists, who lack protective barriers and are at the highest risk. For them, measures such as speed reduction, physical separation, and rapid emergency response are especially critical.

2.2 Physical Factors and Infrastructure Design

Under the Safe-System framework, physical design must anticipate human limitations and minimize the likelihood that errors result in serious harm. A conceptual model links three key components—road characteristics, design parameters, and crossing devices—to guide the design of safe pedestrian crossings:

- **Road characteristics** such as functional class, number of lanes, and traffic volume determine the operating environment and influence the type of crossing needed.
- **Design parameters** include sight distance, speed selection, and conflict points; these parameters translate the Safe-System principles of visibility, survivable speeds, and conflict reduction into measurable design criteria.
- **Crossing devices** such as refuge islands, stop lines, and signage provide the physical tools to implement these parameters.

These elements interact with human behavior to produce either safe or unsafe outcomes. Crosswalks should be tailored to the road's operational context and the vulnerability of users. A single "one-size-fits-all" design is insufficient.

Sight distance

A key technical requirement is ensuring that drivers and pedestrians have adequate Approach Sight Distance (ASD) and Crossing Sight Distance (CSD). ASD is the length of roadway a driver needs to perceive a crossing, decide to slow or stop, and complete the maneuver safely. If ASD is too short, drivers may not see pedestrians until they are too close to stop, leading to "screening" crashes when sightlines are blocked by parked vehicles or roadside objects. CSD is the distance a pedestrian must be able to see approaching vehicles to judge a safe gap. Sight distances should be determined by speed and reaction time (Austroads, 2010). For example, at 30 km/h with a 2.5 s reaction time, the minimum ASD is approximately 8 m; at 60 km/h, it increases to about 28 m; and at 80 km/h, it reaches 58 m (Queensland Department of Transport and Main Roads, n.d.). Designers must ensure that vegetation, parked vehicles, street furniture, and advertising boards are kept outside these sight-distance envelopes for both drivers and pedestrians. In complex environments, such as multi-lane roads or near intersections, additional measures like relocating parking, trimming vegetation, or adding curb extensions may be necessary to preserve sightlines.

Speed selection

Speed selection is not solely about vehicles; it must reflect how fast pedestrians can walk and how long they need to clear a crossing. Two relationships are critical. First, **the risk of fatal injury to a pedestrian struck by a car rises steeply with speed.** At 30 km/h, drivers can stop in roughly 8–12 m, and a collision is likely survivable. At 60 km/h, the stopping distance more than doubles, and the impact force increases fourfold, making severe injury almost certain. For example, an older adult walking at 1.1 m/s takes about 10 s to cross an 11-m-wide road. During that time, a car travelling at 60 km/h covers 167 m—far beyond the typical ASD—and leaves little opportunity to avoid a collision. By contrast, if speeds are limited to 30 km/h, the vehicle covers only about 83 m in those 10 s, giving the driver more time to see and stop for the pedestrian (International Transport Forum, 2012).

Second, **pedestrian signal timing is usually calculated by dividing crossing width by an assumed walking speed.** International guidelines often use 0.9–1.2 m/s for signal timing, with 0.9 m/s catering to older adults and people with disabilities. When crossing widths exceed 10 m, signals must allocate enough green time for these slower walkers, and drivers must expect a longer pedestrian phase. Setting vehicle speeds at or below 30 km/h ensures that drivers approaching the crossing during the clearance interval have enough time to stop or slow should someone still be crossing (National Academies of Sciences, Engineering, and Medicine, 2006). Taken together, these factors show that speed limits and physical traffic-calming measures (e.g., raised crosswalks, chicanes, speed humps) must be coordinated with pedestrian walking speeds and crossing widths.

Conflict points

Crossings introduce **conflict points** where vehicle paths intersect with pedestrian paths, creating opportunities for collision. The number and geometry of conflict points determine the complexity of a crossing. Straight mid-block crossings on single-lane roads have two vehicle–pedestrian conflict points (one per traffic direction). Multilane roads add additional conflicts because drivers in different lanes may obscure each other's view (known as "multiple-threat" situations). Intersections can create up to twelve conflict points, including turning movements. Minimizing these conflicts is a central design objective (Wang et al., 2021). Solutions include refuge islands that allow pedestrians to cross one direction of traffic at a time, converting a four-point conflict into two two-point conflicts; slip-lane removal or redesign, eliminating high-speed turning movements that expose pedestrians to unsignaled conflicts; channelization and signal phasing that separate pedestrian phases from vehicle left- or right-turn phases; and curb extensions that physically shorten crossing distances and narrow the turning radius. Poorly designed crosswalks can create screening collisions when pedestrians step out from behind parked cars or street furniture into the path of an oncoming vehicle.

Integrating design elements

Sight distance, speed selection, and conflict reduction should not be considered in isolation. A raised crossing, for example, both highlights the crossing to drivers (improving sight recognition) and physically enforces lower speeds. Combining a refuge island with a curb extension reduces conflict points and widens the field of view for both drivers and pedestrians. These integrated measures align with the Safe-System principle of redundancy. If one element fails, another still protects the pedestrian. However, technical design must be complemented by enforcement and education. Only the police currently enforce crossing laws. Additionally, penalties are often weak. A robust system would include clear regulations for speed limits near crossings, automated speed and red-light cameras, and public campaigns reminding drivers and pedestrians of their responsibilities.

3. CROSSWALK TYPES AND GLOBAL GUIDELINES

Pedestrian crossings are not uniform features but vary according to their design, control mechanisms and the contexts in which they are installed. Around the world, governments and professional bodies have developed frameworks to classify crossings and to set clear warrants for when and how each type should be applied. These systems

reflect a common principle: that crosswalks must be designed to balance pedestrian demand with vehicle flows, while ensuring that inevitable human error does not result in death or serious injury. Understanding the range of crosswalk types and the international guidelines that govern them provides a valuable benchmark for improving pedestrian safety in Thailand.

3.1 Classification of Crossings

Pedestrian crossings are generally classified based on the level of traffic control they employ. Two main categories are recognized (USDOT, 2024).:

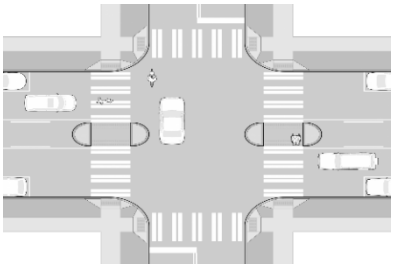
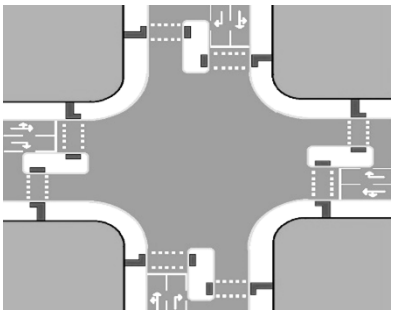
Controlled crossings rely on traffic signals or signage to compel drivers to yield. These include conventional signalized crosswalks, pelican or puffin crossings equipped with pedestrian detection technology, and crossings integrated with cycleways such as toucan or parallel crossings.

Uncontrolled crossings lack active traffic control but may feature markings, signage, or design elements like refuge islands to guide drivers. These depend more on driver courtesy and visibility cues.

Within these categories, further distinctions are made depending on road geometry, pedestrian demand, and traffic volume. Raised crossings enforce speed reduction physically, while staggered crossings guide pedestrians through refuge islands, minimizing conflict points. This typology reflects a principle found in many international standards. Crossing design must be tailored to context-specific risks, including speed environment, pedestrian volume, and vehicle flows (Table 1).

Table 1

Examples of Pedestrian Crossing Classification by Safety Equipment

Pedestrian Crossing Classification	Specification
Conventional crossing 	Installation criteria: • Installation Location: Intersections • Pedestrian Volume: Low to High • Traffic Volume: Low to High • Maximum Speed Limit: Applicable to any speed level • Traffic Signal: Required • Pedestrian Refuge Island: Required/Not required, depending on the number of traffic lanes
Raised crossing 	Installation criteria: • Installation Location: Intersections / Road sections • Pedestrian Volume: Medium to High • Traffic Volume: Medium to High • Maximum Speed Limit: Below 30 km/h • Traffic Signal: None • Pedestrian Refuge Island: None
Staggered crossing 	Installation criteria: • Installation Location: Intersections / Road sections • Pedestrian Volume: Low to Medium • Traffic Volume: Medium • Maximum Speed Limit: More than 30 km/h (if installed in a road section) • Traffic Signal: Required / Not required • Pedestrian Refuge Island: Required

Note. From *Global Street Design Guide*, by Rockefeller Philanthropy Advisors Inc /Global Designing Cities Initiative, 2016, Island Press.

The installation of safety equipment to enhance safety at pedestrian crossings requires careful consideration of both specific criteria and differing objectives. A review of studies, standards, and manuals related to pedestrian crossing design in countries such as the United Kingdom, the United States, the Commonwealth of Australia, and New Zealand reveals that safety equipment is installed in a manner consistent with the classification of crossings. The prioritization of crossings varies significantly among these countries, depending on their unique context. For example:

- The United States considers three main factors: (1) the average traffic volume in both directions, classified by the presence of a pedestrian refuge island; (2) the maximum speed limit or the 85th percentile speed; and (3) the Average Annual Daily Traffic (AADT) (Blackburn et al., 2018).
- The United Kingdom considers two primary factors for determining pedestrian crossing types: (1) the average traffic volume on the road section in both directions and (2) the average pedestrian demand during peak hours (Jain & Rastogi, 2016).
- The Commonwealth of Australia and New Zealand determine the type of pedestrian crossing based on the Level of Service (LOS) for pedestrians. The LOS is calculated from various context-specific factors for each crossing, such as pedestrian space, pedestrian flow rates, crossing speed, and crossing delays (Austroads, 2013).

The installation criteria presented above reflect the varying priorities in pedestrian crossing design and their different contexts, including: (Table 2)

- United States: US regulations mandate that drivers must always prioritize pedestrians at all types of crossings. This may be why pedestrian crossing demand is not the top priority in design, as it's an inherent legal requirement for drivers to yield.
- Commonwealth of Australia and New Zealand: These countries prioritize pedestrians and vulnerable road users in their road design. Their focus is on the pedestrian crossing capability, which is the ability of pedestrians to cross safely and conveniently, rather than on risks from traffic and physical factors.
- United Kingdom: The UK prioritizes the risk associated with traffic and demand for crossings. The risk from physical factors, such as lane width or road characteristics, is considered a secondary priority.

3.2 Warrants and Thresholds

Several countries formalize when a crossing is warranted. The United Kingdom, for example, applies a **PV² threshold**—where P is peak pedestrian flow, and V is vehicle flow—to determine whether a crossing should be controlled or can remain unsignalized. Simple zebra crossings are considered where vehicle volumes are moderate (300–500 per hour), and pedestrian flows are substantial (400–1,100 per hour). Higher traffic intensities trigger warrants for pelican or puffin crossings, often paired with refuge islands, as illustrated in Figure 1.

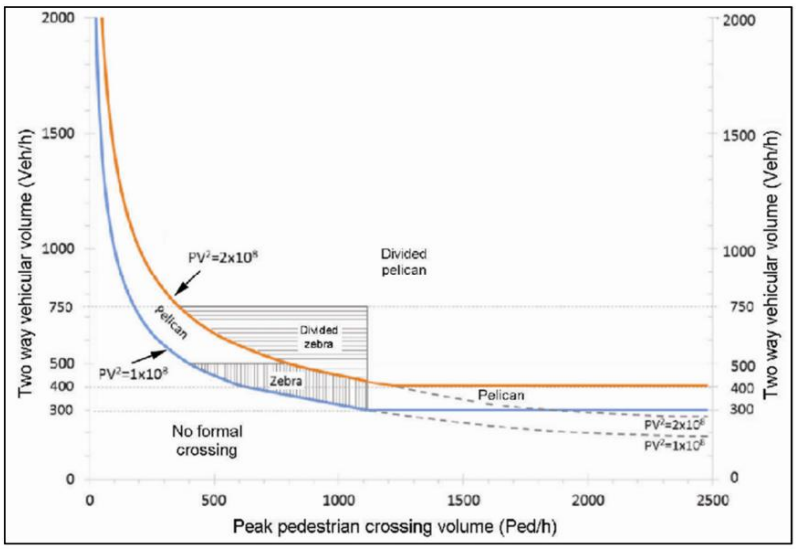
Table 2

Comparative Table of Pedestrian Crossing Classification Models

Role Model	Primary Priority	Secondary Priority
United States	Risk associated with physical and traffic factors	Pedestrian demand for crossing
United Kingdom	Risk associated with traffic and demand for crossings	Risk associated with physical factors
Commonwealth of Australia and New Zealand	Pedestrian crossing capability	Vehicular traffic factors

Figure 1

Criteria for the Installation of Equipment at Various Types of Pedestrian Crossings in the United Kingdom



Note. From Review of Pedestrian Crossing Guidance LTN 1/95, by Transport Scotland, 2018.

This quantitative approach is echoed in other systems. Australia and New Zealand apply tools like the **Pedestrian Selection Tool** to weigh crash history, traffic speed, and pedestrian demand when deciding between grade separation and at-grade design (Austroads, 2013). The United States, through NACTO and MUTCD guidance, emphasizes not only demand thresholds but also geometric design, sightlines, and integration with speed management (Blackburn et al., 2018).

3.3 Design Elements in International Guidelines

International guidelines emphasize that effective pedestrian crossings must integrate three core design principles: **visibility, speed control, and conflict reduction**. Each principle translates into concrete infrastructure elements that shape how drivers and pedestrians behave at crossing points.

Visibility

Visibility is the foundation of safe crossing design. Drivers must be able to see a crossing and any pedestrians waiting to use it with enough time to slow or stop, while pedestrians need clear sightlines to judge safe gaps in traffic.

- **Markings and contrast**: The UK's *Traffic Signs Manual* (Department for Transport et al. 2019) specifies that zebra stripes be laid at least 2.4 m wide, in high-contrast paint, and refreshed regularly to ensure legibility. In the United States, NACTO (National Association of City Transportation Officials, 2013) recommends "continental" (long bar) markings rather than parallel lines, as these are more visible at night and in wet conditions.
- **Lighting**: Both Austroads (Aumann & Whitehead, 2017) and the UK require dedicated lighting over mid-block crossings. Studies show that well-lit crosswalks reduce nighttime crashes by as much as 40%.
- **Sight distance**: Many guidelines link required sight distance to speed. For example, UK standards require a stopping sight distance of at least 22 m at 20 mph, increasing to 80 m at 40 mph (Manual for streets, 2007). This ensures drivers have sufficient reaction time to yield.

Speed Control

Because crash survivability decreases steeply as speed increases, most international standards integrate physical and regulatory measures to enforce lower speeds near crossings.

- **Raised crossings**: Austroads recommends raised tables on streets with limits of 50 km/h or less, particularly in school zones and shopping areas (Aumann & Whitehead, 2017). These not only slow vehicles but also elevate pedestrians, making them more visible.
- **Curb extensions**: Common in NACTO guidance, bulb-outs or curb extensions narrow the roadway, shorten crossing distance, and encourage lower turning speeds at intersections (NACTO, 2013).
- **Speed zones**: Many European cities designate "20 mph zones" (30 km/h) around residential and high-pedestrian areas (Musial et al., 2025). Crossing design is integrated into these zones with complementary signage, markings, and vertical deflection.

Conflict Reduction

Crossings inherently create conflict points between vehicle and pedestrian paths. Reducing both the number and complexity of these conflicts is central to Safe-System design.

- **Refuge islands**: Widely recommended in Austroads, UK, and NACTO standards, islands break long crossings into two stages, reducing exposure and simplifying decision-making. Minimum widths are usually 1.8–2.0 m to accommodate wheelchairs, strollers, and groups of pedestrians (Austroads, 2023).
- **Staggered crossings**: The UK's "staggered pelican" layout forces pedestrians to re-orient on a refuge island, ensuring they face approaching traffic before crossing the second half of the road (Austroads, 2023).
- **Stop lines**: Guidelines in both the UK and US emphasize placing stop lines 2–6 m back from the crosswalk. This prevents drivers from blocking the crossing and improves sightlines between waiting pedestrians and approaching vehicles (Golembiewski & Chandler, 2011).
- **Signal phasing**: Advanced pedestrian signals, leading pedestrian intervals (LPIs), and exclusive crossing phases are used internationally to reduce turning-vehicle conflicts. For example, New York City's widespread adoption of LPIs (giving pedestrians a 3–7 second head start) has cut pedestrian-vehicle crashes at treated intersections by over 50% (Federal Highway Administration, 2024, February 1).

Integration and Redundancy

A crucial insight from international guidelines is that these design elements work best in combination. A raised crossing alone may slow vehicles but may not ensure visibility at night without proper lighting. A refuge island improves safety on a wide road, but only if it is wide enough and aligned with pedestrian desire lines. The Safe-System philosophy calls for redundancy: if one safeguard fails (e.g., a driver does not yield), others (low approach speeds, clear sightlines, protected refuge) should still prevent serious injury.

3.4 Global Lessons for Safe System Design

Together, these typologies and warrants illustrate the Safe System principle. Infrastructure must be designed so that inevitable human error does not result in death or serious injury. Crosswalks are therefore not stand-alone features but part of a broader system of speed management, sightline clearance, and conflict reduction. International models—whether the PV^2 method in the UK, Level of Service (LOS) criteria in Australia, or NACTO's urban design standards—share a common thread: tailoring crossing type and features to measurable risk factors and maintaining redundancy through layered protections.

4. THAILAND'S CURRENT PEDESTRIAN LANDSCAPE

4.1 Regulatory and Design Gaps

Thailand's pedestrian safety framework is hampered by fragmented responsibilities and inconsistent design practices. Unlike countries that adopt a unified manual or statutory guideline, Thai crosswalk standards are dispersed among the Department of Highways, the Department of Rural Roads, municipal authorities, and academic institutions (Land Traffic Act, B.E.1979; Highways Act, B.E. 1992; Bangkok Metropolitan Administration, 2024). Each body issues its own instructions, which results in duplication, inconsistent terminology, and a lack of clear accountability for maintenance and upgrades.

The design of roads further reflects a vehicle-centric orientation. Lane widths are generous, and turning radii are wide, which encourages drivers to travel at higher speeds even in pedestrian-dense areas. National speed regulations allow limits from 45 km/h in urban settings to 100 km/h on highways (Land Traffic Act, B.E.1979). Still, little distinction is made for sensitive locations such as schools, markets, or bus terminals. The Safe-System principle that survivable speeds for pedestrian impacts are 30 km/h or less is rarely translated into enforceable speed zones.

In practice, most crosswalks in Thailand default to simple zebra markings regardless of traffic speed, lane configuration, or pedestrian demand. There is no systematic warrant process—such as the PV^2 method used in the UK—to determine when a crossing should be signalized, raised, or supported by a refuge island. This absence of unified crossing-type criteria leads to mismatched solutions: multilane arterials may have only painted stripes, while quiet streets may carry excessive traffic control (Department of Highways, Bureau of Highway Safety [DoH, BHS], 2021).

Universal design requirements are inconsistently applied. Ramps for wheelchairs are missing or poorly aligned; tactile paving may begin and end abruptly; and audible signals are rare. Stop lines are often painted directly on the crosswalk, allowing drivers to stop on top of pedestrians' space. Overhead lighting is sporadic, and obstructions such as parked cars, poles, or vegetation frequently block sightlines. The lack of regular audits and maintenance compounds these shortcomings, leaving faded markings and malfunctioning signals unaddressed (DoH, BHS, 2021).

Enforcement remains weak. Only police are empowered to cite drivers who fail to yield, and penalties are minimal. Observed behavior suggests low compliance. Drivers often ignore signals or stop lines. On the other hand, pedestrians cross outside designated areas, reflecting a lack of trust in the infrastructure. The fragmented governance structure, coupled with poor enforcement and absent maintenance regimes, creates a landscape in which design and practice consistently fail to protect pedestrians (DoH, BHS, 2021).

4.2 Field Evidence from Bangkok and Chiang Mai

Field surveys in Bangkok and Chiang Mai provide direct insight into how these regulatory and

design gaps manifest in practice. Fourteen crossings—eight in Bangkok and six in Chiang Mai—were observed across varied contexts, including school zones, markets, residential streets, and busy arterials.

The physical state of the crossings revealed numerous deficiencies. Many lacked accessibility features such as ramps, tactile paving, and audible signals. Refuge islands, where present, were often too narrow to accommodate groups or mobility devices and were cluttered with signage or poles. Several crossings exceeded 20 meters in length, exposing pedestrians to traffic for prolonged periods. Sightlines were obstructed by illegally parked cars, motorcycles, or vegetation, preventing both drivers and pedestrians from reacting safely (DoH, BHS, 2021).

Signal timing frequently failed to accommodate the actual walking speeds of users. While average pedestrians crossed at about 1.3 m/s, older adults and people with disabilities averaged closer to 1.1 m/s. At wide crossings, clearance intervals were inadequate, forcing slower walkers to finish crossing against a red light. Long wait times for green signals—sometimes exceeding one minute–caused many pedestrians to cross early or outside the crosswalk entirely (DoH, BHS, 2021).

Driver behavior compounded these risks. Observations in Bangkok recorded thousands of instances of drivers stopping beyond the stop line and widespread speeding through crosswalk approaches. In both Bangkok and Chiang Mai, drivers frequently failed to yield, particularly in multilane scenarios where vehicles in one lane obscured others, creating "multiple threat" situations. Pedestrians, sensing low compliance, often darted across gaps in traffic rather than relying on formal controls.

The surveys highlighted a clear mismatch between infrastructure design and user behavior. Deficiencies in visibility, speed management, and enforcement encouraged unsafe practices on both sides. Suggested remedies included:

- Installing accessible features consistently (ramps, tactile paving, audible signals).
- Relocating stop lines at least six meters upstream to preserve sightlines.
- Widening and decluttering refuge islands.
- Adding advanced warning signage and automated enforcement.
- Reducing approach speeds to 30 km/h in sensitive zones.
- Extending pedestrian green phases to accommodate slower walkers.

These findings confirm that Thailand's pedestrian environment is not simply a matter of poor compliance but of deficient design and maintenance. Addressing these issues requires not only stricter enforcement but also systemic redesign to align with Safe-System principles of visibility, speed control, and conflict reduction.

5. ALIGNING GLOBAL LESSONS WITH THAI NEEDS

Thailand's pedestrian safety framework exhibits notable divergences from established international practices in terms of classification systems, design consistency, and enforcement mechanisms. Nevertheless, the foundational principles that underpin global guidelines—namely visibility, speed management, and conflict reduction—are already acknowledged within Thai policy discourse. The critical task, therefore, is not the wholesale adoption of foreign models but rather the institutionalization, contextual adaptation, and systematic enforcement of these principles within Thailand's governance structures.

5.1 Areas of Alignment

Certain elements of Thai practice demonstrate nascent alignment with international standards:

- **Recognition of Safe-System principles**: Official documents already acknowledge the importance of driver sightlines, speed control, and minimizing conflict points—three pillars found in UK, US, and Australian manuals.
- **Emerging use of raised crossings**: Although inconsistent, some Thai municipalities have begun introducing raised zebra crossings near schools and hospitals, mirroring global emphasis on vertical deflection to slow vehicles.

- **Integration of smart technology**: Pilot projects with AI-enabled enforcement cameras and adaptive traffic signals show promise, and in some cases even surpass international benchmarks by leveraging advanced monitoring in contexts with limited police resources.

These examples indicate that Thailand is not starting from scratch but has already begun embedding international concepts into local practice.

5.2 Key Divergences

Despite these areas of progress, field evidence shows substantial gaps when compared to international standards:

- **Lack of classification and warrants**: Whereas the UK applies the PV^2 formula and Australia uses selection tools based on demand and crash risk, Thailand has no formal process to match crossing type with traffic conditions. The result is over-reliance on simple zebra markings, even on multilane arterials where international guidance would mandate signals, refuge islands, or grade separation.
- **Inconsistent application of design elements**: Refuge islands are often too narrow or obstructed, stop lines are painted directly at crossings, and curb extensions are rarely employed. These diverge sharply from the precise dimensional requirements and best practices codified abroad.
- **Weak enforcement**: International cities increasingly rely on automated enforcement—speed cameras, red-light cameras, and fines scaled to income—whereas Thailand relies almost exclusively on police officers. This gap explains persistent driver non-compliance recorded in Bangkok and Chiang Mai.
- **Accessibility shortfalls**: Universal-design features such as tactile paving, audible signals, and properly aligned ramps are sporadic in Thailand, while international guidelines make them standard.

5.3 Opportunities for Adaptation

Effective reform requires selective adaptation of international best practices, calibrated to Thai institutional and socio-cultural contexts:

Context-sensitive speed management: International evidence suggests that lowering speeds to 30 km/h near crossings dramatically improves survival rates. Thailand could begin with targeted "slow zones" in high-risk areas—schools, transit nodes, and markets—supported by raised crossings and automated enforcement.

Simplified warrant systems: While PV^2 calculations may be technically demanding for local authorities, a simplified set of thresholds—based on lane count, traffic volume, and pedestrian flows—could guide consistent decisions without overwhelming capacity.

Scalable universal design: Low-cost interventions such as correctly aligned ramps, standardized tactile paving, and adequate refuge island width could be mandated in all new projects, with retrofits prioritized for high-volume crossings.

Technology as an enforcement multiplier: AI-based monitoring and camera enforcement can compensate for limited police presence, and Thailand's early experiments could become a model for other low- and middle-income countries with similar constraints.

5.4 Challenges to Implementation

Implementing these adaptations will require overcoming structural barriers:

- **Fragmented governance**: With multiple agencies issuing their own manuals, Thailand will need a unified national guideline to provide consistency.
- **Resource constraints**: Smaller municipalities may lack budgets for full compliance with global standards, necessitating a phased approach with low-cost, high-impact interventions first.
- **Cultural and behavioral factors**: High motorcycle shares, driver non-compliance, and pedestrian impatience (crossing before signals) complicate the direct transfer of international models. Education campaigns and enforcement must accompany infrastructure change.

- **Maintenance gaps**: Even well-designed crossings deteriorate quickly without regular audits and repainting. Building capacity for long-term upkeep is as important as initial installation.

6. CONCLUSION AND POLICY IMPLICATIONS

This study has examined how the design and upkeep of crosswalks influence pedestrian safety in Thailand. Drawing on the Safe-System philosophy, international design standards, and empirical surveys in Bangkok and Chiang Mai, the analysis highlights a central finding. When streets are designed with human vulnerability at the forefront, they become safer, more inclusive, and more socially cohesive. Conversely, neglecting the design and maintenance of crossings perpetuates elevated risks of injury and death, particularly for those least protected.

The Safe-System framework emphasizes that human beings are inherently prone to error and possess limited tolerance to crash forces. Consequently, transport infrastructure must be engineered to absorb these errors and prevent catastrophic outcomes. For pedestrian crossings, this requires three essential conditions: clear visibility, moderated vehicle speeds, and minimization of conflict points. Yet in Thailand, many crossings fail to satisfy these safeguards. Refuge islands are undersized or obstructed, curb extensions are absent, stop lines are misaligned, and pedestrian signals inadequately account for slower walking speeds, particularly among older adults and persons with disabilities. These shortcomings are compounded by lapses in maintenance—such as faded markings, malfunctioning signals, and obstructed sightlines—that undermine the effectiveness of even well-designed facilities and convey a societal disregard for pedestrian safety.

Addressing these deficiencies demands a comprehensive policy response. At the design level, crosswalks should be clearly marked, adequately wide, and constructed from durable, high-visibility materials. Refuge islands must be spacious, unobstructed, and aligned with pedestrian desire lines, while curb extensions can shorten crossing distances and reduce turning speeds. Stop lines should be positioned upstream to preserve sightlines and provide drivers with adequate deceleration distance. Proper lighting and signage are essential to ensure visibility at all hours, and signal timing must accommodate slower walkers, potentially supported by sensor-based adaptive technologies. Universal design elements, including ramps, tactile paving, and accessible push buttons, should be systematically integrated to guarantee inclusivity.

Equally vital is the institutionalization of maintenance. Infrastructure quality inevitably deteriorates, even under optimal design, unless routine upkeep is embedded within governance structures. Municipal authorities should establish regular audits, allocate recurrent budgets for repainting and signal calibration, and implement clear accountability mechanisms for maintenance failures. Proactive maintenance sustains not only the technical performance of crossings but also communicates to all road users that pedestrian safety is a civic priority.

Design and maintenance must be reinforced by enforcement and education. Forgiving design reduces the consequences of human error but cannot prevent deliberate violations. Stronger enforcement is therefore necessary, including scaled penalties, expanded use of automated monitoring technologies such as red-light and speed cameras, and consistent sanctioning of non-compliance. Complementary education campaigns should promote a culture of shared responsibility by reframing streets as collective social spaces. Drivers must be encouraged to reduce speeds and yield to pedestrians, while pedestrians should be supported in crossing safely through clear and memorable messaging strategies such as “Stop, Look, Listen, Think.”

Finally, innovation and community engagement are essential for long-term transformation. Emerging technologies—including in-pavement lighting, adaptive signals, and intelligent speed assistance—provide new opportunities for risk reduction. Pilot projects in high-risk contexts can generate evidence for scaling these solutions nationally. At the same time, communities should be empowered to identify hazardous locations and propose interventions. Such participatory processes not only enhance responsiveness to local needs but also foster legitimacy, ownership, and long-term accountability in implementation.

Reorienting Thailand's streets around people rather than cars is therefore both a technical challenge and a moral imperative. Crosswalks, as the everyday interface between vehicles and pedestrians, symbolize societal choices about whose safety is prioritized. By embedding Safe-System principles into design, institutionalizing maintenance, strengthening enforcement, and embracing innovation and community engagement, Thailand can transform its pedestrian environment from one of systemic neglect into one of dignity and protection. In doing so, streets can evolve from corridors of risk into corridors of life, enabling safer, more inclusive, and more sustainable urban futures.

BIBLIOGRAPHY

Alhajyaseen, W., & Nakamura, H. (2012). Design criteria for crosswalk width and position at signalized intersections. *Journal of Civil Engineering and Architecture*, *6*(6), 844–857.

Aumann, P., & Whitehead, M. (2017). *Guide to road design part 4: Intersections and crossings–general (AGRD04-17).*

Austroads. (2004). *Guide for the planning, design, and operation of pedestrian facilities.*

Austroads. (2010). *Guide to road design part 4A: Unsignalised and signalised intersections.* https://austroads.com.au/publications/road-design/agrd04a-10

Austroads. (2013). *Guide information for pedestrian facilities*. https://austroads.com.au/publications/road-design/ap-r423-13

Austroads. (2023). *Guide to road design part 4: Intersections and crossings–general.* https://austroads.com.au/publications/road-design/agrd04

Bangkok Metropolitan Administration. (2024). *Traffic and Transportation Department* [สำนักการจราจรและขนส่ง]. https://traffic.bangkok.go.th/AboutUS/TTD.html

Bangkok Metropolitan Administration, Department of Public Works. (2016). *Bangkok Metropolitan Administration standard drawings for roadworks, B.E. 1999* [แบบมาตรฐานงานทางกรุงเทพมหานคร พ.ศ. 2542].

Blackburn, L., Zegeer, C., & Brookshire, K. (2018). *Guide for improving pedestrian safety at uncontrolled crossing locations.* Federal Highway Administration. https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/STEP-guide-improving-ped-safety.pdf

Cerema. (2021, February 15). *Evaluation of three-dimensional pedestrian crossing trials.* https://www.cerema.fr/system/files/documents/2021/10/evaluation_of_three-dimensional_pedestrian_crossing_trials.pdf

Department of Disease Control. (2022). *Integrated road traffic injury surveillance system.* Ministry of Public Health.

Department of Highways. (2013). *Manual for traffic sign Installation at intersections* [คู่มือการติดตั้งป้ายจราจรบริเวณทางแยก].

Department of Highways. (2013). *Standard drawings for Local Administrative Organization roads* [แบบมาตรฐานทางสำหรับองค์กรปกครองส่วนท้องถิ่น].

Department of Highways. (2021). *Department of Highways standard drawings, B.E. 2015 (revised B.E. 2021)* [แบบมาตรฐานกรมทางหลวง พ.ศ. 2558 (ฉบับแก้ไข พ.ศ. 2564)].

Department of Highways, Bureau of Highway Safety. (2021). *A study to establish guidelines for the design and implementation of safe pedestrian crossings to enhance road safety* [การศึกษาเพื่อกำหนดแนวทางการจัดทำและการใช้ทางข้ามถนนปลอดภัยเพื่อยกระดับความปลอดภัยในการใช้รถใช้ถนน].

Department of Local Administration. (n.d.). *Standard for road markings under the road accident prevention standards* [มาตรฐานเครื่องหมายจราจรบนพื้นทาง. ใน มาตรฐานการป้องกันอุบัติภัยทางถนน].

Golembiewski, G., & Chandler, B. (2011). *Intersection safety: A manual for local rural road owners.* https://trid.trb.org/View/1104596

Great Britain. Department for Transport., Northern Ireland. Department for Infrastructure. (2019). *Traffic signs manual*.

Highways Act, B.E. 1992 [พระราชบัญญัติทางหลวง พ.ศ. 2535].

Highway Code. (2024). *Pedestrian crossings (Rules 191–199).* https://highwaycode.org.uk/pedestrian-crossings/

International Transport Forum. (2012). *Pedestrian safety, urban space and health.* OECD Publishing. https://doi.org/10.1787/ 9789282103654-en

Jain, U., & Rastogi, R. (2016). Pedestrian crossing warrants: A review of global practices. *Current Science,* 111, 1016–1027. https://doi.org/10.18520/cs/v111/i6/1016-1027

Jain, U., & Rastogi, R. (2017). Re-examination of PV2 criteria for developing pedestrian crossing warrants. *Transportation Research Procedia,* 25, 1707–1716. https://doi.org/10.1016/ j.trpro.2017.05.130

Jain, U., & Rastogi, R. (2020). Revision of PV2 criteria based pedestrian crossing warrants. *Transport, 35*(2), 168–178. https://doi.org/10.3846/transport.2020.12474

Koonce, P., Rodgerdts, L., Lee, K., Quayle, S., Beaird, S., Braud, C., Bonneson, J., Tarnoff, P., & Urbanik, T. (2008). *Traffic signal timing manual.* Federal Highway Administration. https://nacto.org/docs/usdg/signal_timing_manual_fhwa.pdf

Land Traffic Act, B.E. 1979 [พระราชบัญญัติจราจรทางบก พ.ศ. 2522].

Manual for streets. (2007). *Thomas Telford.*

Miller, G. S. (2010). *Approved policy for mid-block pedestrian and trail crossings.* Washington County Board of Commissioners. https://www.washingtoncountyor.gov/lut/documents/appendix-h-road-construction-standards/download?inline

Musial, S., Bunn, S., & Lally, C. (2025). *Public health impacts of 20 mph limits and zones.* Parliamentary Office of Science and Technology. https://doi.org/10.58248/PB65

National Academies of Sciences, Engineering, and Medicine. (2006). *Improving pedestrian safety at unsignalized crossings.* Transportation Research Board. https://doi.org/10.17226/13962

National Association of City Transportation Officials. (2013). *Urban street design guide* (2nd ed.). Island Press.

NZ Transport Agency Waka Kotahi. (2007). *Guidelines for the selection of pedestrian facilities*. https://www.nzta.govt.nz/assets/resources/pedestrian-planning-guide/docs/guidelines-selection-of-pedestrian-facilities.pdf

NZ Transport Agency Waka Kotahi. (2026). *Signalised crossings*. Pedestrian Network Guidance. https://nzta.govt.nz/assets/Walking-Cycling-and-Public-Transport/docs/pedestrian-network-guidance/docs/3.4-crossings-v1.2-feb-2026.pdf

Peterson, B. (2023, December 30). *Raised crosswalks can elevate pedestrian safety.* Crafton Tull. https://www.craftontull.com/insights/infrastructure/raised-crosswalks-can-elevate-pedestrian-safety

Queensland Department of Transport and Main Roads. (n.d.). *Traffic and road use management manual 3, signing and pavement marking.*

Schroeder, B. J., Alston, M., Ryus, P., Brown, S., Worth O'Brien, S., Brookshire, K. (2023). *Crosswalk marking selection guide.* https://rosap.ntl.bts.gov/view/dot/72439

Scottish Road Research Board. (2018). *Review of pedestrian crossing guidance LTN 1/95.* https://www.transport.gov.scot/publication/review-of-pedestrian-crossing-guidance-ltn-195/

United States. Department of Transportation. (2024). *What is a safe system approach?* https://www.transportation.gov/safe-system-approach

United States. Federal Highway Administration. (2011). *FHWA functional classification guidelines.*

United States. Federal Highway Administration. (2018). *Pedestrian refuge island: Safe transportation for every pedestrian: Countermeasure tech sheet.* https://rosap.ntl.bts.gov/view/dot/49602

United States. Federal Highway Administration. (2024, February 1). *Leading pedestrian interval.* https://highways.dot.gov/safety/proven-safety-countermeasures/leading-pedestrian-interval

VicRoads. (2011). *Midblock crossings – Choosing a safe place to cross.* https://www.vicroads.vic.gov.au/-/media/files/formsandpublications/safety-and-road-rules/midblockcrossingsfactsheetjuly2011.ashx

VicRoads. (2011). *Pedestrian crossings with traffic lights.* https://www.vicroads.vic.gov.au/-/media/files/formsandpublications/safety-and-road-rules/crossingswithlightsfactsheetjuly2011.ashx

Wang, J., Yang, C., & Zhao, J. (2021). Conditions for setting exclusive pedestrian phases at two-phase signalized intersections considering pedestrian–vehicle interaction. *Journal of Advanced Transportation, 2021*(1), 1-14. https://doi.org/10.1155/2021/8546403

World Health Organization. (2018). *Global status report on road safety 2018.* https://www.who.int/publications/i/item/9789241565684

Zegeer, C. V., Seiderman, C., Lagerwey, P., Cynecki, M., Ronkin, M., & Schneider, R. (2002). *Pedestrian facilities user's guide: Providing safety and mobility.* https://rosap.ntl.bts.gov/view/dot/35637

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