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A performance model for post-crash response in Thailand: An importance–performance analysis approach

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ABSTRACT

Road traffic crashes remain a critical public safety issue in Thailand, particularly in the Eastern Economic Corridor (EEC), where high mobility demand and operational complexity increase post-crash risks. Effective post-crash response requires timely information flow, coordinated decision-making, emergency medical care, and appropriate legal procedures; however, performance gaps among responsible agencies still exist. This study evaluates post-crash response performance and develops a performance-based improvement model using Importance–Performance Analysis (IPA). A quantitative survey was conducted with 196 police officers directly involved in post-crash operations in the EEC. The findings identify 25 indicators grouped into two factors: the Post-crash Response Information and Coordination Factor (PRICF) and the Post-crash Response Injury Care and Legislation Support Factor (PRILSF). The results show that PRILSF performs strongly in emergency medical transfers, traffic control, and law enforcement. In contrast, PRICF shows significant performance gaps in information flow, inter-agency communication, and dispatch coordination. Several high-importance indicators were located in the "Concentrate Here" quadrant, indicating systemic bottlenecks that limit overall response effectiveness. Based on the IPA results, this study proposes a performance model that highlights the interdependence between information coordination and injury-care outcomes. The findings provide policy-relevant and practical insights to strengthen post-crash response systems and improve road safety resilience in Thailand.

1. Introduction

Road traffic crashes remain a major public safety problem worldwide. According to the World Health Organization (WHO), approximately 1.19 million people die annually as a result of road traffic crashes, with 92 percent of fatalities occurring in low- and middle-income countries (WHO, 2023). Thailand continues to experience persistently high levels of road traffic injuries and fatalities, underscoring the urgent need for effective post-crash response systems that can mitigate preventable loss of life and long-term societal impacts. The Eastern Economic Corridor (EEC), comprising Chonburi, Rayong, and Chachoengsao provinces, represents a particularly high-risk context for road traffic crashes. The concentration of industrial zones, major transport corridors, and logistics-intensive activities generates high mobility demand and complex traffic conditions, increasing both the frequency and severity of road crashes. While the EEC is widely recognized for its economic and logistics significance, post-crash response within this region must be conceptualized primarily as a public safety and emergency management system, rather than as a logistics or supply chain performance issue. Effective post-crash response is therefore essential not only for safeguarding public health, but also for sustaining social stability and economic continuity in this strategic development area (Klinjun et al., 2021; Oo et al., 2026).

Previous research by the authors developed and validated a factor structure for post-crash response management in the EEC, identifying two main factors: the Post-crash Response Information and Coordination Factor (PRICF) and the Post-crash Response Injury Care and Legislation Support Factor (PRILSF). These factors were established through exploratory factor analysis (EFA) based on

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stakeholder data collected from agencies involved in post-crash operations (Muangpan et al., 2025). While this prior study successfully clarified the factor structure underpinning post-crash response, it did not evaluate how effectively these components are implemented under real operational conditions. This limitation is critical, as structurally sound systems may still underperform due to coordination failures, information delays, or institutional constraints.

Understanding the gap between the perceived importance of post-crash response indicators and their actual operational performance is essential for evidence-based decision-making. Identifying indicators that perform well enables responsible agencies to sustain existing strengths, whereas detecting highly important but underperforming indicators supports targeted intervention, strategic resource allocation, and policy development aligned with local operational realities. Performance-gap analysis, therefore, provides a practical foundation for strengthening multi-agency emergency response capacity in complex and high-risk environments such as the EEC (Mousazadeh et al., 2025; Lin et al., 2025; Markou-Pappas et al., 2024).

To address this gap, the present study applies Importance–Performance Analysis (IPA) to systematically evaluate and compare the importance and performance of 25 validated post-crash response indicators associated with PRICF and PRILSF. The IPA framework enables these indicators to be classified into strategic priority zones, thereby supporting recommendations for operational improvement and resource prioritization across responsible agencies. Accordingly, this study aims to: (1) evaluate the perceived importance and current performance of post-crash response indicators within the EEC context; (2) identify critical performance gaps that constrain response effectiveness; and (3) develop a performance-based model for improving post-crash response management grounded in empirical IPA findings. The findings contribute to academic and policy-oriented discourse on road safety, emergency management, and strategic planning in rapidly developing economic regions.

2. Literature review

2.1. Post-crash response management

Post-crash response refers to the coordinated set of actions undertaken immediately following a road traffic crash to reduce injury severity, prevent secondary harm, and restore normal traffic and social conditions. The World Health Organization (WHO, 2016) conceptualizes post-crash response as a core pillar of road safety systems, comprising five key components: crash detection, communication, emergency care, definitive care, and legal and administrative procedures. The effectiveness of these components depends not only on their individual capacity, but also on the quality of coordination, information exchange, and decision-making across responsible agencies. In complex and high-risk contexts such as Thailand's Eastern Economic Corridor (EEC), post-crash response operates primarily as a public safety and emergency management system, rather than as a logistics or supply chain function. Although the EEC is characterized by logistics-intensive economic activity, post-crash response requires real-time coordination among police, emergency medical services, rescue foundations, hospitals, and local administrative authorities. Previous studies have consistently identified fragmented command structures, delayed information flows, and limited interoperability between agencies as key constraints undermining response effectiveness in rapidly developing regions (WHO, 2016; WHO, 2018).

Recent emergency management literature emphasizes that deficiencies in post-crash response are often systemic rather than purely operational, arising from fragmented governance structures, institutional silos, unclear lines of authority, and limited inter-agency coordination capacity (Kapucu and Garayev, 2011). Without systematic prioritization of response components, agencies may focus on visible operational tasks while neglecting critical coordination and information functions that shape overall outcomes. Consequently, analytical approaches that can identify priority gaps between what is considered important and what is currently performed are essential for strengthening post-crash response capability and enhancing road safety resilience.

2.2. Importance-performance analysis (IPA)

Importance–Performance Analysis (IPA), originally proposed by Martilla and James (1977), is a strategic evaluation technique that compares the perceived importance of service attributes with their actual performance. The IPA framework classifies attributes into four quadrants: "Keep up the good work," "Concentrate here," "Low priority," and "Possible overkill," providing a practical basis for performance diagnosis and resource prioritization (Slack, 1994; Azzopardi and Nash, 2013). By visualizing gaps between importance and performance, IPA supports informed decision-making in environments characterized by resource constraints and multiple stakeholders.

Although IPA has been applied across diverse domains, including healthcare, public services, and transportation safety, its relevance to post-crash response lies in its ability to capture operational and coordination deficiencies within multi-agency emergency systems. In road safety research, IPA has been employed to evaluate emergency medical services, trauma care readiness, and crash-response programs, demonstrating its effectiveness in identifying high-importance attributes that suffer from performance shortfalls (Chen et al., 2020). Such applications highlight IPA's suitability for examining emergency response systems where coordination quality, timeliness, and institutional interaction are

critical determinants of performance. Within the context of post-crash response management, IPA offers a structured mechanism for translating complex operational assessments into actionable priorities. By distinguishing between well-performing components and critical gaps, IPA enables policymakers and practitioners to allocate resources more effectively and address systemic weaknesses that constrain overall response effectiveness. This approach is particularly valuable in high-risk and rapidly developing regions such as the EEC, where improvements in coordination and information management can yield substantial gains in public safety outcomes.

3. Research methodology

This study employed a quantitative research methodology to evaluate the performance of post-crash response indicators in Thailand's Eastern Economic Corridor (EEC). The methodological framework was developed to ensure validity, reliability, and scientific rigor through statistically grounded procedures and structured data collection. Importance–Performance Analysis (IPA) was adopted as the primary analytical technique to identify strengths and weaknesses across relevant indicators, thereby supporting the development of an evidence-based performance model. The methodology comprised five components: research design, population and sample, research instrument, data collection, and data analysis.

3.1. Research design

A survey-based quantitative design was implemented to enable the systematic collection of numerical data from a large group of respondents directly involved in post-crash operations. This design was considered appropriate because it facilitated the application of statistical techniques to investigate performance levels in real operating environments. In addition to employing IPA as the main analytical tool, the development of the performance model was grounded in the empirical validation of 25 post-crash response indicators established through exploratory factor analysis (EFA) conducted in the previous phase of the research. This sequential approach ensured that IPA was not used in isolation but rather as a continuation of validated constructs. By comparing respondents' perceptions of the importance of each indicator with their evaluation of actual performance, IPA enabled the classification of all indicators into four strategic priority quadrants:

- Quadrant I: Post-Crash Response Excellence (Keep up the good work)
- Quadrant II: Post-Crash Response Focus (Concentrate here)
- Quadrant III: Post-Crash Response Monitor (Low priority)
- Quadrant IV: Post-Crash Response Overkill (Possible overkill)

This classification provides a strategic mechanism for determining which aspects of post-crash response should receive immediate resource allocation, continued support, or performance maintenance, as shown in Fig. 1.

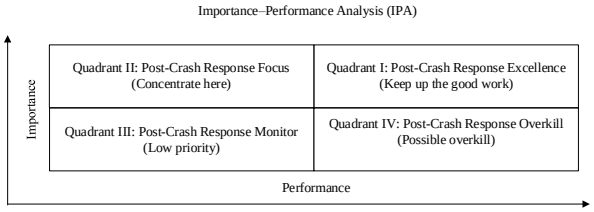

Fig. 1: Conceptual model of post-crash response management with importance–performance analysis (IPA)

3.2. Population and sample

The population comprised 295 police officers responsible for traffic operations across the five districts with the highest rates of road traffic fatalities in 2023 within the Eastern Economic Corridor (EEC), which includes Chonburi, Rayong, and Chachoengsao. The population covered officers of varying ranks—from superintendent, deputy superintendent, inspector, and sub-inspector to frontline traffic officers—who were directly involved in post-crash coordination, emergency response, and crash investigation.

A probability sampling approach was applied using simple random sampling to ensure equal selection opportunity for all members of the population. The sample size was calculated using Yamane's (1973) formula at a 95 percent confidence level and a 5 percent margin of error, yielding a minimum requirement of 170 participants. A total of 196 fully completed questionnaires were returned, surpassing the required sample size and ensuring adequate representativeness and statistical reliability.

3.3. Research instrument

A structured questionnaire served as the principal research instrument and was developed from international frameworks including those of the World Health Organization (WHO) as well as relevant empirical literature. The questionnaire consisted of three sections. The first section gathered demographic information such as age, rank, station affiliation, and years of service. The second section assessed 25 post-crash response indicators across two validated factors: the Post-crash Response Information and Coordination Factor (PRICF), comprising 14 indicators, and the Post-crash Response Injury Care and Legislation Support Factor (PRILSF), comprising 11 indicators. Respondents rated each indicator on a seven-point Likert scale ranging from 1 (very poor/not important) to 7

(excellent/extremely important), for both importance and performance.

The third section included open-ended questions for additional comments and recommendations regarding post-crash operations. Content validity was assessed by three experts in road safety and emergency management to ensure clarity and relevance. A pilot test involving 30 police officers demonstrated strong internal consistency, with Cronbach's alpha values of 0.91 for the importance scale and 0.89 for the performance scale, confirming excellent reliability of the instrument.

3.4. Data collection

Primary data were collected from police officers responsible for traffic operations in large and medium-sized police stations within the Eastern Economic Corridor (EEC). Data collection took place between May and June 2024 through direct distribution of questionnaires at selected stations, with formal coordination from station commanders to facilitate participation. Before completing the survey, respondents were informed of the study objectives, participation confidentiality, and voluntary rights. Of the 295 distributed questionnaires, 196 were completed and returned, exceeding the minimum required sample size for analysis.

3.5. Data analysis

Both descriptive and inferential statistical techniques were employed to ensure a comprehensive interpretation of the results. Descriptive statistics—frequencies, percentages, means, and standard deviations—were used to summarize demographic information and overall evaluations of each indicator. Exploratory Factor Analysis (EFA) was applied to confirm the underlying structure of the 25 post-crash response indicators. The Kaiser–Meyer–Olkin (KMO) value of 0.961 indicated excellent sampling adequacy, and Bartlett's test of sphericity yielded a chi-square value of 5,581.411 ($p < 0.001$), confirming the suitability of the data for factor extraction. Indicators with factor loadings greater than 0.50 and eigenvalues exceeding 1.0 were retained, validating the two-factor structure comprising the Post-crash Response Information and Coordination Factor (PRICF) and the Post-crash Response Injury Care and Legislation Support Factor (PRILSF).

Subsequently, Importance–Performance Analysis (IPA) was conducted to compare the perceived importance and actual performance of each indicator. The IPA cross-hairs were determined using the grand mean values of importance and performance scores, following the original approach proposed by Martilla and James (1977). Each indicator was then plotted within the IPA matrix to identify strategic priority zones. Indicators positioned in Quadrant II ("Concentrate here") represented high-importance attributes with relatively low performance, signaling critical areas requiring immediate attention. Finally, gap analysis was conducted to quantify the differences between importance and performance scores, providing additional insight into performance strengths and deficiencies across indicators. The integration of EFA, IPA, and gap analysis established a robust empirical foundation for developing evidence-based recommendations to enhance post-crash response management in the EEC.

4. Results and discussion

This section presents the results of the data analysis and discusses key findings in relation to post-crash response performance in Thailand's Eastern Economic Corridor (EEC). The results are organized into three components: (1) descriptive patterns of importance and performance, (2) IPA quadrant distribution, and (3) synthesis of strategic performance implications.

4.1. Descriptive analysis of importance and performance

Table 1 summarizes the mean importance and performance scores of post-crash response indicators across the two validated factors. Overall, respondents rated all indicators as highly important, with mean importance scores ranging from 5.78 to 6.32, while mean performance scores ranged from 5.72 to 6.29 on a seven-point Likert scale. These findings indicate that post-crash response functions are widely recognized as critical and that the current system operates at a generally satisfactory level. Nevertheless, consistent gaps between importance and performance scores suggest that several indicators are not being implemented at a level commensurate with their perceived criticality.

Across most indicators, performance scores were lower than the corresponding importance scores, indicating systematic underperformance relative to stakeholder expectations. The only exception was PRIC1 (completeness and accuracy of crash information), for which the performance score slightly exceeded the importance score. This result suggests that initial crash information collection has benefited from institutional improvements, such as standardized reporting procedures and digital documentation tools, and represents a relative strength within the post-crash response system. In contrast, indicators associated with information exchange, inter-agency coordination, dispatch processes, and resource adequacy under the PRICF factor exhibited the largest performance gaps. These gaps reflect limitations in communication flows and operational synchronization that can delay response actions and reduce overall system efficiency.

Indicators under the PRILSF factor generally demonstrated smaller gaps, reflecting comparatively stable performance in emergency medical management, scene control, and legal enforcement. However, indicators related to detailed reporting,

damage assessment, and post-crash investigation continued to underperform relative to their importance, indicating the need for enhanced specialized competencies and improved technical support. Overall, the descriptive results suggest that while the post-crash response system in the EEC is functioning at an acceptable operational level, its performance does not fully align with stakeholder expectations across several critical dimensions. Strengthening post-crash response effectiveness therefore requires a dual focus on preserving existing strengths—particularly in the accuracy of initial crash information—while addressing persistent gaps in coordination, communication, and specialized post-crash processes. These findings provide a foundation for the subsequent IPA quadrant analysis, which identifies strategic priorities for targeted improvement.

Table 1: Mean scores of importance and performance for post-crash response factors and indicators

No.	ID	Description	Importance		Performance	
			Mean	S.D.	Mean	S.D.
		PRICF	6.07	0.98	6.01	0.99
1	PRIC1	Completeness and accuracy of crash information	5.92	0.99	6.04	0.94
2	PRIC2	Having a single emergency telephone number	6.08	1.02	6.05	1.00
3	PRIC3	Timeliness of severity assessment by the emergency call taker	6.04	0.92	6.01	0.88
4	PRIC4	Accessibility and timeliness of emergency reporting channels	6.14	0.88	6.08	0.89
5	PRIC5	Public awareness and clarity of emergency reporting channels	6.16	0.85	6.11	0.87
6	PRIC6	Timely and accurate verification of emergency call information	6.15	0.84	6.10	0.84
7	PRIC7	Timely and accurate crash information by emergency call takers	6.20	0.90	6.14	0.96
8	PRIC8	Adequate stakeholders in emergency response coordination	5.78	1.22	5.72	1.16
9	PRIC9	Timeliness of information transfer and coordination	6.08	1.01	6.00	1.03
10	PRIC10	Post-crash response time of stakeholders	6.20	0.88	6.10	0.90
11	PRIC11	Appropriateness of vehicle type selection	6.16	1.00	6.05	1.05
12	PRIC12	Appropriateness of vehicle route selection	6.18	0.90	6.11	0.90
13	PRIC13	Real-time vehicle tracking system	5.93	1.16	5.82	1.18
14	PRIC14	Adequacy of vehicles for post-crash response	5.89	1.14	5.76	1.22
		PRILSF	6.16	0.88	6.08	0.91
1	PRILS1	Knowledge and skills of emergency responders in basic first aid	5.99	1.00	5.89	0.99
2	PRILS2	Accurate and appropriate assessment by emergency responders	6.14	0.91	6.05	0.94
3	PRILS3	The promptness in transporting injured individuals to medical care	6.28	0.80	6.16	0.86
4	PRILS4	Traffic control to prevent secondary crashes	6.32	0.77	6.29	0.77
5	PRILS5	Post-crash management of uninvolved persons at the scene	6.14	0.85	6.09	0.92
6	PRILS6	Timeliness in managing the post-crash scene	6.15	0.87	6.12	0.90
7	PRILS7	Accurate post-crash reporting by emergency responders	6.13	0.90	6.06	0.95
8	PRILS8	Appropriate law enforcement	6.27	0.81	6.17	0.87
9	PRILS9	Establishment and appropriate enforcement of measures	6.20	0.85	6.07	0.94
10	PRILS10	Accurate recording of post-crash damage assessment	6.04	0.95	5.99	0.94
11	PRILS11	Efficiency of post-crash investigation	6.12	0.95	6.02	0.97
		Total	6.11	0.93	6.04	0.95

4.2. IPA grid and quadrant distribution

The IPA results classified post-crash response indicators into four strategic quadrants: Quadrant I (Post-Crash Response Excellence), Quadrant II (Post-Crash Response Focus), Quadrant III (Post-Crash Response Monitor), and Quadrant IV (Post-Crash Response Overkill). Fig. 2 presents the overall distribution of the two post-crash response factors, while Figs. 3 and 4 illustrate the placement of individual indicators under the PRICF and PRILSF factors, respectively. Rather than reiterating descriptive statistics, this section focuses on the strategic implications of quadrant positioning, highlighting the differing roles of indicators across quadrants in terms of performance maintenance, priority improvement, and continuous monitoring.

4.2.1. Analysis of the importance and performance of post-crash response factors

The Importance–Performance Analysis (IPA) results at the factor level are illustrated in Fig. 2, which presents the relative positioning of the two post-crash response factors. The Post-Crash Response Injury Care and Legislation Support Factor (PRILSF) is positioned within Quadrant I (Post-Crash Response Excellence), indicating high perceived importance combined with strong operational performance. This positioning reflects consistently effective implementation of emergency medical transfer, traffic control, and law enforcement procedures during post-crash operations. As a result, PRILSF represents a consolidated operational strength that contributes to overall system stability and should be sustained through continuous support, monitoring, and incremental refinement. In contrast, the Post-Crash Response Information and Coordination Factor (PRICF) is positioned within Quadrant III (Post-Crash Response Monitor), indicating comparatively lower perceived importance and lower performance relative to PRILSF. This placement suggests that, from the perspective of police officers, information coordination and inter-agency communication are not prioritized to the same extent as injury care and legal response functions, despite their functional relevance within the overall post-crash response process. The positioning of PRICF in Quadrant III should not be interpreted as indicating that

information and coordination functions are unimportant or redundant. Rather, it highlights a latent structural vulnerability within the post-crash response system, whereby coordination-related processes tend to operate in the background of frontline operations and may receive limited attention unless failures become visible. Lower performance levels across PRICF indicators—particularly those related to information transfer, dispatch coordination, and data verification—suggest that existing coordination mechanisms may be insufficient to support increasingly complex and multi-agency response demands in the Eastern Economic Corridor.

The contrasting factor-level positions of PRILSF and PRICF reveal a strategic imbalance within the post-crash response system. While injury care and legal enforcement functions demonstrate mature and reliable performance, information and coordination functions remain underdeveloped and under-recognized in terms of operational priority. From a system-level perspective, insufficient attention to PRICF may constrain the effectiveness of otherwise well-performing response components, especially under high-demand or complex incident scenarios. Accordingly, performance improvement strategies should adopt a monitoring and capacity-building approach for PRICF, focusing on the gradual enhancement of coordination structures, communication protocols, and information management capabilities. Strengthening PRICF over time can support better integration across agencies and improve overall system resilience, without diverting excessive resources from core medical and legal response functions that are already performing well.

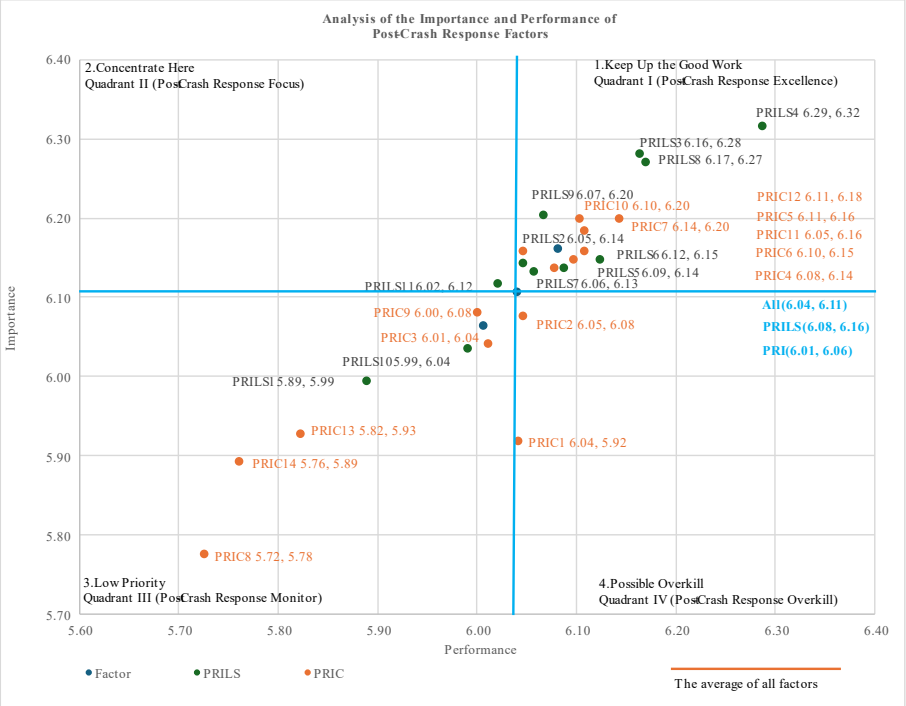

Fig. 2: Importance–performance analysis of overall factors

4.2.2. Analysis of the post-crash response information and coordination factor (PRICF)

The indicator-level IPA results for the Post-crash Response Information and Coordination Factor (PRICF) are presented in Fig. 3. PRICF is positioned within Quadrant III (Post-Crash Response Monitor), indicating comparatively lower perceived importance and lower overall performance relative to other post-crash response factors. However, a more detailed examination at the indicator level reveals a heterogeneous distribution across all four IPA quadrants, suggesting that information and coordination functions within PRICF do not perform uniformly. Several PRICF indicators are located in Quadrant I (Post-Crash Response Excellence), reflecting high importance and strong performance in areas such as crash information accuracy, documentation, and selected coordination practices. These indicators represent existing strengths within the information and coordination domain and demonstrate that certain components of PRICF have reached a relatively mature operational level. At the same time, a number of PRICF indicators are positioned in Quadrant III, indicating lower perceived importance and lower performance. From the perspective of police officers, this pattern suggests that some information and coordination functions are regarded as secondary to immediate frontline tasks, such as emergency medical assistance, traffic control, and legal procedures. While these indicators do not currently warrant urgent intervention, their positioning highlights the potential risk of systemic neglect if operational complexity continues to increase.

Notably, PRIC9 is positioned in Quadrant II (Post-Crash Response Focus), representing a critical exception within the overall PRICF pattern. Despite

the aggregate placement of PRICF in Quadrant III, the positioning of PRIC9 indicates that this specific coordination-related function is perceived as highly important but insufficiently performed. This divergence suggests a focal coordination gap and may signal an emerging operational risk within the post-crash response system. From a systems perspective, PRIC9 can be interpreted as a transitional indicator whose strategic importance is increasing more rapidly than its operational capability. This misalignment reflects a growing recognition among frontline personnel of the importance of the function captured by PRIC9, while existing coordination mechanisms, information systems, or procedural arrangements have not yet adapted to support its effective implementation. As a result, PRIC9 represents a priority area where targeted intervention may yield disproportionate benefits for improving overall coordination effectiveness.

Taken together, the mixed quadrant distribution of PRICF indicators suggests that performance improvement strategies should adopt a differentiated approach. Indicators positioned in Quadrant II, particularly PRIC9, require priority attention through focused enhancement of coordination structures, communication protocols, and information management capacity. In contrast, indicators located in Quadrant III should be subject to continuous monitoring and gradual capacity-building to prevent future performance deterioration. Strengthening PRICF in this manner will help mitigate latent coordination vulnerabilities and enhance the overall resilience of the post-crash response system as operational demands in the Eastern Economic Corridor continue to intensify.

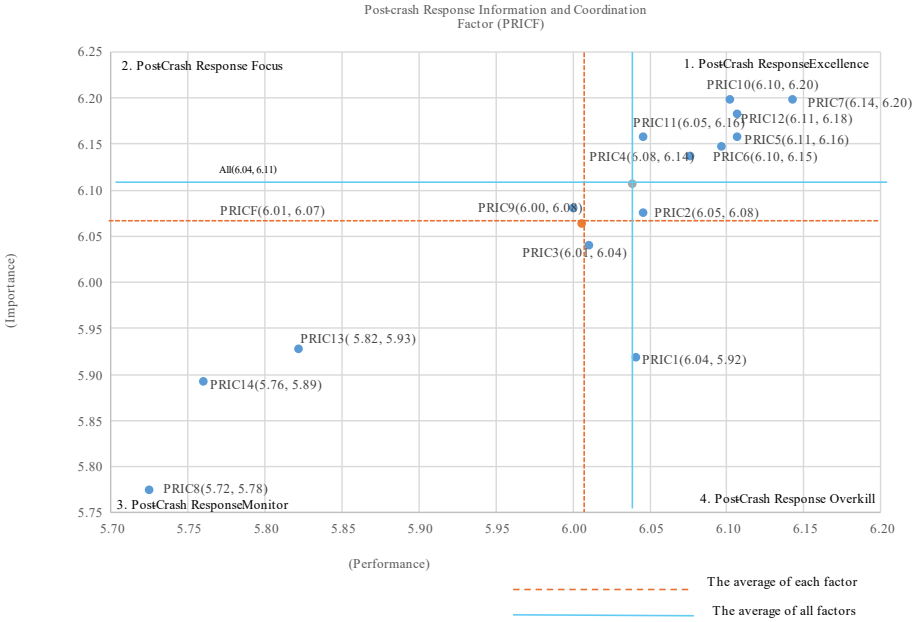

Fig. 3: Importance–performance analysis of indicators under the PRICF

4.2.3. Analysis of the post-crash response injury care and legislation support factor (PRILSF)

The indicator-level IPA results for the Post-crash Response Injury Care and Legislation Support Factor (PRILSF) are shown in Fig. 4. Most indicators are positioned in Quadrant I (Post-Crash Response Excellence), confirming that injury care, traffic control, and legal enforcement functions demonstrate consistently high importance and strong operational performance. These results indicate that PRILSF constitutes a mature and reliable component of the post-crash response system in the Eastern Economic Corridor.

Nevertheless, closer examination reveals that PRILS9 and PRILS11 warrant particular attention. Both indicators are located near the quadrant boundaries, reflecting high perceived importance but less consistent performance. This positioning suggests that, while legal enforcement and post-crash investigation are generally effective, their implementation may vary across agencies or operational contexts. Such variation may result in procedural inconsistencies in legal enforcement, evidence handling, and post-crash investigation processes.

From a system-level perspective, PRILS9 and PRILS11 represent stability-sensitive indicators whose effectiveness depends on regulatory clarity, procedural standardization, and inter-agency alignment. Although these gaps do not undermine the overall Quadrant I positioning of PRILSF, they highlight areas where targeted refinement could further strengthen procedural consistency and institutional reliability.

Overall, PRILSF remains a core strength of the post-crash response system. However, reinforcing legal standardization and investigative coordination—particularly with respect to PRILS9 and PRILS11—will be essential for sustaining high performance and ensuring long-term procedural efficiency and public trust.

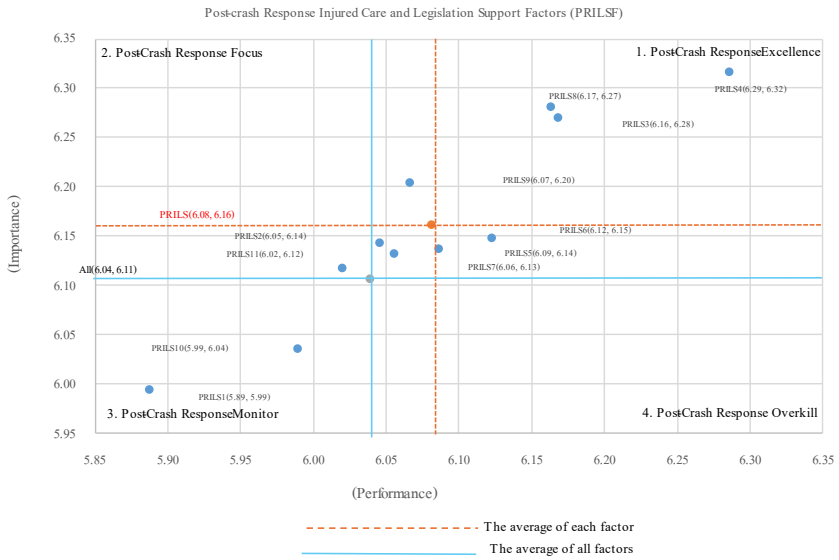

Fig. 4: Importance–performance analysis of indicators under the PRILSF

4.3. Summary of IPA findings

The results of the Importance–Performance Analysis (IPA), synthesized from Table 1 and Figs. 2–4, provide an integrated overview of post-crash response performance in Thailand's Eastern Economic Corridor (EEC). Across nearly all indicators, perceived importance exceeded performance, confirming the presence of systematic performance gaps within the response system. At the factor level, the Post-crash Response Injury Care and Legislation Support Factor (PRILSF) was positioned in Quadrant I (Post-Crash Response Excellence), indicating high importance and strong performance. This finding underscores the reliability of emergency medical transfers, traffic control, and legal enforcement procedures, which collectively form a stabilizing foundation for post-crash response operations. In contrast, the Post-crash Response Information and Coordination Factor (PRICF) was located in Quadrant III (Post-Crash Response Monitor), reflecting lower perceived priority and comparatively weaker performance.

The contrast between PRILSF and PRICF reveals a structural imbalance within the post-crash response system. While frontline medical care and legal procedures operate with relatively high capability, their effectiveness is constrained by upstream limitations in information flow, communication, and coordination mechanisms. As illustrated in Fig. 5, weaknesses in PRICF can limit the overall efficiency of downstream injury care and legislative support, even when these functions perform well in isolation.

Taken together, the IPA findings indicate that overall system performance is constrained not by deficiencies in medical or legal competence, but by coordination-related processes. Addressing this imbalance requires a differentiated strategy that maintains the strengths of PRILSF while progressively strengthening PRICF through improved information management, inter-agency coordination, and system integration. These insights provide a strategic foundation for the development of an integrated post-crash response performance model, as discussed in the following section.

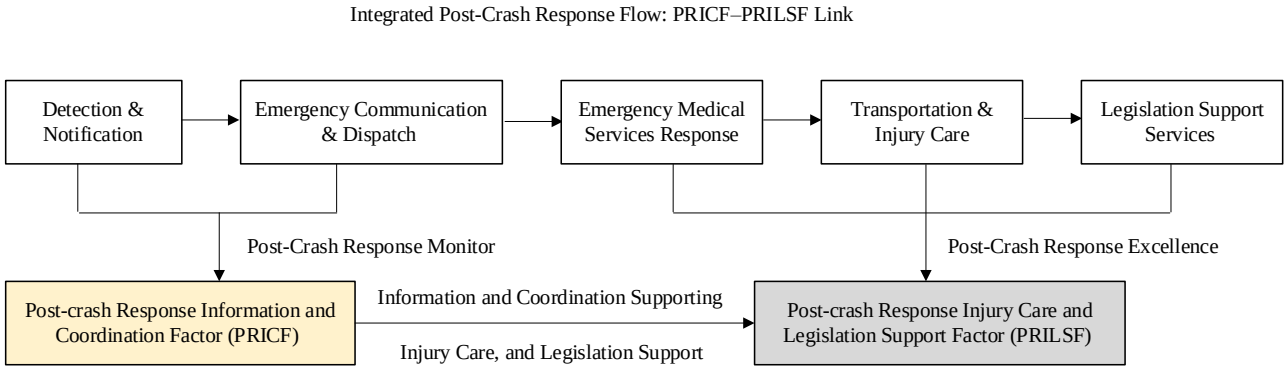

Fig. 5: PRICF–PRILSF integrated response flow

Fig. 5 illustrates this relationship through the PRICF–PRILSF Integrated Response Flow, demonstrating how upstream functions—Detection & Notification and Emergency Communication & Dispatch (PRICF)—sequentially enable downstream Emergency Medical Services Response, Transportation & Injury Care, and Legislation Support Services (PRILSF). Effective information

coordination facilitates timely mobilization and informed decision-making, thereby reducing injury severity and mortality risk. Conversely, deficiencies in PRICF constrain subsequent response stages, resulting in suboptimal medical and legal outcomes despite otherwise strong operational capacity.

Fig. 6 presents the Post-crash Response Management Model integrated with the IPA results, translating the empirical findings into a system-level performance framework. The model positions the Post-crash Response Information and Coordination Factor (PRICF) in Quadrant III, representing upstream functions such as detection, notification, and emergency communication that operate as enabling inputs to the response system.

In contrast, the Post-crash Response Injury Care and Legislation Support Factor (PRILSF) is located in Quadrant I, reflecting strong performance in downstream medical, legal, and rehabilitation processes.

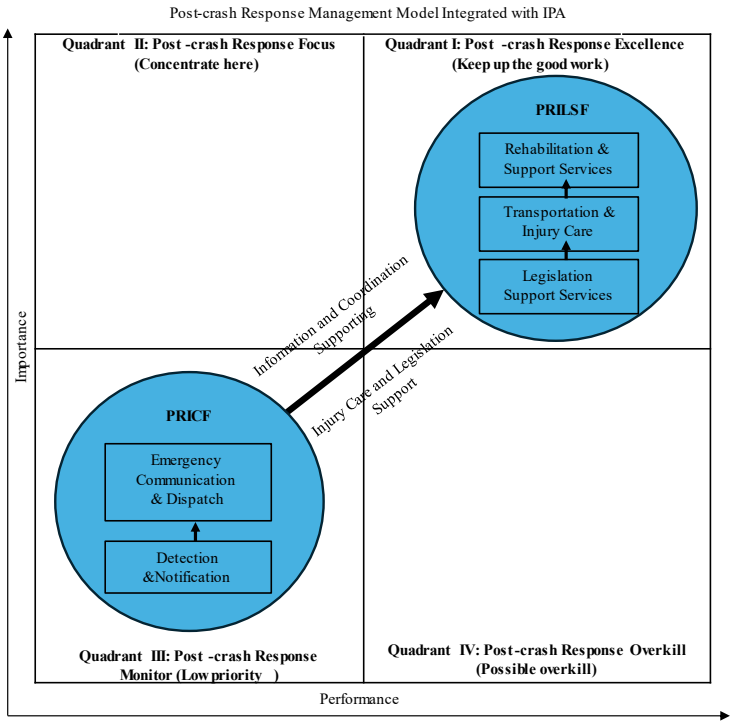

Fig. 6: A performance model for post-crash response management

The directional linkage between PRICF and PRILSF illustrates that effective injury care and legislative support outcomes depend on timely and coordinated information flow. Accordingly, the model highlights that overall post-crash response performance is constrained not by deficiencies in medical or legal capability, but by limitations in information coordination. Strengthening PRICF therefore represents the primary leverage point for system-wide performance improvement, while maintaining excellence in PRILSF remains essential for sustaining response effectiveness.

4.4. Discussion

The Importance–Performance Analysis (IPA) results indicate that the post-crash response system in Thailand's Eastern Economic Corridor (EEC) exhibits both consolidated strengths and latent structural vulnerabilities. At the factor level, the Post-crash Response Injury Care and Legislation Support Factor (PRILSF) was positioned in Quadrant I (Post-crash Response Excellence), reflecting strong performance in emergency medical transfer, traffic control, and legal enforcement. In contrast, the Post-crash Response Information and Coordination Factor (PRICF) was located in Quadrant III (Post-crash Response Monitor), indicating comparatively lower perceived importance and performance. This contrast suggests that, although medical and legal response functions operate effectively, information coordination and inter-agency communication remain under-recognized within the overall response system.

Importantly, indicator-level analysis revealed that selected coordination-related indicators—most notably PRIC9—were positioned in Quadrant II (Post-crash Response Focus), signaling emerging priority areas where perceived importance has begun to outpace operational performance. This pattern indicates that information integration and command coordination are becoming increasingly critical under complex response conditions, even though they have not yet been fully institutionalized as high-priority functions. As a result, limitations in upstream information coordination constitute a key constraint on system-wide effectiveness, despite the maturity of medical and legal services.

These findings are consistent with international frameworks and prior research. The World Health Organization (WHO, 2016) emphasizes early detection, effective communication, and unified

coordination as core elements of emergency response effectiveness. Similarly, studies on emergency and disaster management highlight that fragmented communication structures and the absence of centralized coordination often delay decision-making and reduce operational precision (Comfort, 2007; Kapucu and Garayev, 2011). The EEC case extends this literature by providing empirical evidence that strong medical and legislative capacity alone is insufficient to ensure system-wide efficiency without effective information coordination.

From a theoretical perspective, this study advances the application of IPA in public safety management. While IPA has traditionally been employed in service quality and logistics contexts (Martilla and James, 1977; Azzopardi and Nash, 2013), its integration with a factor-based framework (PRICF–PRILSF) demonstrates its utility for diagnosing structural imbalances and guiding strategic prioritization in multi-stakeholder emergency systems.

The integration of IPA results into the conceptual model yields clear implications for policy and practice. Strengthening digital communication infrastructure, improving interoperability across agencies, and enhancing coordination capacity through targeted training and unified command arrangements are essential for addressing weaknesses in PRICF. At the same time, sustaining high performance in PRILSF requires continuous reinforcement of medical and legal procedures through training, simulation, and periodic cross-agency evaluation.

The findings suggest that post-crash response management in Thailand is transitioning from functionally fragmented operations toward a more integrated and data-driven paradigm. The interaction between PRICF and PRILSF, as illustrated in Figs. 5 and 6, provides a strategic roadmap for operational enhancement and policy development aimed at reducing preventable road-crash fatalities and strengthening emergency-management resilience in the EEC and comparable contexts. Importantly, this study moves beyond performance description to offer an actionable framework for system-level improvement.

5. Conclusions

This study evaluated the performance of post-crash response indicators in Thailand's Eastern Economic Corridor (EEC) using Importance–Performance Analysis (IPA). Twenty-five indicators were examined under two key factors: the Post-crash Response Information and Coordination Factor (PRICF) and the Post-crash Response Injury Care and Legislation Support Factor (PRILSF), based on data collected from 196 police officers. The results provide a systematic assessment of operational strengths and performance gaps within the regional post-crash response system.

The findings indicate that although both importance and performance ratings were generally high, performance consistently lagged behind perceived importance, revealing clear improvement needs. At the factor level, PRILSF was positioned in Quadrant I (Post-crash Response Excellence), reflecting strong and reliable execution of injury care, traffic management, and legislative procedures. In contrast, PRICF was located in Quadrant III (Post-crash Response Monitor), indicating that information management, dispatch coordination, and inter-agency communication remain comparatively under-prioritized. At the indicator level, however, the presence of high-importance coordination indicators in Quadrant II signals emerging systemic pressures that require strategic attention.

Three overarching conclusions can be drawn. First, the EEC demonstrates mature operational capability in injury care and legislation support, which should be preserved and institutionalized as best practice. Second, deficiencies in information flow and coordination represent the most critical constraints on overall system effectiveness, highlighting the need for targeted investment in communication infrastructure, interoperable protocols, and integrated command mechanisms. Third, the IPA framework proved effective in diagnosing performance gaps and supporting evidence-based prioritization within a complex, multi-agency emergency response system.

From a policy and operational perspective, strengthening post-crash resilience requires upgrading digital communication systems, enhancing data-sharing interoperability, and implementing focused capacity-building programs for first responders. Establishing a more integrated command framework in the EEC would further improve coordination efficiency and response timeliness, while sustained reinforcement of medical and legal procedures is essential for maintaining high PRILSF performance.

Although this study focused on the EEC, the proposed performance model is transferable to other high-risk regions in Thailand and to comparable contexts in Southeast Asia. Strengthening PRICF is expected to yield broader benefits by improving the speed, consistency, and quality of first-responder services, thereby enhancing national road-safety resilience.

5.1. Limitations and future research

This study relied on self-reported perceptions from police officers, which may not fully capture the perspectives of other stakeholders involved in post-crash response. Future research should incorporate viewpoints from medical personnel, rescue organizations, insurance agencies, and crash victims to provide a more comprehensive assessment. Longitudinal and intervention-based studies are also recommended to evaluate the long-term impacts of communication-system enhancements and targeted

training initiatives on post-crash response performance.

List of abbreviations

EEC	Eastern economic corridor
EFA	Exploratory factor analysis
IPA	Importance–performance analysis
KMO	Kaiser–Meyer–Olkin
PRICF	Post-crash response information and coordination factor
PRILSF	Post-crash response injury care and legislation support factor
S.D.	Standard deviation
WHO	World Health Organization

Compliance with ethical standards

Ethical considerations

All participants provided informed consent before joining the study. They were personnel involved in post-traffic crash response operations. The study protocol was approved by the Ethics Committee of Burapha University (IRB No. IRB4-160/2024).

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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