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Research Article

AI-Assisted Thematic Analysis of EMS Workforce Resilience: Insights from Thailand's Emergency Care System

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Abstract: Thematic analysis of the Thai emergency medical service (EMS) is conducted with the support of an AI-assistant tool, NotebookLM. Initially, the results from AI in a few tasks related to thematic analysis are compared with those from manual analysis. Subsequently, the same collected dataset was analyzed entirely using NotebookLM with the analysis method following classical steps of thematic analysis through the designed series of prompts. The AI-generated report indicates major factors influencing Thai EMS, including policy governance, infrastructure and resources, community engagement, system resilience and preparedness, and workforce development. Although the AI tool can streamline data analysis and save time, its results are still less comprehensive than the manual analysis conducted by the researcher.

Keywords: emergency medical service, working environment, occupational safety, professional training, thematic analysis, artificial intelligence tool

Introduction

An emergency medical service (EMS) is a comprehensive system that provides the arrangements of personnel, facilities, and equipment for the effective, coordinated, and timely delivery of health and safety services to victims of sudden illness or any emergency events (Al-Shaqsi, 2010). The main components of the EMS system include community-level care, pre-hospital care, in-hospital treatment, and post-hospital management. Each component is crucial to save life, and they should work in coordination to prevent death and disability (Olive C, 2006). The EMS of Thailand adopts the combined models of Anglo-American (Scoop and Run) and Criteria Based Dispatch (CBD) (Nimmolrat et al., 2021) and also follows Service d'Aide Médicale Urgente (SAMU) from France. The service providers are trained by the Australian education system, while the division and classification of healthcare facilities are based on the American College of Surgeons model (JICA, 2015).

EMS workforce serves on the front lines of emergency medical care, which is one of the most important components in an EMS system of any country. They are a critical part of the nation’s emergency response system and the front line of medical responses (Administration, 2011; OSHA, 2009). EMS providers, as health care providers, play an

important role in preventing and containing the spread of infectious diseases, delivering proper pre-hospital care to the patients, and are important for overall response and service delivery. However, there is evidence suggesting that solely education and training are insufficient in the preparation of pre-hospital staff when an emergency occurs. Undoubtedly, the mental health of first responders is a compelling concern, especially during infectious disease mass outbreaks, reducing their coping level and proper mechanisms (Sánchez-Zaballos & Mosteiro-Díaz, 2021; Ventura et al., 2020). Paramedics, emergency medical technicians, ambulance drivers, nurses, and other staff of the EMS system constitute a high-risk working group dealing with adverse mental health impacts (Du et al., 2022). To address the behavioral and mental health issues and various challenges faced by the EMS workforce, supporting their resilience through a process of recovery following those adverse events becomes necessary. This involves behavioral, cognitive, and affective responses that support positive adaptation of psychological well-being and functioning. Workforce resilience is strongly associated with their life and job satisfaction, improved coping ability, and self-esteem (Foster et al., 2020).

Existing theories and frameworks relevant to the personal resilience capacities of the EMS workforce reveal knowledge gaps on how to properly respond during public health emergencies. Resilience is important in frontline workers as it will help them adapt to unforeseen circumstances. Staying resilient means utilizing the resources available at the scene, properly mobilizing the emergency service providers, and ensuring the safety of all involved (Sagan et al., 2021). There exists limited data on emergency care delivery during emergencies and the factors that influence the capacity and coping mechanisms of the EMS workforce. The latest pandemic has caused increased burnout and stress among the EMS providers, with uncertain long-term mental and physical health effects, which are yet to be researched in Thailand. No previous studies have specifically addressed the evaluation of resilience capacities of the front-line workers or identified resilience measurement tools in the context of Thai EMS providers. The events of previous years have brought attention to the importance of emergency care workers' resilience in protecting them from the most stressful situations and adversities.

To gain further insights into the Thai EMS, we conducted thematic analysis on the collected data. Different from previous attempts, an AI assistant tool, NotebookLM, was applied to aid the research. Using an AI tool, especially the ones developed with a large language model (LLM), is a recent trend in analyzing research data (Christou, 2023).

NotebookLM

NotebookLM, developed by Google, is designed to be an AI research assistant tool (Google, 2025). It received a few notable awards, including "The Best Inventions of 2024" by Time magazine (Booth, 2024), "Technical Achievement" by Webby Awards (Webby Awards, 2025), and "Best AI Research Tool" by Tom's Guide (Hughes, 2025). Initially launched as a web application in 2023, it is now available on Android and IOS ("NotebookLM", 2025). While other AI tools, such as ChatGPT and Gemini, target general audiences for general inquiries, NotebookLM focuses on research and education purposes and contains several specialized functions as described next. An AI tool having similar capabilities to NotebookLM does not exist.

The intelligence of NotebookLM is powered by the Gemini 2.0 model at the time of this research. Several useful features available to students, educators, and researchers are listed below.

1. Summarization of a document. Students and researchers can upload learning materials or research articles in various file formats such as text, Google Docs and Slides, PDFs. Website URLs, video, and audio can also be used as sources.

In addition, NotebookLM can search new sources on the Internet. Once the sources are uploaded, the user can chat through a chatbot window to gain information from the selected sources. For audio files, NotebookLM automatically transcribes the audio into text. This is ideal for qualitative researchers who may have conducted interviews and want to summarize the content quickly. Streamlining this data preparation task makes NotebookLM a particularly useful choice as an AI research assistant.

2. Generation of briefing document, study guides, FAQs, and timelines. The "Briefing doc" function provides an executive summary and details of the source content. The Study guide collects keywords and questions that students are expected to understand and answer. It also has a quiz and answers, which are beneficial for review. FAQs and timelines are additional learning formats that allow learners to quickly recall key concepts.
3. Creation of a mind map. Within seconds, NotebookLM draws a mind map from the source content. Learners see the big picture of the content, and can expand each branch in the mind map for more detail. When a branch of a key idea is expanded, the corresponding detailed information is shown on the chatbot interface. Widely recognized in education contexts, a mind map is an effective tool for student learning for illustrating associations between concepts (Davies, 2011). In our case, the mind map aids the researcher in identifying patterns in the data.
4. Generation of podcasts. Depending on the amount of source material, generating a podcast can take several minutes. The length of podcasts can be customized to short (≈5 mins), default (≈10 mins), or long (≈20 mins). The podcast can be downloaded in an .m4a file, allowing users to access it flexibly. The effectiveness of podcasts in learning has been explored, and students have reported as more effective than textbooks or their own notes (Evans, 2008).
5. Generation of narrative presentations. This recent feature creates narrated video slideshows from the learning content (Wang & Bin Shafqat, 2025). Visuals are recognized as effective in multimedia instruction (Mayer, 2011).

With support for more than 50 languages and a free version available, NotebookLM adoption is expected to be widespread in educational and research communities worldwide. With respect to data privacy, the uploaded sources will not be used for model training (Google, 2025).

Literature Review

Every country or state delivers EMS in different ways. In Asia, the EMS systems are developing rapidly and are in different states and maturity. For example, Singapore, Japan, and Korea have a comprehensive and systematic emergency care system. However, in other countries, the system is still in its infancy, which needs several improvements (Rahman et al., 2015). Emergency care should be accepted as an entire system having different components interlinked with each other. All components must work together in a coordinated manner in order to provide effective and efficient health care to the public (Olive C, 2006). There is insufficient research on which components of the emergency medical system have the most crucial role, which mechanism is most effective to provide quality of care, increase accessibility, and improve the emergency care service delivery, based on country context (Moresky et al., 2019). In many countries, the unbroken chain of care provided from the scene until transporting victims and patients to the hospital's emergency unit is neglected, which leads to an increasing number of deaths and disability.

For strengthening the health care system properly and effective pre-hospital care, community first aid, and availability of emergency services in all first-level hospitals are crucial, which will help save many lives (World Health Organization, 2019).

The EMS services in Thailand are divided into 4 levels of advanced life support (ALS), intermediate life support (ILS), basic life support (BLS), and first responder service (FR). In the past, there was an availability of medical transport services for injured people residing in urban areas of Thailand, with limited coverage. The service was provided by a group of volunteers with little training and no proper transportation service. Also, the centralized control centers didn't exist, which are responsible for the dispatch of ambulances. It was not uncommon to find patients transported to hospitals being turned away. Even now, most regions have common pitfalls in the pre-hospital care system, which exhibits fragmentation and a poor systematic approach in the service delivery of EMS. The obstacles for a well-developed and comprehensive EMS system in Thailand still include a lack of structural models, concerns about extra cost, inappropriate training services, and sustainability issues due to the growing popularity and high demand for emergency services (Suriyawongpaisal, 2012).

Emergency services providers are the backbone of the EMS system, and the system is dependent upon their workforce to perform emergency response and provide effective care to the patients in risky and dynamic circumstances. A principal component of any country's EMS system is its workforce. The capacity of the EMS system to deliver efficient and quality services depends upon a qualified and fit workforce. Researchers have focused on the service providers working for the modern EMS system for 40 years or more on their clinical care delivered, education, and training. But limited studies have moved beyond that to understand the various workforce issues and working styles to deliver emergency care across different states and levels. Some of the countries have well-planned to meet the workforce needs and development; however, most of the countries lack efforts and plans to develop their workforce, identify their needs, health and safety, and the best ways in retention, recruitment, and satisfaction. In recent times, the focus has shifted to the EMS workforce, their needs, and importance. Countries have been working on the need to train a qualified EMS team and produce enough workforce to prepare for unforeseen circumstances (Essie Reed & Stephen, 2021).

In terms of EMS workforce issues and challenges, a review study has found that the burnout rate among the paramedics ranged between 16% and 56% which is huge, and has suggested it could be due to the imbalance between the relationship of work demands and their income. The retention of healthcare professionals, including nurses, doctors, and dentists, has been the subject of numerous prior studies. However, the retention of paramedics and frontline workers has received less attention. This may be due to the professions existing for a short period and not being popular among the communities, or even among medical professionals. In this era, frontline workers face many problems, such as a lack of acceptance by the medical fraternity and a lack of professional bodies in some countries, leading to resignation from their positions. So, there are problems of retention and satisfaction, along with other mental health issues, among the emergency workforce (Huabbangyang, 2021).

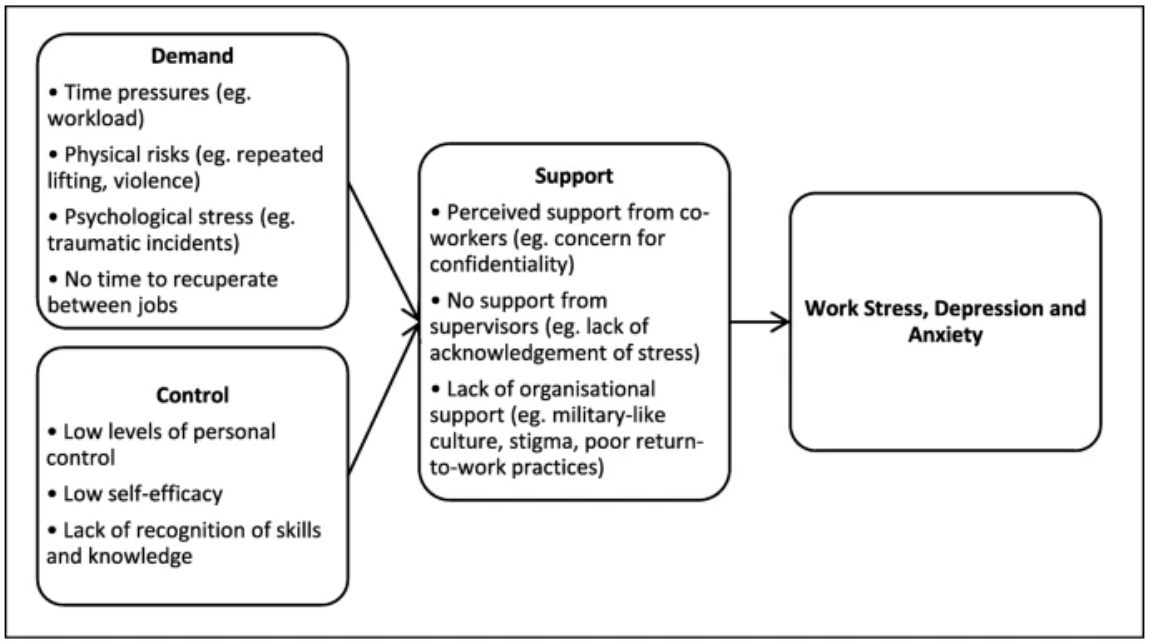


Figure 1. Conceptual model of EMS providers' work-related issues (Lawn et al., 2020).

The importance of the emergency service providers is acknowledged in the research on the resilience of the health system. They identify the workforce as one of the building blocks of the healthcare system, which is necessary for the resilience of the system. In addition to funding and health information systems, the health workforce is one of the three most important components of health system resilience. On the other hand, the understanding of the significance of the emergency health workforce for the resilience of health systems in many nations remains limited and needs to be further investigated and planned. The disease outbreak crisis has been a unique chance to learn more about the role that the health workforce plays in terms of resilient health systems, and in particular, how the workforce's capacity for adaptation, absorption, and transformation varies between health systems and levels (Burau et al., 2022).

The application of AI in qualitative research

As a large language model, an AI tool such as ChatGPT has received considerable attention from research communities on how it can assist in the qualitative analysis process. An AI commercial software, ATLAS.ti, claims to save data analysis time by up to 90% (ATLAS.ti, 2005). Developed with the OpenAI GPT model, it discovers insights from the data and replaces the manual coding process. Another popular software is MAXQDA, which positions itself as an AI research assistant. MAXQDA summarizes the content, lets the user interact with the data, and allows the user to select the codes generated from it (VERBI Software, 2025). Both ATLAS.ti and MAXQDA focus on the coding process of qualitative analysis.

A scholar has attempted to apply ChatGPT in conducting quantitative analysis and compared it with his own manual process using two familiar datasets (Morgan, 2023). The methodologies were Reflexive Thematic Analysis by Braun and Clarke (2022) and Iterative Thematic Inquiry (Morgan & Nica, 2020). The researcher enters prompts to ChatGPT (GPT-3.5 version) iteratively until ChatGPT produces his desired report. The study found that ChatGPT tends to produce more descriptive than interpretive responses (Morgan, 2023).

Nevertheless, the researcher indicated a positive experience with ChatGPT for qualitative analysis in terms of simplicity and time savings.

ChatGPT-assisted thematic analysis offers an effective approach to developing junior qualitative researchers (Zhang et al., 2023). From a pilot study, a framework and a series of prompts were introduced, and changed the attitude of the researchers from negative to positive. The framework addresses transparency and explainability of the research process, and enhances researchers' critical thinking and reflexivity (Zhang et al., 2023).

Apart from ChatGPT, other AI tools have been explored for thematic analysis to gain insights into the effects of cutaneous leishmaniasis on patients (Bennis & Mouwafaq, 2025). These include Gemini, Llama, Claude, DeepSeek, and NotebookLM, which generate themes and subthemes. The accuracy of AI analysis was measured by internal and external consistency using Cohen's Kappa compared with hand-coding (Bennis & Mouwafaq, 2025). The results showed the improvements in consistency, reproducibility, and generalizability of AI-assisted qualitative analysis (Bennis & Mouwafaq, 2025).

Research Question

RQ1: How capable is NotebookLM in accomplishing tasks related to thematic analysis?

RQ2: What are the strengths, areas for improvement, and recommendations in the Thai EMS system, as analyzed by NotebookLM?

To answer RQ1, we compare a few tasks that were completed using NotebookLM with those resulting from the earlier analysis of the first author's work (Pant, 2025). The tasks are: (1) summarizing, (2) identifying sub-themes, and (3) counting instances. To answer RQ2, NotebookLM was applied to conduct thematic analysis end-to-end with the pre-designed prompts.

Methodology

We briefly describe how an earlier work was conducted manually without an AI assistant (Alina, 2025). Understanding the manual process provides a baseline for comparing the methodology and results with the AI assistant. The assistance from AI in this paper is applied only after the raw data has been collected.

A mixed method was applied for the research, although only the qualitative part is the main focus of this paper. Data was collected in order to find the gaps and measure the resilience capacity of service providers of the EMS system of Thailand. For the in-depth interviews, purposive sampling was used to select the experts of EMS Thailand to conduct interviews. Experts are representatives of WHO, Ministry of Public Health, provincial public health offices, and tertiary hospitals. Key informant interviews with a semi-structured interview guideline were conducted to gather the valuable opinions of stakeholders and experts about workforce resilience, workforce planning, and policy development. The questionnaire was constructed through an intensive literature review and preliminary findings of the survey with the frontline EMS workers. The questions were reviewed and validated by experts from AIHD, Mahidol University, and it was ensured that the translated instruments remained relevant and suitable for the Thai professionals. In total, six key stakeholders from MOPH: each representing the international agency, NIEM, and provincial public health directors, were interviewed, including tertiary hospitals. The interview process followed research ethical guidelines and was conducted by the first author. Interviews were audio-recorded and transcribed with the software: Otter.ai and Whisper. All interviews were conducted in English.

For the interviews, NVivo-14 software was used for thematic analysis. The questionnaires were labeled and coded by the researcher. The codes generated were finalized into themes for policy recommendations. The criteria for coding the data were based on the preliminary findings and aligned with the resiliency frameworks (Kruk et al., 2017; Lyng et al., 2022; World Health Organization, 2007; Khan et al., 2018; Foroughi et al., 2022).

Thematic analysis was conducted using the deductive approach based on the theories and agenda for the workforce planning and development. Themes were categorized based on the safety attitudes, wellness, teamwork climate, and behavioral health, which are observed components of resilient service providers.

The same datasets serve as input for the AI-assisted thematic analysis. The workflow of the AI-assisted analysis is illustrated in Fig. 2. It outlines the main steps in processing and analyzing data with features and prompting on the AI tool. It should be noted that the workflow is specific to NotebookLM features and may not generalize to other AI tools.

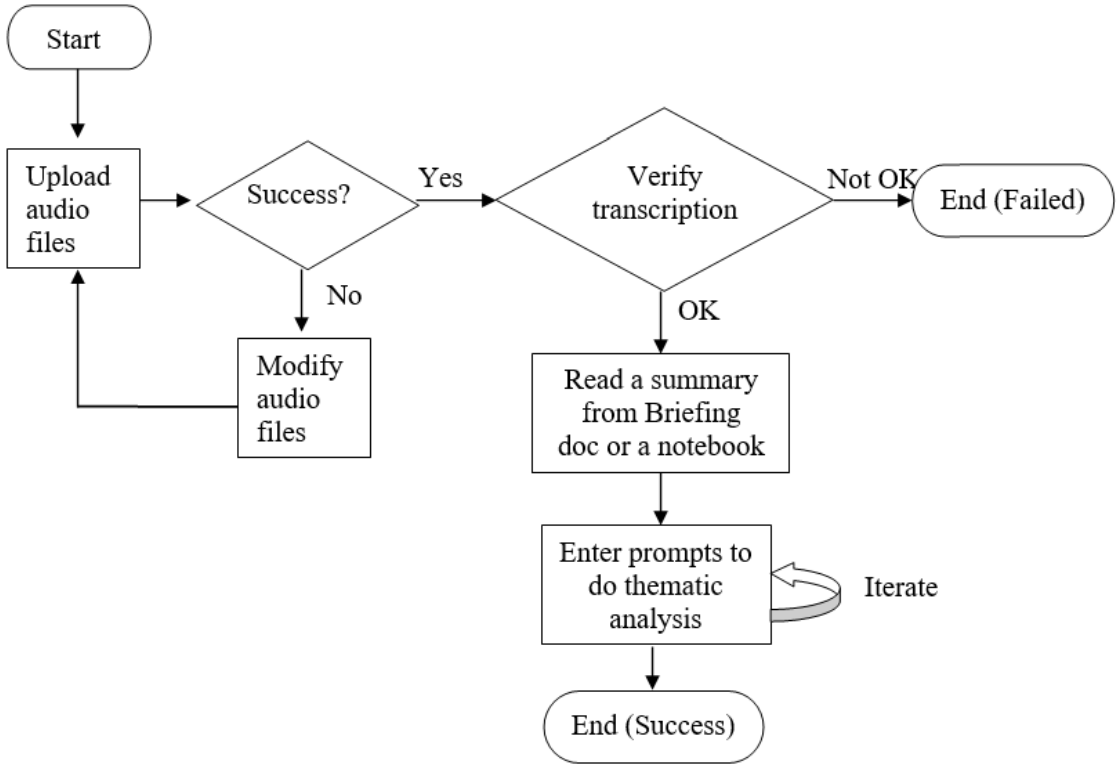


Figure 2. The process of conducting AI-assisted thematic analysis using NotebookLM

The analysis starts with collecting raw interview audio files in .mp3 or .m4a formats. Each file corresponds to a single interview session lasting from 30 minutes to 1.5 hours. Each file will be uploaded as a source for a single notebook. The modification process includes splitting files into smaller ones or resampling the files to enhance audio quality. NotebookLM automatically transcribes the audio into text, which can be verified by the user.

Experiment 1

In this experiment, the three tasks mentioned earlier are examined. The outputs from NotebookLM were taken from either pre-existing features or user prompts. This process

was conducted without referring to any established frameworks or prior information about the research objectives.

1. Summarization

The summary of the source is provided at the center of the main chatbot window. On the right side of the notebook, we obtain the Executive summary from the Briefing note. Sometimes, the summary contains personal information (PI) such as the name of the interviewee. In this case, NotebookLM was prompted to remove the PI to obtain a cleaned summary.

To measure the similarity between the summary from the researcher and that from NotebookLM, we first apply the Sentence Transformer model (Reimers & Gurevych, 2019) to create embeddings of the summary. Cosine similarity is computed between the embeddings to obtain a similarity score. The score ranges from -1 to 1, where 0 indicates no semantic similarity and 1 indicates identical meaning. This process can be implemented easily with Python using the relevant open-source libraries.

2. Identifying Sub-themes

First, the main themes of the interviews were identified from the earlier researcher's qualitative analysis (Pant, 2025). They are (1) EMS provider's wellness, (2) EMS provider's safety, (3) EMS provider's competence, (4) structure and resources, and (5) policy development. For each main theme, NotebookLM was prompted to identify sub-themes in each interview. The prompt was formatted as follows:

You're an expert qualitative researcher. I'm giving the main theme, which is <main theme>. Identify the sub-themes under this main theme.

The prompt applied the Persona pattern (White et al., 2023), which indicates the role-play strategy in prompting for qualitative analysis (Zhang et al., 2024). For each main theme, the sub-themes from all interviews were combined with the following prompt:

Each line in the source is a sub-theme. Combine similar sub-themes and re-group the sub-themes in the source.

The source refers to the input text containing sub-themes from all interviews under the same main theme.

We aimed to compare the degree of overlap between sub-themes identified by the researcher and those identified by NotebookLM. This was quantified using the Jaccard index, defined as the ratio of the cardinality of the intersection and the cardinality of the union of the sub-theme sets. Mathematically, let A be the set of sub-themes identified by the researcher and X be the set of sub-themes identified by NotebookLM. The Jaccard index is written as $J(A, X) = |A \cap X|/|A \cup X|$. The value of the Jaccard index ranges from 0 to 1, where 0 indicates no overlap and 1 indicates complete overlap.

3. Counting Instances

We attempt to count the number of instances for a given sub-theme with NotebookLM and compare with the researcher's number. The sub-themes that the researcher identified were used as input to NotebookLM. Then, the following prompt was given for each interview.

You're an expert qualitative researcher. Given the main theme of <main theme> and the sub-theme of <sub-theme>. Count the number of instances under this sub-theme.

Experiment 2

The objective of this experiment was to conduct an end-to-end thematic analysis with NotebookLM. First, we created a series of prompts that correspond to thematic analysis according to Braun and Clarke's six-phase framework (Braun & Clarke, 2006; Ahmed, 2025). The research objectives were also added to NotebookLM source as additional supporting information. Additionally, similar frameworks to those previously applied by the researcher in conducting manual analysis were also included in the source. The prompts were refined with reference to both the research objectives and the applied frameworks. For each prompt, we needed to select the corresponding sources as illustrated in Fig. 3.

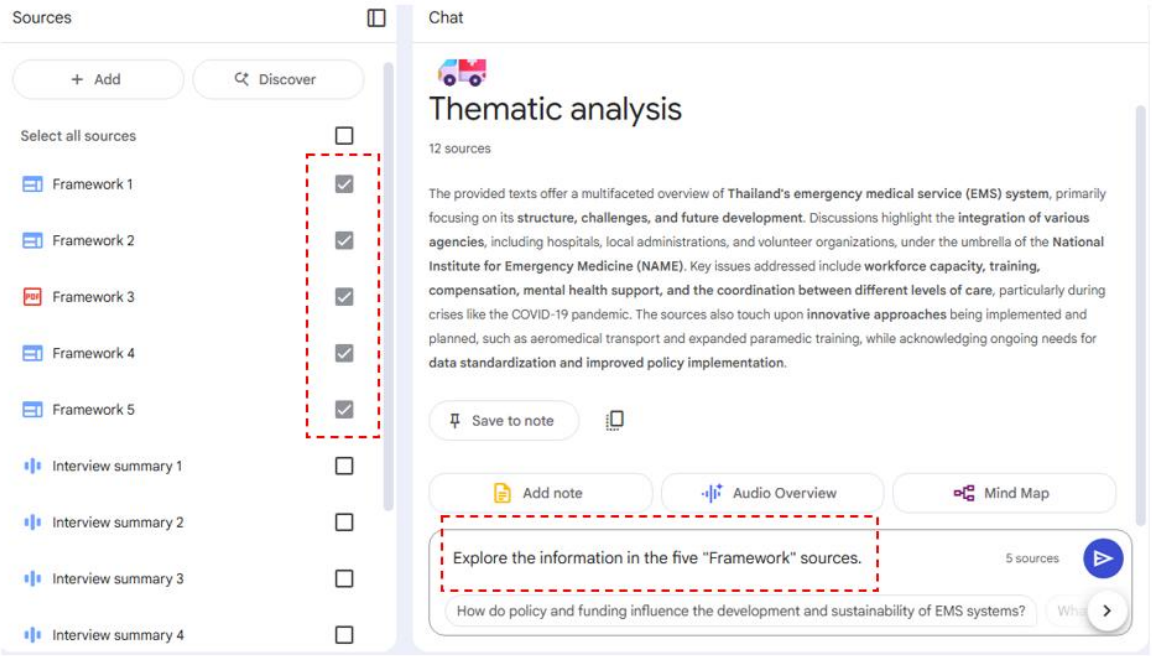


Figure 3. Source selection corresponding to the prompt

The prompts were created using AI prompt engineering techniques in conjunction with the thematic analysis steps described in Braun & Clarke's framework. Since thematic analysis is a complex process, we need to break down the tasks and sequence them properly, similar to the chain-of-prompt technique (Wei et al., 2024). In addition, the persona pattern (White et al., 2023) was applied to guide or structure the response generated by the AI expert model. The following is a series of prompts entered into NotebookLM sequentially, along with their objective. The prompts were motivated by the discussion in Ahmed (2025) and were iteratively modified until satisfactory responses were obtained.

Prompt #1: "Explore the information in the five "Framework" sources."
Objective: Let NotebookLM be familiar with the frameworks.

Prompt #2: "You're an expert qualitative researcher conducting deductive thematic analysis. Explain about Braun and Clarke's six-phase thematic analysis framework."
Objective: Set the role of NotebookLM to be an expert qualitative researcher and utilize Braun and Clarke's framework.

Prompt #3: "What is the "Objectives of the research" source?"
Objective: Remind of the research objectives for thematic analysis.

Prompt #4: "Now, conduct deductive thematic analysis using the frameworks you've learned. Remind of the objectives of the research. Generate initial codes and collect the instances from the "Interview summary" source. List the output in the following format:

Code 1 : Instance 1 from the interview
Code 1 : Instance 2 from the interview
.
.
Code 2 : Instance 1 from the interview
Code 2 : Instance 2 from the interview
.
.
Code n : Instance 1 from the interview
Code n : Instance 2 from the interview"
Objective: This prompt corresponds to Phase 2 of Braun and Clark's steps. NotebookLM will make a list of codes and instances of each code.

Prompt #5: "Next, search for themes from the codes by grouping similar codes together. Ensure that the themes are not too broad or too narrow and address the objectives of the research. Present the analysis in the following format:

Theme 1 : Code 1
Theme 1 : Code 2
.
.
Theme 2 : Code 1
Theme 2 : Code 2
.
.
Theme n : Code 1
Theme n : Code 2"
Objective: Following Phase 3 of Braun and Clark's steps, the prompt returns a list of themes and the codes.

Prompt #6: "Now, review the themes and revise if needed. The codes within the theme should fit together. Also, the themes should be clearly distinct from one another."
Objective: The themes are revised according to Phase 4 of Braun and Clark's steps for the researcher to review and revise the themes.

Prompt #7: "Define and name the themes so that the names capture the core essence. Names should be concise and not be overly vague."
Objective: To have well-defined names of the themes, Phase 5 of Braun and Clark's steps ensures the reflective and meaningful naming.

Prompt #8: "Write the report into a narrative. The report includes an introduction, a methods section, a results section presenting the themes, and a discussion section."
Objective: The report is produced according to the Phase 6 of Braun and Clark's steps, with explicitly informed sections.

Results

Experiment 1

1. Summarizing

The summaries from both the Briefing note and the main chatbot window are highly similar to the researcher's summary for all interviews, as shown in Table 1. NotebookLM also evaluated English proficiency scores for each interview, indicating that English usage was sufficient and did not impact the similarity scores.

Table 1 Similarity score of the summary text by the researcher and NotebookLM.

Interview No.	Executive Summary from Briefing note	Summary from the main window	English proficiency score (1-5)
1	0.8133	0.8479	4
2	0.7181	0.7658	4
3	0.7308	0.7818	3
4	0.7656	0.8063	3
5	0.7983	0.7984	3
6	0.7878	0.7279	3

2. Identifying Sub-themes

The sub-themes identified by NotebookLM do not exactly match those identified by the researcher, primarily due to differences in wording. Nevertheless, sub-themes with similar meaning were considered overlapping. The results, presented in Table 2, indicate a small to medium degree of overlap.

Table 2 The number and Jaccard index of overlapping sub-themes identified by the researcher and NotebookLM.

Main theme	Jaccard's index
EMS provider's wellness	0.333
EMS provider's safety	0.375
EMS provider's competence	0.714
Structure and resources	0.4
Policy development	0.545

The sub-themes generated by NotebookLM typically consist of two or more words representing similar concepts or topics. These sub-themes are occasionally vague and cover broad conceptual areas. Examples of such sub-themes from NotebookLM are presented below.

"Training and Competency Development"
"Workforce and Human Resources"
"Governance, Structure, and Regulation"
"Preparedness, Future Planning, and Continuous Improvement"

3. Counting instances

The number of instances identified by NotebookLM is the aggregated count of the instances across all interviews. As can be seen in Table 3, it is apparent that there is a notable discrepancy between the number of instances identified by the researcher and those

identified by NotebookLM, with the latter reporting substantially higher numbers of instances.

Table 3 The number of instances for each sub-theme.

Main theme	Sub-theme	No. of instances (researcher)	No. of instances (NotebookLM)
EMS provider's wellness	Mental health counseling	5	23
	Workload and overtime	4	68
	Burnout prevention	3	51
	Work environment	4	92
EMS provider's safety	PPEs	3	6
	Risk benefits	4	47
	Compensation and incentives	6	65
EMS provider's competence	Training	12	76
	Skill development	2	122
	Continuous education	4	58
	Refresher training	3	48
	Certification	4	94
	Hospital coordination	7	62
Structure and resources	Equipment	7	44
	Ambulance	6	77
	Aeromedical enhancement	3	12
	Dispatch centers	3	21
	Communication devices	4	37
Policy development	Workforce shortage management	4	108
	Workforce planning	3	122
	Paramedic profession advancement	3	124
	Temporary EMS staff management	3	43
	Policy and governance	5	225
	Decentralization	2	39
	Budget allocation	3	60
	Surge capacity	8	59

NotebookLM tends to include all the words within a sentence that are semantically related to sub-themes. As a result, the interpretations of sub-themes is often broader than that of the researcher. For example, under the main theme 'Policy development', the sub-theme 'Decentralization' generated by NotebookLM includes the following instances.

"So the model used in actually hospital that at that time could to so the every hospital in province set up their own"

"when people call 1669 it will go to the the disp this dispatch center of that province อือฮึ not into the center anymore."

"the emergency patient uh that come from Ambulant the destination must be accepted in the first priority.

Yeah, this should be right and but the problem is when I do the survey they said that there is they are having problem to from the receiving end of the hospital they need the insurance they check the UFC's"

Although the above examples show some aspects of 'decentralization', they may also imply concepts such as 'discrepancy' or 'lack of enforcement' and do not necessarily contribute directly to policy development. Evidently, NotebookLM interpretation extends beyond what the researcher intended, emphasizing the need for human oversight in thematic analysis.

Next, consider the example in the sub-theme "burn-out prevention" under the main theme of EMS's wellness.

" my objective is uh firstly to know about what is the resilience capacity what are what is the coping uh capacity and level of the of those"

NotebookLM interpreted the resilience capacity as related to "burn-out prevention" and counted it as a single instance. However, the quote in question originated from the interviewer's dialogue, and the instance was mistakenly included in the counting. NotebookLM is unable to distinguish between the interviewer's question and the interviewee's response.

Experiment 2

The report written by NotebookLM describes seven themes under Thai EMS systems: EMS System Architecture, Workforce Development, Staff Well-being & Incentives, Service Delivery Challenges, Volunteer & NGO Dynamics, Crisis Preparedness, Standards & Data Management. In addition, NotebookLM provides an analysis of the strengths and areas for improvement. These findings are illustrated in Fig. 4 and Fig. 5.

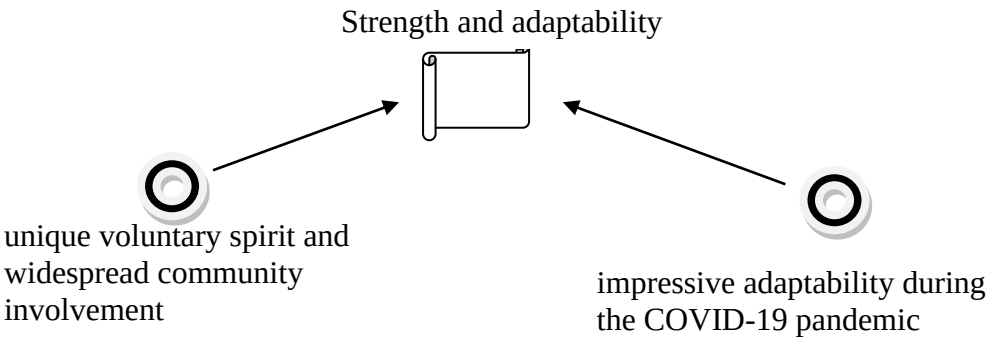


Figure 4. Strengths of the Thai EMS system

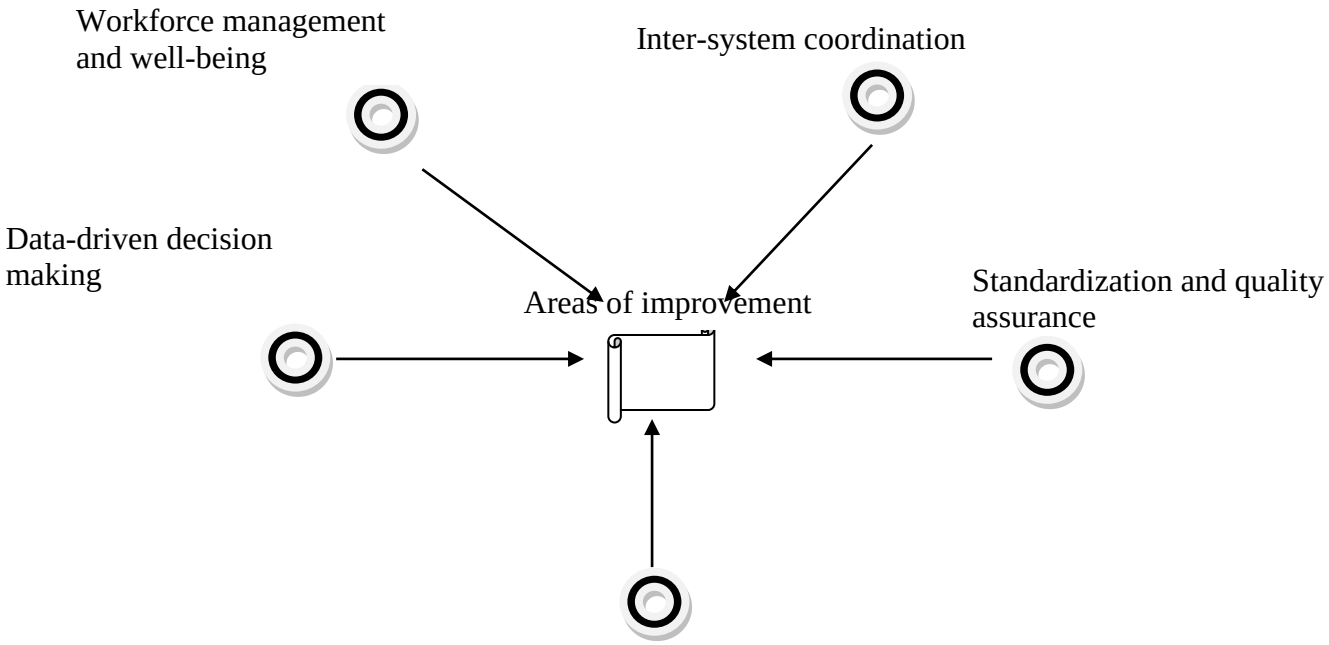


Figure 5. Areas of improvement of the Thai EMS system

Fig. 6 illustrates the recommendations derived from NotebookLM's thematic analysis report, while Fig. 7 illustrates the recommendations based on earlier manual analysis conducted by the first author. It is apparent that manual analysis is more comprehensive and includes more specific action items than the NotebookLM report. For example, although prioritizing workforce wellness is a recommendation from NotebookLM, it does not address aspects such as mental health support and screening.



Figure 6. Recommendation based on thematic analysis from NotebookLM



Figure 7. Recommendation provided from manual analysis

Discussion

From Experimental 1, for the summarization task, the summaries provided by NotebookLM, are semantically similar to the researcher's summaries. The English proficiency of the speakers in the interviews appears to have little impact, as NotebookLM was able to transcribe the audios into text. For the sub-theme identification task, the results show a relatively medium to large gap compared with the coding created by the researcher. This discrepancy may not be totally unexpected since even two human researchers may produce inconsistent sub-themes depending on their expertise level, reflexivity, and potential biases. For the instance counting task, however, the results were less reliable since NotebookLM collected all related words to the sub-themes and counted the corresponding sentences as instances. NotebookLM even counted the sentences from the interviewer, which should have been excluded. This reflects the weakness of NotebookLM in the instance counting task, which may not be applicable.

Nevertheless, from Experimental 2, NotebookLM is able to complete the thematic analysis and write a report. The tool demonstrated particular strength in summarization and theme generation, producing a coherent thematic report. Its ability to transcribe, extract codes, and cluster themes suggests potential for streamlining qualitative research workflows.

The AI-assisted thematic analysis identified five core domains influencing EMS workforce resilience in Thailand: wellness, safety, competence, behavioral health, and policy development. These domains are consistent with global frameworks on health system resilience and highlight the complex challenges facing the Thai EMS workforce.

The thematic report generated by NotebookLM provided a structured overview of Thailand's EMS system, identifying seven key themes that aligned closely with the study objectives. Importantly, it captured contextual strengths, such as the unique volunteer-driven EMS service delivery and system adaptability during the COVID-19 pandemic, reflecting the resilience embedded in community engagement. At the same time,

the report highlighted persistent challenges, including workforce well-being, coordination, and data standardization issues that were also consistently emphasized in in-depth interviews.

Although the generated themes were generally coherent, some lacked specificity and occasionally combined distinct concepts under broad categories (e.g., "Governance, Structure, and Regulation"). This suggests that researcher input remains vital to achieve analytical depth and contextual accuracy. Nevertheless, the findings demonstrate the potential of NotebookLM to support thematic analysis effectively, particularly when guided by well-designed prompts and clear research frameworks.

Fig. 6 illustrates the recommendations drawn based on NotebookLM thematic analysis report, while Fig. 7 illustrates the recommendations based on the earlier manual analysis by the first author. It is apparent that the manual analysis provided more comprehensive and precise action items, while NotebookLM produced broader venues.

Given that the thematic analysis in this study drew on only six expert interviews, the findings should be interpreted within the constraints of this limited sample. Future studies incorporating a larger and more diverse participant group, particularly frontline EMS providers, are recommended to enhance the analytical depth and strengthen the broader applicability of the results.

Conclusion

This study highlights the importance of workforce resilience for strengthening Thailand's emergency medical services (EMS) system. Thematic analysis, aided by an AI tool, identified five domains that influence EMS providers' ability to respond to and recover from PHEs. The results align with international frameworks for health system resilience while revealing context-specific strengths (for example, community-driven service delivery) and gaps (workforce well-being and coordination mechanism) within the Thai EMS.

Future work should develop resilience measures tailored to the Thai context and include frontline providers' real-life experiences in addition to expert perspectives. Combining AI-assisted analysis with human judgment may increase the efficiency and transparency of qualitative research; however, careful methods are required to maintain contextual accuracy and meaningful interpretation of the qualitative study. At the policy level, investments in workforce mental health support, patients' data standardization, and long-term workforce planning are essential. Strengthening inter-organizations' coordination and integrating resilience training into EMS education will be critical for preparing the system for future public health emergencies.

Furthermore, this study acknowledges the limitation of NotebookLM in accurately counting thematic instances, mainly because it tends to over-identify semantically related content. Therefore, future research using AI tools for quantitative aspects of qualitative analysis should apply careful methodological checks to ensure the validity and reliability of the findings. In addition, there is still room for improvement of the AI theme generation, which can be considered in future research.

AI technology has grown tremendously at an unprecedented rate. The results from this paper only recognize the capabilities of the current specific AI tool, NotebookLM, at the time of this writing. As the technology continues to progress, we anticipate that AI can increasingly support the qualitative analysis by bridging the gaps faced by junior researchers, reducing the time of general researchers, and enhancing the overall quality of the research, even for experienced experts in the field.

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