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Development of Performance Indicators in Operational Level for Pre-hospital EMS in Thailand

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***Abstract*—**The objective of this research is to develop the performance indicators (PIs) in operational level for the Pre-hospital Emergency Medical Service (EMS) system employing in Thailand. This research started with ascertaining the current pre-hospital care system. The team analyzed the strategies of Narerthorn, a government unit under the ministry of public health, and the existing PIs of the pre-hospital care. Afterwards, the current National Strategic Plan of EMS development (2008-2012) of the Emergency Medical Institute of Thailand (EMIT) was considered using strategic analysis to developed Strategy Map (SM) and identified the Success Factors (SFs). The analysis results from strategy map and SFs were used to develop the Performance Indicators (PIs). To verify the set of PIs, the team has interviewed with the relevant practitioners for the possibilities to implement the PIs. To this paper, it was to ascertain that all the developed PIs support the objectives of the strategic plan. Nevertheless, the results showed that the operational level PIs suited only with the first dimension of National Strategic Plan (infrastructure and information technology development). Besides, the SF was the infrastructure development (to contribute the EMS system to people throughout with standard and efficiency both in normally and disaster conditions). Finally, twenty-nine indicators were developed from the analysis results of SM and SFs.

***Keywords*—**Emergency Medical Service, Performance Indicator, Success Factor, Thailand

I. Introduction

SINCE 2001, a government unit, namely Narenthorn, under the Ministry of Public Health was founded to develop and control the practice of Emergency Medical Service (EMS) in Thailand in response to growing need from the public for pre-hospital professional care, mainly, for road traffic injuries. The ultimate goal of Narenthorn is to contribute a sustainable and effective pre-hospital EMS in Thailand by setting up the system covering all areas in the country and involving local stakeholders (public sectors, private sectors, and local administrative organizations) to provide community based health management. In 2008, Emergency Medical Institute of Thailand operated under the Ministry of Public Health was found prior to formally sustain the growth of pre-hospital EMS and inherit the responsibility from Narenthorn.

The emergency death is the number one cause of death in the world. In Thailand we have the emergency 4 million times a year and about 6,000 dead before reach the hospital. The good management of EMS system can safe the patient life from 9,000 to 12,000 [1]. The improvement of the quality's life by service the people using the EMS system can qualify the life of the people. In Thailand, the emergency health management can be divided in to two systems, emergency medical service system and emergency health prevention system. The former study revealed that the emergency health prevention system reduces the cause of death more than the healing system. But the emergency health prevention system itself has constrains in practical such as the deployment of the strategy down to the practice level, traffic law enforcement and human factors. To assess or improve the efficiency of the operation clearly, the application of PIs is used.

Currently, three organizations, Narenthorn, National Health Security Office (NHSO), and Khonkhan province, have developed key performance indicators (KPIs) and PIs for the pre-hospital EMS system. The first two organizations developed three to five KPIs a year with difference purpose. Only Khonkhan developed the operational level indicators. However those indicators could not represented the efficiency and effectiveness of the practice in each area precisely. Therefore, the research team attempts to develop the set of PIs, which is not only to provide the monitoring system but also to be the vehicle motivating the various areas to concern for their growth rates and their quality of practices.

II. Research Background

A. Emergency Medical Service (EMS)

EMS should be concerned as the system linked between pre-hospital care and care at the hospital. However, all components must work together. Pre-hospital care is defined as *"the care provided in the community (at home, school, work or recreation area) until the patient arrives at a formal health-care facility capable of providing definitive care"* [2].

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The service covers accidents and emergency. Six key processes in pre-hospital EMS as presented in Fig.1.

Most of the pre-hospital care systems in any countries are composed of these three levels; First Responder (FR), Basic Life Support (BLS) and Advanced Life Support (ALS), ranked by low-to-high ability of operations [3]. Each level varies due to the ability of personnel, medical equipment and transportation. In Thailand, all service providers have to register to Emergency Medical Institute of Thailand.

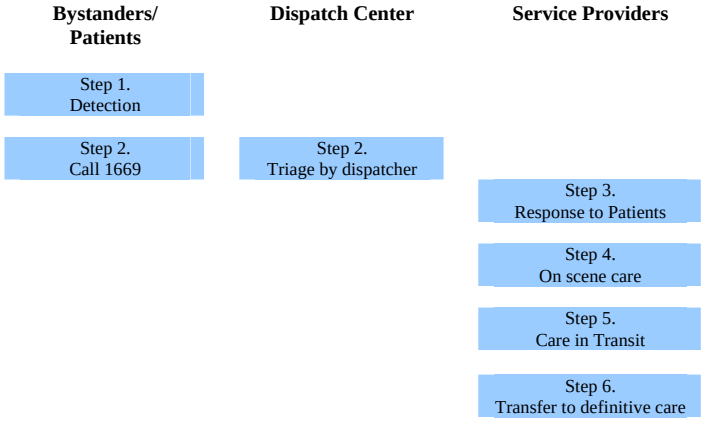

Fig.1 Pre-hospital EMS processes

B. Performance Indicator

The application of performance indicator in the EMS system showed the increasing efficiency of the EMS system. For example, reference [4] studied of using clinical indicators in emergency medicine: documenting performance improvements to justify increased resource allocation in Australia. The result showed that using clinical indicator data allows a quantitative assessment of the impact of increased emergency department resource allocation. Moreover, reference [5] studied development and implementation of a nationwide health care quality indicator system in Taiwan. The results showed that the indicator series has been used and analyzed among various levels of hospitals after 5 year of implementation. However, most of the performances measurements have been encountered in practice [6] are divided into three types: *(1) Input measures* (the lowest of the performance measurement spectrum is the tracking of program inputs. Typical inputs include staff time and budgetary resources. Inputs are generally the simplest elements to measure, but provide limited information for decision making and analysis of actual results.), *(2) Output measures* (Results generated from the use of program inputs are the domain of the output measure. These metrics track of number of people served, services provided, or units produced by a program or service. They may sometimes be referred to as activity measures. Output measures may provide information on whether or not desired results are being achieved.) and *(3) Outcome measures* (As noted, input and output measures demonstrate effort expended and numbers served, but reveal little about whether or not these interventions are making a difference-whether the targeted population is any better off as a result. The outcome measure answers this call.)

Besides that three type of performance measurement, should separate by; *(1) Lag* Measures focusing on results at the end of a time period. Normally, the lag measures are characterizing historical performance. And *(2) Lead* Measures that "drive" or lead to the performance of lag measures. Normally, the lead measures intermediate processes and activities. Otherwise, the important characteristic of indicator; validity, objectivity, reliability, sensitivity, specificity, universality, acceptability, etc, should decided for KPIs development.

III. Research Methodology

The overall research methodology can be concluded as Fig. 2.

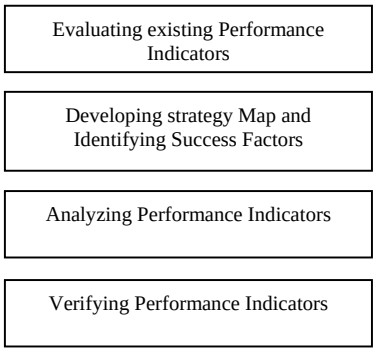

Fig. 2 Research Methodology

In the stage of evaluating existing PIs, the criterion and the criterion weight were assigned to assess the PIs. All weight assigned were compiled from literature review. Table I shows the detail of the criteria and criteria weight using in evaluating. All the assessed PIs using in this paper are the operational level PIs developed by Khonkhan province. Those PIs were differing from Narenthorn and NHSO, which are using in higher level (above provincial scale).

Subsequently, the strategy maps were developed by analyzes the key objective of the national strategic plan for EMS system development (2008-2012) [9]. The strategic analysis method was used to identify the success factors in the form of minor objectives. The developed strategy map was analyzed using constituents in different dimensions of the concept idea of man, machine/equipment, method/procedure, planning, controlling network, and organization management and so on. The team further analyzed the minor objectives in order to ascertain the efficiency and effectiveness of developed PIs. Besides, the analysis of each constituent above we add more dimensions to cover all minor objectives as follow: quantity, quality, time, cost, safety and satisfaction [10].

The next stage was to analyze each success factors in the form of minor objectives to develop the PIs in operational level. In this stage the team transform the minor objectives from previous stage to the PIs and classified those PIs in to six dimensions namely; quantity, quality, time, cost, safety and satisfaction. In addition, the two characteristics of the PIs

namely leading and lacking were analyzed. Finally, the responsibility of those PIs, organization or person, were assigned.

The last stage was verified the strategy map and the PIs with the EMS system experts both policy and practical levels. Suggestions and issue points from the experts were taken to improve those PIs to the appropriated and practicable PIs.

TABLE I
CRITERIA FOR EVALUATION

TOPIC	DEFINITION	WEIGHT	REF.
VALIDITY	EVALUATE REAL OPERATION ABILITY	0.30	[7]
EASILY UNDERSTOOD	EVALUATE MEANING OR DESCRIPTION COMMUNICATION FOR EASILY UNDERSTANDING	0.20	[8]
SUCCESS ABILITY	EVALUATE APPLICATION AND SUCCESS POSSIBILITY	0.10	[7]
AVAILABILITY AND ACCURACY OF DATA	EVALUATE COMPLETION AND SUFFICIENCY IN DATA COLLECTION.	0.10	[7]
COMPARABILITY OF PIS	EVALUETE COMPARABILITY OF KPIS WITH OTHER PROVINCE OR IN THE PAST.	0.10	[7]
QUANTITATIVE	EVALUATE TYPE OF DATA IN OPERATION DATA COLLECTION	0.10	[8]
CAUSE & EFFECT LINKAGE	EVALUATE CAUSE AND RESULT RELATED WITH OBJECTIVE OF THE STRATIC PLAN	0.05	[8]
TIMELY	EVALUATE SUITABILITY OF FREQUENCY IN DATA COLLECTION	0.05	[7]

IV. RESEARCH OUTCOMES

A. Evaluating existing PIs

The evaluating of Khonkhan PIs using the criteria mentioned in the methodology above reveal that the PIs developed by Khonkhan are most appropriate in frequency of data collection (100%). The second to the most appropriate is all the PIs are not only complete and enough for later analyzing but also easily understand (97.44%). Remarkably, the output of those Khonkhan PIs can use to compare with the data in the past or compare with other provinces (87.18%). However, some points should be reformed such as cause and effect linkage between the PIs and the objective of the strategic plan for EMS system development (2008-2012) of Emergency Medical Institute of Thailand (61.54%). This is because all the Khonkhan PIs were developed before the setting of the national strategic plan.

B. Development strategy map and identifying success factors

Figure 3 shows the national strategic plan (2008-2012) for EMS system development of EMIT that the team was used. We found that only the first dimension of the national strategic plan, infrastructure development and information technology development, is appropriate to further study.

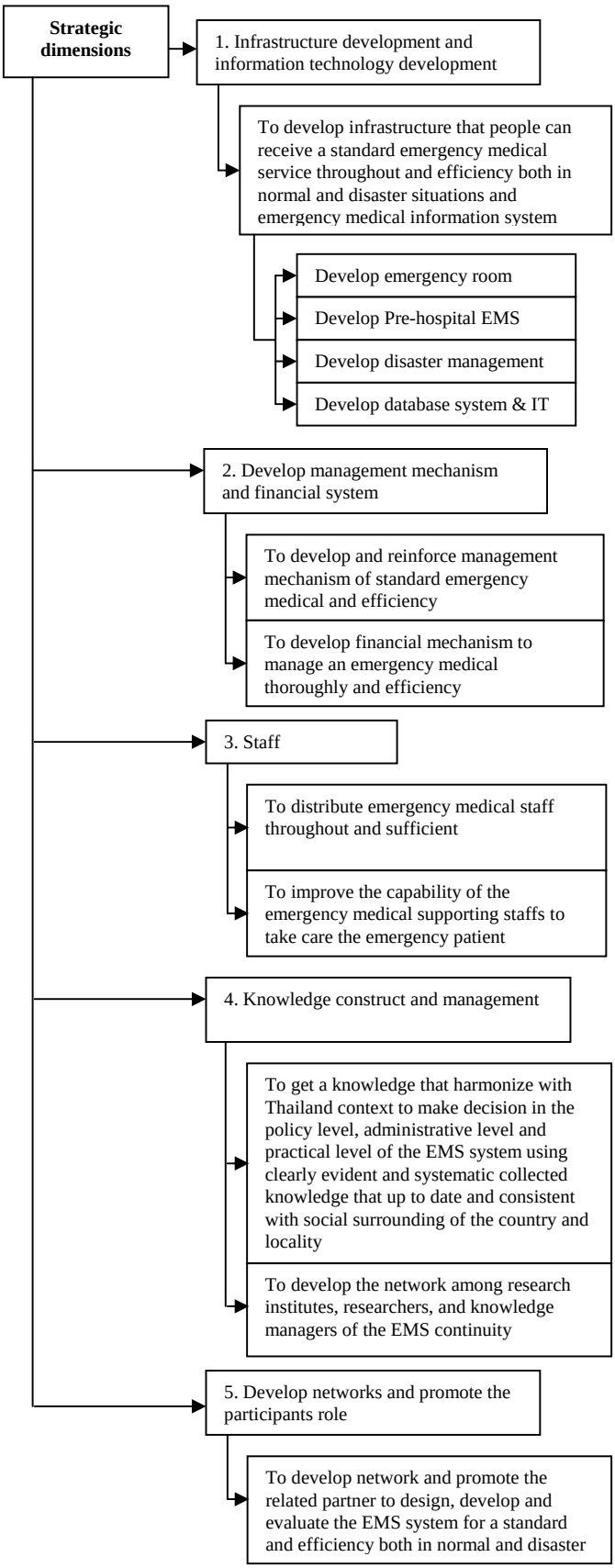

Fig. 3 National strategic plan for EMS system development (2008–2012)

Because of the aim of this dimension is to construct all the infrastructures such as man, tools/equipment, and practical car of the EMS system in order to coverage all area with EMS operation unit. Meanwhile the other dimensions of the national strategic plan are in policy level for the EMIT top management.

Subsequently, the success factors of the first dimension of national strategic plan were indentified in the form of minor objectives. We found that people can receive a standard EMS throughout and efficiency both in normal and disaster situation because of infrastructure development. To achieve the success factors as mentioned, the EMS system should be composed of four sub systems; emergency room system at hospital, pre-hospital EMS system, disaster condition management system, and database and information technology system. Later, four compositions were taken to define minor objectives using difference dimensions as been mentioned. Remarkably, the minor objectives of emergency room system at hospital were similar to hospital quality standard (Hospital Accreditation: HA) [11]. Besides, the minor objectives of database and information technology system need the top management level to identify and develop. Thus, only two subsystems, per-hospital EMS system and disaster condition management system, are brought to identify the minor objectives. Table II provides the details of minor objectives.

TABLE II
MINOR OBJECTIVES OF INFRASTRUCTURE AND INFORMATION TECHNOLOGY DEVELOPMENT

COMPONENTS	MINOR OBJECTIVES
Pre-Hospital EMS	• To develop the staff by training and evaluation for increasing the number of staff to cover all local administration • To develop the knowledge revision mechanism for staff • To develop the tool and vehicle in order to have efficiency and safety standard • To develop the system of efficiency revision of tool and vehicle • To make the organization chart and job description of staff • To satisfy staff • To reduce the time to the scene according to the topography • To develop the standard operation procedure • To develop communication equipment, data collection and evaluation program • To develop the easily calling number and the reserved network for informing • To increase the number of people acknowledgment and accept the EMS system • To develop the capability of people can evaluate and inform the situation • To increase the number of doctor in command control center for controlling the staff and operation unit • To develop the motivation mechanism for all hospitals to be the EMS network
Management system in disaster condition	• To develop the staff for making the acknowledgment about disaster management, related law and operation obligation • To prepare the material, tool and vehicle ready for disaster condition operation • To develop the operation and obligation approach for disaster condition

TABLE II (CONTINUED)
MINOR OBJECTIVES OF INFRASTRUCTURE AND INFORMATION TECHNOLOGY DEVELOPMENT

COMPONENTS	MINOR OBJECTIVES
Management system in disaster condition	• To promote the hospitals and related organizations making the mitigation plan for disaster in each area • To increase the training for operation in disaster condition • To develop the communication system for help support in each area • To set up the operation network system in disaster condition

C. Analyzing and verifying PIs

To develop PIs in operational level, the minor objectives from Table II were analyzed to classify those PIs by characteristic, dimension and responsibility organization. It should be mentioned here that, to verify the strategy map, success factors and PIs with the EMS experts, the team works parallel with analyzing process. The points and suggestions of the experts from verifying process was taken to modify those PIs. Table III summarizes the detail of those operational level PIs in different approaches.

TABLE III
PERFORMANCE INDICATORS IN OPERATION LEVEL FOR EMS

PERFORMANCE INDICATORS	TYPES		DIMENIONS						RESPONSIBLE MEN
	LEADING	LACKING	QUANTITY	QUALITY	TIME	COST	SAFETY	SATISFACTION	
1. Percentage of local administration organization sending staff for training	✓		✓						*B*
2. Percentage of registered local operational units		✓	✓						*B*
3.Percentage of operational unit having results		✓	✓						*B*
4.Percentage of operational units having motivation system	✓		✓					✓	*A,B*
5.Percentage of operation of local operational units after informed from command control center		✓	✓						*B*
6.Percentage of trained staffs passing standard training course	✓		✓	✓				✓	*A*
7.Percentage of operational unit having standard welfare system	✓		✓				✓	✓	*A*

TABLE III (CONTINUED)

PERFORMANCE INDICATORS	TYPES		DIMENIONS						RESPONSIBLE MEN
	LEADING	LACKING	QUANTITY	QUALITY	TIME	COST	SAFETY	SATISFACTION	
8.Percentage of satisfied staffs in operation		✓						✓	*A,D*
9.Percentage of operational units passing the equipment and vehicle standard evaluation system	✓			✓					*D*
10.Percentage of operational units using equipment and vehicle standard manual	✓			✓					*A*
13.Number of Dead Case conferences	✓		✓						*A*
14.Percentage of operation having standard time at scene on severity level		✓			✓				*D*
15.Percentage of ABC standard operation		✓		✓					*A,D*
16.Percentage of operation using standard time to definite care		✓			✓				*A,D*
17.Percentage of reporting to emergency room before arriving the hospital		✓		✓			✓		*A,D*
18.Percentage of operational unit and command control center having organization chart	✓		✓						*A*
19. number of late response calling from random check		✓		✓	✓				*C*
20.Number of no response calling from command control center		✓		✓					*A,C*
21. Number of EMS public relations plan	✓		✓						*A*
22. Percentage of people in province recognized EMS		✓	✓						*A*
23. Percentage of emergency call (1669)		✓	✓						*A*

TABLE III (CONTINUED)

PERFORMANCE INDICATORS	TYPES		DIMENIONS						RESPONSIBLE MEN
	LEADING	LACKING	QUANTITY	QUALITY	TIME	COST	SAFETY	SATISFACTION	
24. Percentage of EMS in total medical services		✓	✓						*A*
25. Percentage of people remember EMS number (1669)		✓	✓						*A*
26.Percentage of reporting using provincial standard time		✓			✓				*C*
27.Percentage of command passing the standard (under triage/over triage)		✓		✓					*C*
28.Percentage of command using provincial standard time		✓			✓				*C*
29. Responding by radio receiver ratio		✓	✓						*A*

Note ; A = Provincial public health office, B = Local administration, C = Command control center, D = Operational unit

As can be seen, a dimension of cost is not match with all PIs in Table III. This is because cost considering is not in the first dimension of the national strategic plan (2008-2012), the infrastructure and the information technology development. The money considering is in the second dimension of the national strategic plan (2008-2012), management mechanism and financial system development. Currently, all the operational units are working on documentations and accounting as an income-expense foundation of their units. So these data can develop to the performance indicators to measure the operational unit worthy.

V. Discussion and Conclusion

The objective of this research is to develop the performance indicators (PIs) that harmonize with national strategic plan of Emergency Medical Institute of Thailand. These PIs can use to measure the real efficiency and effectiveness of overall operations of the provincial scale. This research composes of two main steps as follow; the first step is the evaluating of existing PIs. We found that these PIs have some weaknesses such as cause and effect linkage between PIs and the objective of the strategic plan. The second step of this research is to develop performance indicators using method of the success factors analysis through the strategy map which harmonize with strategic objective of strategic plan. Subsequently, the success factors have been considered prior to identify the PIs for the pre-hospital care system. As a result, the set of PIs have been formulized.

To verify the set of PIs, the team has interviewed with the relevant practitioners for the possibilities to implement the

PIs. Some of criteria have been considered; for example, validity, easily understood, success ability, availability and accuracy of data. By the evaluation, the feedback has proposed some improvements. In summary, we have shown that twenty-nine performance indicators were developed. Consequently, the set of performance indicators has been proposed to Emergency Medical Institute of Thailand prior to further analyze, validate and deploy. Remarkably, for this research, the scope does not include the implementation of change. The team is assigned to develop the set of performance indicators and verify for the possibility to be implemented.

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