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Assessing Performance Efficiency and Operational Challenges of Emergency Medical Services in Samut Songkhram, Thailand: A Mixed-Methods Study

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Abstract

Background: Emergency medical services (EMS) are essential for saving lives and ensuring rapid response during emergencies and disasters. The performance efficiency of EMS systems is a critical component of public health infrastructure, particularly in areas with limited resources.

Objectives: The present study assessed the performance efficiency and operational challenges of EMS in Samut Songkhram province, Thailand.

Methods: A mixed-methods design was employed. Quantitative data were collected from 280 EMS personnel across five units using validated instruments: A 30-item Operational Challenges Scale [Content Validity Index (CVI) = 0.89, $\alpha = 0.92$] and a 27-item Performance Efficiency Scale (CVI = 0.92, $\alpha = 0.90$). Qualitative insights were obtained from focus group discussions with five EMS leaders. Descriptive statistics, multiple regression analysis, and thematic content analysis were applied.

Results: Operational problems were generally rated as very low to low, while overall EMS efficiency was rated as high. Regression analysis indicated that personnel-related challenges ($\beta = 0.526$, $P < 0.001$) and administrative issues ($\beta = -0.132$, $P = 0.010$) were significant factors associated with efficiency, while operational issues demonstrated borderline significance ($\beta = 0.098$, $P = 0.055$).

Conclusions: The EMS units in Samut Songkhram demonstrate strong operational efficiency, particularly regarding response times and equipment readiness. However, personnel and administrative challenges persist. Addressing staffing shortages, improving inter-agency coordination, and ensuring equitable funding are critical to sustaining EMS performance and resilience in Thailand and other low- and middle-income country (LMIC) contexts.

Keywords: Emergency Medical Services, Efficiency, Emergency Care, Disasters

1. Background

Emergency medical services (EMS) are a vital component of health systems worldwide, providing essential life-saving care during both routine emergencies and catastrophic events. The timely delivery of pre-hospital interventions can significantly influence survival outcomes in critical medical situations; for instance, research indicates that rapid ambulance response correlates with notably higher survival rates in cases of out-of-hospital cardiac arrest (1, 2). In large-scale disasters, the public depends on EMS first responders for immediate medical assistance and triage, and these agencies have consistently demonstrated their vital role in supporting communities during crises (3). Recognizing this importance, numerous countries prioritize the strengthening of EMS as a key component of disaster

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preparedness (4). Thailand, frequently challenged by natural disasters and high accident rates, has taken proactive steps to enhance its emergency response capabilities (5). The integration of EMS into disaster response strategies underscores the crucial role of a well-functioning EMS system in enhancing public health and fostering community resilience in the face of emergencies (6).

Thailand's EMS has developed significantly over the past two decades, particularly following the Emergency Medical Act of 2008, which established the National Institute for Emergency Medicine (NIEM) to oversee and standardize EMS nationwide (7). This reform introduced a unified emergency hotline (1669) and established standards for training and equipment, resulting in a rapid expansion of the ambulance network and the recruitment of thousands of trained EMS personnel (8). However, these services have increasingly been used for non-urgent and even social purposes. Consequently, during natural disasters or emergencies, the capacity of these services is restricted and may even lead to negative outcomes and unnecessary fatalities (9). There is a growing need for pre-hospital emergency care and ambulance services (10). This underscores the importance of strategic planning for EMS, which includes ambulance services and Emergency Medical Dispatch Centers (EMDCs) (11).

Previous studies have identified key operational problems hindering EMS performance in Thailand. Surveys among EMS providers reveal issues such as a lack of trained personnel, shortages of medical equipment, and poor coordination among agencies (8). A nationwide survey indicates inadequate staffing and equipment as the most pressing challenges (12). While Thailand's EMS system has expanded, formal evaluations of its performance remain limited, focusing primarily on general service outcomes rather than specific efficiency challenges (8). Experts emphasize the importance of systematic performance assessments and detailed research, particularly at the provincial level, to enhance pre-hospital care delivery (7). Addressing these gaps is essential for strengthening EMS, especially in smaller provinces with unique resource constraints.

Samut Songkhram in central Thailand had not previously been studied for EMS performance. Our findings will inform targeted interventions, such as enhanced training for EMS personnel and improved inter-agency coordination, thereby enhancing emergency service delivery and strengthening health system resilience against disasters.

2. Objectives

The present study aimed to assess the operational efficiency of EMS in the province and identify influencing factors. Using a mixed-methods approach, we quantitatively measured operational issues related to personnel, administration, and on-scene activities, while qualitatively gathering insights from EMS unit leaders through focus group discussions. The objectives were to evaluate the extent of operational problems and performance efficiency, as well as their interrelationship.

3. Methods

3.1. Study Design and Setting

This mixed-methods study combined quantitative surveys with qualitative focus group discussions to assess EMS operational challenges and efficiency. The study was conducted in Samut Songkhram province, Thailand, with data collected between June 1 and October 31, 2023.

3.2. Participants and Sampling

The quantitative survey included all available EMS personnel in the province (n = 280), drawn from five units: Sawang Benjathum (n = 120), Sappharachen (n = 70), and emergency departments from three hospitals — Somdet Phra Phutthaloetla (n = 30), Naphalai (n = 30), and Amphawa (n = 30). A census sampling method was used, whereby all available EMS personnel in the province were invited to participate. Inclusion criteria were full-time EMS personnel or hospital emergency staff with at least six months of work experience in Samut Songkhram province. Exclusion criteria included: (1) Administrative personnel not engaged in field operations or patient care; (2) volunteers, trainees, or students without independent clinical responsibilities; and (3) individuals who declined or withdrew informed consent.

For the qualitative phase, five EMS leaders (heads of EMS units or hospital emergency departments) were purposively selected to capture managerial perspectives. Due to the small number of EMS leaders in the province, only five participants were available; this is acknowledged as a limitation.

3.3. Research Instruments

3.3.1. Quantitative Data Personal Information

This section consisted of four multiple-choice questions covering gender, age, and education level.

- Operational challenges in EMS: This section comprised 30 items, each rated on a 5-point Likert scale (1 - 5). Respondents who had either received or observed EMS were asked to evaluate the operational challenges faced by EMS. The items are divided into three categories: Personnel-related issues (10 items), administrative issues (10 items), and operational issues (10 items). The interpretation of the mean scores is as follows: Very low (1.00 - 1.50); low (1.51- 2.50); moderate (2.51 - 3.50); high (3.51 - 4.50); very high (4.51 - 5.00) (13). The content validity was evaluated by a panel of five experts, resulting in a Content Validity Index (CVI) of 0.89 and a Cronbach's alpha coefficient of 0.92.

- Performance efficiency: This section comprised 27 items rated on a 5-point Likert scale (1 - 5), with 1 representing the lowest level of efficiency. The items were categorized into three dimensions: Personnel (10 items), equipment and tools (7 items), and response time (10 items). The interpretation of the mean scores was as follows: Very low (1.00 - 1.50); low (1.51- 2.50); moderate (2.51 - 3.50); high (3.51 - 4.50); very high (4.51 - 5.00) (13). The content validity was evaluated by a panel of five experts, resulting in a CVI of 0.92 and a Cronbach's alpha coefficient of 0.90.

3.3.2. Data Collection

- Quantitative phase: Quantitative data were collected between June 1 and October 31, 2023, during regular EMS working hours (8:00 a.m. - 4:00 p.m.), using a self-administered questionnaire distributed via Google Forms. This schedule was chosen to ensure participants could complete the survey during their designated shift periods. Participants were briefed on the study objectives, inclusion criteria, and confidentiality measures, and informed consent was obtained. Each participant required approximately 20 - 30 minutes to complete the survey.

- Qualitative phase: Qualitative data were gathered through focus group discussions with five EMS leaders, conducted in October 2023. Sessions lasted 60 - 90 minutes and were audio-recorded with participant permission. Each discussion took place at the participants' EMS stations between 1:00 p.m. and 3:00 p.m., a period identified as operationally least disruptive.

3.4. Data Analyses

Quantitative data were meticulously analyzed using SPSS software. Descriptive statistics — including frequency counts, percentages, median values, means (M), and standard deviations (SD) — were employed to provide a comprehensive summary of participants' demographic characteristics, the extent of operational challenges they faced, and their overall performance efficiency. To explore the associations between these operational challenges and performance efficiency, multiple regression analysis was conducted, with a significance threshold set at $P < 0.05$. In addition, the qualitative component of the study involved rigorous content analysis to identify recurring themes and patterns. This approach enabled a nuanced understanding of the complex issues that impact EMS operations, highlighting the critical factors that affect their effectiveness and efficiency.

4. Results

4.1. Characteristics of Participants

A total of 280 participants took part in the study. Most were male (57.86%), and the majority were aged between 21 - 40 years (80%). In terms of educational background, 71.07% held a bachelor's degree, and 9.29% had a postgraduate degree. Most participants were government officers or employees of state enterprises (54.04%) (Table 1).

Table 1. Characteristics of Participants (n = 280)

Factors	No. (%)
Sex	
Male	162 (57.86)
Female	118 (42.14)
Age (y)	
< 21	16 (5.71)
21 - 30	107 (38.21)
31 - 40	117 (41.79)
41 - 50	34 (12.14)
> 50	6 (2.14)
Education level	
High school	5 (1.79)
Associate degree/high vocational certificate	23 (8.21)
Bachelor's degree	199 (71.07)
Higher than bachelor's degree	26 (9.29)
Currently studying	27 (9.64)

Table 2 shows that 50% of emergency service personnel in Samut Songkhram reported minimal

operational problems, while the other half rated them as low. For performance efficiency, 53.21% of respondents viewed emergency services as very good, and 46.79% rated them as good, indicating a positive assessment of EMS operations in the province.

Table 2. Summary of Operational Problems and Performance Efficiency

Factors	No. (%)
Level of operational problems	
Very low	140 (50.00)
Low	140 (50.00)
Level of performance efficiency	
Very high efficiency	149 (53.21)
High efficiency	131 (46.79)

In Table 3, personnel-related and administrative challenges were rated in the "very low" range (M = 1.49, SD = 0.37; M = 1.50, SD = 0.34, respectively), while operational challenges were slightly higher but still classified as "low" (M = 1.54, SD = 0.39). In terms of performance efficiency, equipment and supplies (M = 4.56, SD = 0.45) and response time (M = 4.70, SD = 0.44) were both rated "very high", whereas personnel efficiency was comparatively lower, though still favorable, at "high" (M = 3.52, SD = 0.48).

Table 3. Mean and Standard Deviation of Operational Problems by Category (n = 280)

Factors	Mean ± SD	Interpretation
Operational problem overall	1.51 ± 0.10	Low
Personnel	1.49 ± 0.37	Very low
Administration	1.50 ± 0.34	Very low
Operations	1.54 ± 0.39	Low
Performance efficiency overall	4.26 ± 0.42	High efficiency
Personnel	3.52 ± 0.48	High efficiency
Equipment and supplies	4.56 ± 0.45	Very high efficiency
Response time	4.70 ± 0.44	High efficiency

In Table 4, the multiple regression analysis indicated that variance in EMS efficiency was significant (Adjusted R^2 = 0.290, F = 38.99, P < 0.05). Personnel-related challenges had the highest standardized coefficient (β = 0.526, P < 0.001), indicating a strong association with efficiency outcomes, while administrative issues showed a smaller but significant negative association (β = -0.132, P = 0.010). However, operational issues did not reach statistical significance (P = 0.055).

4.2. Qualitative Insights

Focus group interviews with five EMS leaders provided valuable context for the survey findings. Participants highlighted communication delays, often due to unclear incident locations, and uneven levels of training among responders. One supervisor explained: "Sometimes our team loses valuable minutes because the location is unclear, and responders are not fully trained to handle complex emergencies."

Participants also described the differences between hospital-based and volunteer EMS teams. Hospital teams typically had better-equipped ambulances and specialized staff, while volunteer responders were more accessible and quicker to mobilize. As one EMS leader noted: "Our hospital teams have more equipment, but volunteers are usually the first to arrive. People in the community call them because they are nearby and can respond faster."

These perspectives help to triangulate the quantitative findings, linking personnel-related challenges (training and preparedness) with administrative issues (coordination between hospital and volunteer teams). Together, the results reveal a consistent picture: EMS units are generally efficient, but gaps in human resources, communication, and system integration remain important barriers to optimal performance.

5. Discussion

The present study examined the operational challenges and performance efficiency of EMS in Samut Songkhram province using a mixed-methods design. Overall, EMS units reported relatively low operational problems and high performance efficiency, particularly in equipment readiness and response times. However, personnel and administrative challenges emerged as key associated factors of reduced efficiency, while operational issues demonstrated a borderline association.

Our findings partially align with Pattanarattanamolee et al. (14), who reported low perceived EMS problems among village health volunteers. However, they contrast with Sittichanbuncha et al. (8), who identified severe gaps in staffing, training, and resources at the national level. This discrepancy may reflect contextual differences. Samut Songkhram is a smaller province with closer coordination networks and lower service demand, whereas national surveys encompassed larger, more complex systems with greater resource strain. The present results underscore the importance of conducting provincial-level evaluations to capture heterogeneity in EMS performance across Thailand.

Table 4. Regression Coefficients and Statistical Significance of Factors Influencing Emergency Medical Services Performance (n = 280) [a]

Variables	Unstandardized Coefficients		Standardized Coefficients	*t*-test	P-Value
	B	Std, Error	Beta		
Personnel	0.335	0.032	0.526	10.414	< 0.001
Administration	-0.092	0.035	-0.132	-2.598	0.010
Operations	0.062	0.032	0.098	1.923	0.055

[a] $R^2 = 0.298$, adjusted $R^2 = 0.290$, F = 38.99.

Regression analysis revealed that personnel-related problems had the strongest association with EMS efficiency (β = 0.526, P < 0.001), followed by administrative issues (β = -0.132, P = 0.010). Operational challenges were not statistically significant but approached significance (β = 0.098, P = 0.055), suggesting that factors such as communication delays and on-scene procedures may influence performance and warrant further study. The regression model in EMS performance suggests that other environmental and systemic factors — such as resource allocation, transportation conditions, and inter-agency coordination — may also play a significant role.

The qualitative findings provided depth to these quantitative patterns. For instance, while personnel-related challenges emerged statistically, focus group participants emphasized communication barriers and gaps in advanced medical training as key operational obstacles. One supervisor explained, “Sometimes our team loses valuable minutes because the location is unclear, and responders are not fully trained to handle complex emergencies.” Another leader contrasted the strengths of hospital-based versus volunteer EMS units, noting, “Our hospital teams have more equipment, but volunteers are usually the first to arrive. People in the community call them because they are nearby and can respond faster.” These perspectives illustrate the complex interplay between personnel capacity, training, and accessibility — dimensions only partly captured by the survey measures.

Taken together, these findings highlight the need for systemic reforms beyond individual-level training. While investment in competency-based training remains vital (15, 16), addressing staffing shortages through strategic workforce planning is equally important (8). Strengthening inter-agency coordination between hospitals, volunteer responders, and provincial authorities would also reduce communication delays and improve system responsiveness (17, 18). Furthermore, revising EMS financing models to ensure equitable resource allocation — particularly to smaller or rural provinces — would help address persistent disparities in staffing and equipment distribution (12). These recommendations echo global EMS strengthening priorities identified in low- and middle-income countries (3, 19) and align with the World Health Organization’s frameworks for emergency care systems, which emphasize integration, equity, and preparedness (20).

5.1. Conclusions

This mixed-methods study demonstrated that EMS in Samut Songkhram province functions efficiently overall, especially in equipment readiness and response times, but faces significant challenges related to personnel and administration. While these issues accounted for nearly one-third of the variance in performance, a substantial portion of variability remains unexplained, likely reflecting broader systemic, environmental, and socio-cultural factors. Addressing these challenges requires not only continuous training and workforce development but also policy-level reforms in resource allocation, inter-agency coordination, and financing. Strengthening EMS systems at both provincial and national levels will enhance equity and resilience in Thailand’s emergency response and offer lessons for other low- and middle-income countries facing similar challenges.

5.2. Implications

The findings of this study carry important implications for both practice and policy. At the practice level, ongoing competency-based training is essential for EMS personnel, particularly in areas such as advanced life support, emergency decision-making, and critical thinking under pressure. These skills not only enhance the confidence and effectiveness of nurses and first responders but also strengthen the overall quality of pre-hospital care.

At the policy level, addressing staffing shortages through strategic workforce planning should be prioritized. This includes ensuring appropriate staff-to-population ratios and creating incentives to retain skilled personnel in provincial EMS units. In addition, inter-agency coordination between volunteer responders, hospital-based EMS teams, and regional authorities must be enhanced to reduce communication delays and improve system responsiveness. Another area for reform is EMS financing. Revising funding models to secure equitable resource allocation —particularly in terms of medical equipment and personnel distribution — will help to balance disparities between rural and urban settings. Together, these practice and policy strategies represent a comprehensive approach to sustaining the efficiency of EMS operations and building resilience in emergency healthcare delivery systems.

5.3. Limitations

This study has several limitations. First, it was limited to a single province, reducing generalizability. Second, self-reported survey data may be affected by social desirability bias. Third, pre-survey briefings could have introduced a Hawthorne effect, with participants altering responses due to awareness of the study. Fourth, data were collected between June and October, which may not reflect seasonal variation in EMS demand and performance. Fifth, the qualitative sample was limited to five EMS leaders; thematic saturation may not have been achieved. Future research should employ multi-province, longitudinal designs with larger qualitative samples to capture broader perspectives.

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Footnotes

Authors' Contribution: Methodology: J. O., A. W., and B. C.; Software: J. O., T. B., and B. C.; Formal analysis: J. O. and B. C.; Writing — original draft preparation: J. O., A. W., T. B., and B. C.; Writing — review and editing: J .O., A. W., T. B., and B. C. All authors have read and agreed to the published version of the manuscript.

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Data Availability: The data sets of this study are not publicly available due to information that could compromise the privacy of the research participants. However, data may be shared upon request to the authors.

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