Original Article

The Influence of Knowledge Management, Safety Climate, and Information Technology Capabilities on a Smart Emergency Logistics System: A Study of BDMS Emergency Services

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Abstract

OBJECTIVES: This research is to study a causal relationship model of knowledge management (KM), safety climate (SCL), and information technology capabilities (ITC) that affect the smart emergency logistics system (SELS) at the emergency services network at Bangkok Dusit Medical Services Public Company Limited (BDMS).

MATERIALS AND METHODS: This research used the mixed-methods research technique: starting first with a qualitative research approach, via in-depth interviews with senior executives, managers, employees, and specialists in emergency services, totaling 16 people, and; by collecting a questionnaire completed by 378 people at EMS-BDMS. Data were analyzed using descriptive statistics and inferential statistics with structural equation modeling.

RESULTS: From the study, it was found that KM, SC, and ITC had a positive influence on SELS. The analysis of the structural equation model found that it was in line with the empirical data and scored at a good level. The Cronbach's alpha coefficient confidential score was between 0.82 - 0.94.

CONCLUSION: This research shows that the development and mobilization of emergency care with KM, SCL, and ITC as SELS forms an innovative model (Kritwaroj Model) of the SELS.

Keywords: knowledge management (KM), safety climate (SCL), information technological capabilities (ITC), smart emergency logistics system (SELS), emergency medical service (EMS)

The global emergency medical service (EMS) is a complex system, which has continuously developed over time. These services are characterized by a variety of service providers, together with the guidelines of patient care integrated with patient transportation, indicators of quality care, analyzing, quality service improvements, and the investment in logistic management and healthcare supply chain or emergency logistics and humanitarian supply chain.[1] The ITC can be used to improve the effectiveness of EMS, making it possible to communicate with each other through the system and raising the quality-of-service standard nationwide. Starting from the incident location, an EMS command station is set up as a notification center that can assess, order rescue, and safely transfer patients to hospital. KM and certified training are required and the SCL must be established in the workplace alongside the promotion of research development to raise the level of information technology in the EMS system, and to build organization capability in digital systems. The infrastructure and innovative equipment have been developed to support the operation of EMS to be of international system standard. All users can access the EMS comprehensively, in safety, equally, which reduces inequality in line with the Ministry of Public Health's smart healthcare policy. The system is part of the Smart Planet ideal, which has been proposed by International Business Machines Corporation (IBM) since 2009[2] and is in alignment with the directives of the National Emergency Medical System Development Plan 4th Issue A.D. 2023-2027.[3]

In Thailand, environmental management systems are being continuously developed. In the past, there have been multiple problems with EMS systems. A quality EMS model has to be integrated. There is a quality management system with an emergency prevention plan, we take learning from success factors and obstacles, which in turn leads to continuous improvement. At the outset of the development of the EMS system, problems were identified in KM, skills, knowledge enhancement systems, experience in patient assistance and emergency response. Therefore, it is necessary to use knowledge from hospital personnel to help manage the KM system, to later implement improvements in practice in order to develop the capability of the operators to have the knowledge and ability to perform task appropriate measures in each situation to reduce the number of deaths, increasing the chances of survival. Another important problem is the lack of knowledge and challenges of building health professionals' KM systems for disaster preparedness and urgent emergencies. This includes the spread of pneumonia caused by the Coronavirus Disease 2019 (COVID-19). The cost of training or teaching new employees as a result of work safety and operations presents a challenge, particularly in the occupational safety of personnel in emergency medical operations. This is an issue needing to be addressed by national policy, coordination and development of emergency medical systems found outside the hospital, in the hospital and between hospitals. For example, solving the emergency patient segregation system that is lower than the actual emergency level of the patient (Under Triage), reducing the overcrowding problem in the emergency department unable to transfer patients in a timely manner to avoid delays. When it comes to the problem of delays, patients are not being taken to their destinations in time, and access to the incident area is limited due to a lack of coverage of the service area, which may be over or under serviced, and if it takes more than 15 minutes to reach the patient, this is 53.38% longer than the standard period recommended, which should not exceed 8 minutes. Furthermore, to exacerbate this, the outbreak of COVID-19 has had a tremendous detrimental impact on EMS.[4-6] Most of the delays in ambulance exits were caused by the need to employ personal protective equipment. This was compounded by the ever-changing environment affecting health status, decision-making, safety in the workplace, and personnel.[7] In the course of helping patients, it was found that ambulances in Bangkok and its vicinity were faced with the challenge of insufficient personnel.[8] This greatly affects the safety of patients and personnel. If patients receive initial treatment quickly and accurately before reaching hospital, the patients' safety will increase. The development of an EMS system for patients in place before reaching the hospital is greatly needed. Emergency response is considered the golden hour of medical care.[4] The IT competence issue revealed that the changes and impacts that occurred in the era of globalization are both uncertain and may change quickly and with greater intensity than before. In addition, IT will be increasingly used as an important tool in the emergency medical systems of the future. Emergency medical practitioners are also inadequately prepared for future changes or maybe face inequality in access to IT. There are also limitations in the governance of the financial system to support emergency medical missions, affecting the development of digital health systems. For example, in cases where there is no smartphone, computer, or Internet- of Things (IOT), resulting in a lack of knowledge and inability to access new information technologies. Therefore, we must encourage this group to have access to necessary basic IT equipment, considered as part of helping access, to make the health system improve further.[9] In addition, sending medical information in the past from multiple sectors sent to a central form processing hub posed other issues. Most forms are still on paper, this can cause discrepancies that take time to verify and cross-check. Improper storage and delivery issues can cause loss of valuable information across the organization. Incorrect order handling commands cause serious and time -consuming delays. Inadequate stock management also affects the use of expired items or equipment, which can negatively affect the quality of medical care or patient safety. Therefore, management of logistics and procurement and traceability of health centers are both essential for good coordination of high-quality healthcare through advanced information and communication technologies. These can be used to help manage personnel shortages in the current EMS system.[10,11]

BDMS-EMS Center is one of the EMS systems that provides patient transportation/evacuation on land, by air, and by sea, throughout the region of Thailand and the Asia-Pacific region. The service standard has been raised to an international standard. EMS smart logistics is developed and applied from KM, SCL management, and IT utilization. Since the establishment of EMS Center which was established on December 21, 2013, we now count on the cooperation of 5 hospitals in the BDMS network. In the past, the service provided only emergency transportation/evacuation from the incident area and critical care service. However, to provide better effective services with the highest safety standard, EMS Center has had to extend its service to cover all emergency transportation services systems. Patients are provided services provided by an expert medical team specializing in emergency transport by land, air, and sea, in compliance with the international standard certified by the Commission on Accreditation of Medical Transport Systems: CAMTS from the USA. BDMS-EMS has been certified for the 3rd time and is ready to operate 24 hours a day. The dispatch centers have been established in Bangkok and Phuket province and we are planning to extend their service in the near future. The medical service team is ready to approach the incident scene quickly and safely. Patients can be transported to hospitals or from one hospital to another seamlessly with its up-to-date IT. The BDMS-EMS center is an EMS with smart logistics, and its staff have been taught and trained in a modern simulation center which is certified by Society for Simulation in Healthcare (SSH). It provides emergency medical transportation through a ground ambulance, air ambulance, and marine ambulances under the same medical standards with an expert medical team who specializes in emergency assistance and transportation to be an option for patients and the people in

choosing these services. This is a modern EMS which conforms with the master plan of medical communication technology, in addition, the services are there to support the safety policy of staff, patients, and society. The services are responsive to the economy and to society, to the Thailand 4.0 and Smart Healthcare,[12] and will encourage employees to feel proud of being a member of the network and to be part of the organization. Therefore, the researcher presents this research to add to the academic knowledge and to be of use to EMS of BDMS and other EMS networks, both in the government sector and private sectors.

Despite recent improvements in EMS, in the current day there are still incidences of risk and insecurity, which affect the organization and can cause many losses to people, physically and mentally, as well as to property. The researcher is interested in studying a comprehensive health service business organization that focuses on KM policies. The safety standards management and development of communication and IT systems is vital, and can benefit The National Emergency Medical Services, to better respond, in line with the changing situation, at both national and global levels. This also includes the changing nature of demands on emergency medical systems and future challenges we are not aware of yet. This development is part of improvements to an emergency operating system that meets international quality standards. Taking into account the Thailand context, it also corresponds to the draft research plan for the year 2022-2024 that emphasizes research for development, review, and implementation in forms, processes, guidelines, measures, tools, IT, and innovation with quality.[13,14] This development accounts for the needs of the nation to update the current emergency medical system to reflect a new normal or an EMS new normal, as well as creating a research network including Research Management along with the synthesis of policy proposals that meet quality standards both domestically and internationally. From the outset of this research, the study defines the determination of the value of KM, SCL, ITC, and Smart logistics in EMS and is used to further develop an innovative model for the development of Thai emergency medical services derived from the research results, within the following research framework, see Figure 1.

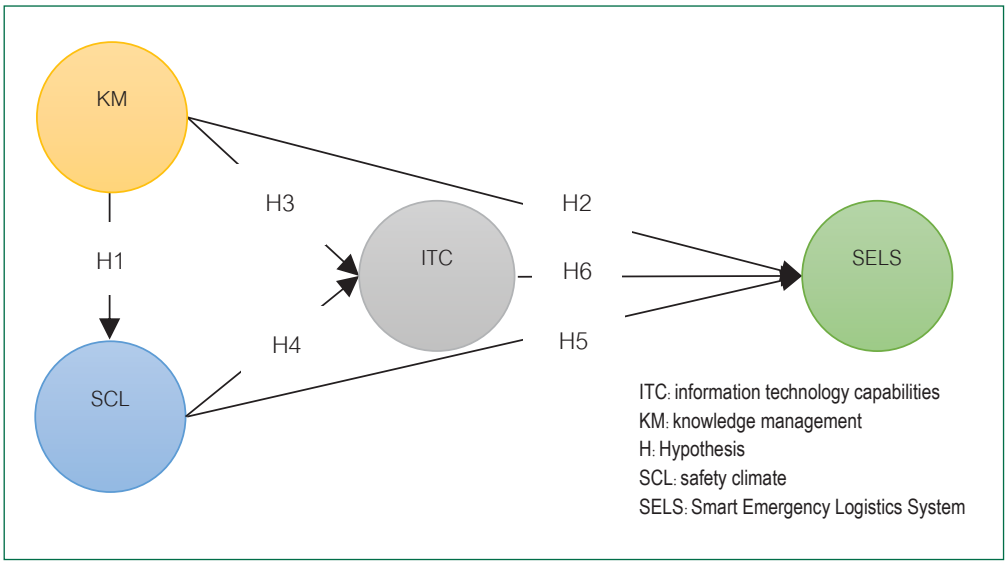

Figure 1: Research framework

Materials and Methods

This study used mixed-methods research in form of an exploratory sequential design, starting with qualitative research via in-depth interviews with 16 participants who held high management level posts, middle managers, staff, and specialists in the field of EMS. The empirical data were used to design the research framework. Then, the quantitative research was followed by collecting the data through 378 questionnaires during the COVID-19 pandemic period. Finally, the qualitative research was conducted by interviewing 9 participants consisting of high-level management and managers within the BDMS network. The data were used to confirm the result of the research and to summarize, discuss and put forward recommendations. The main participants were management personnel in the BDMS network selected by purposive sampling. The decision to select the participants was made depending on the background and appropriateness of the given data. The population in this study was the staff whose work related to EMS within the BDMS network. The samples were also selected by purposive sampling.

The Inclusion criteria for participating in the research:

1. An employee of the group BDMS operating in connection with the EMS system
2. work experience in EMS > 1 year
3. ability to speak, read, and write Thai.
4. Aged ≥18 years.

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The exclusion criteria: inability to speak, read and write Thai.

The size of the population was calculated based on the concept of Comrey and Lee.[15] The criteria for sample size and appropriate level for analysis was 300 units which is a good level and more than the ratio of sample units to an observed variable of 10 to 1 from the structural equation model. Since the multivariate analysis was analyzed to maximize the completion of the data, a sample population of 378 were selected and descriptive statistics were used to analyze the data, such as Percentage, Mean, Standard deviation, and Coefficient of variation to explain the personal characteristics, data and variables opinions in the research framework.[16] In addition, inferential statistics were used to test the hypotheses. The computer program was also used to analyze the structural equation model.

The questionnaire was performed by content validity with an Item-Objective Congruence (IOC) to check the quality of the research tools in the study. For IOC 5 experts, these are Associate Professors, Physicians, and Specialists with expertise in emergency medical service systems, and the Medical Simulation Center, included professors from the Department of Health Education and Behavioral Sciences Faculty of Public Health, Department of Logistics and Supply Chain, and senior executives in the business industry. Reliability by the specified criterion, Cronbach alphas, considered more significant than 0.70 indicating satisfactory internal consistency and reliability. The obtained alpha values fall between 0.82 and 0.94, indicating that the data is adequate. [16]

In this study, the sample group voluntarily granted their right to participate in the program by signing a consent document. The collection of data was protected to prevent anyone access or to cause a direct impact on participants. The study is reported in form of summary data in which participants gave information in a questionnaire indicating that they voluntarily gave the information to the program. The collecting of data of personal information of the sample group is kept confidential and summarized in the form of overall data. This information will duly be disposed of after the program is completed. This study has been approved by the Institutional Review Board (IRB) of Bangkok Hospital, see reference IRB document number COA2022-43.

Results

The sample as a total of 378 participants, most of those who answered the questionnaire were female (60.5%), aged between 31-40 years old (49.21%), graduated with a bachelor's degree (73.34%), had 5-10 years of work experience (55.3%), and worked in the central region (47.62%).

The results found that the highest mean score in each category respectively as follows. For KM, it was question number KU2 "My EMS uses all knowledge to solve problems and improve processes." (4.350 ± 0.707) . For SCL, it was question number TE5 "My colleagues and I agree that having clear safety goal is important." (4.350 ± 0.495). For ITC, it was question number TUI1 "IT is used to support the data and assists in the planning of appropriate EMS." (4.540 ± 0.587). For SELS, it was question number SLC1 "My EMS can deliver service by patient type and be able to follow patients' transportation in real-time by the Dispatch Time indicator which results in quality audit reliability." (4.540 ± 0.639).

The data frequency distribution analysis found that all the variables were not statistically significant, which explained that the data from observed variables was distributed as a normal curve and found that the correlation value was between 0.286 - 0.533 and did not affect multicollinearity.

The results of checking the structural validity of the measurement model for each component by Confirmatory Factor Analysis (CFA), all 4 components (KM, SCL, ITC, SELS) are consistent with the empirical data as follows: KM consists of 6 indicators that have a factor loading between 0.693-0.289. The Average Variance Extracted (AVE) is 0.574, which is acceptable. Composite reliability (CR) is equal to 0.889, which is acceptable. Indicating that they are consistent with the empirical data, and can measure KM components with goodness of fit indices as follows: *Chi-Square* = 1.21, *df* = 3, *Chi-Square/df* = 0.403, *p* = 0.751, *CFI* = 1.000, *GFI* = 0.999, *AGFI* = 0.993, *RMSEA* = 0.000. SCL consists of 7 indicators that have a factor loading between 0.700-0.888. AVE is 0.603, which is acceptable, and CR is equal to 0.913, which is acceptable. Indicating that they are consistent with the empirical data, SCL components measured with goodness of fit indices as follows: *Chi-Square* = 2.88, *df* = 5, *Chi-Square/df* = 0.576, *p* = 0.718, *CFI* = 1.000, *GFI* = 0.998, *AGFI* = 0.988, *RMSEA* = 0.000. ITC consists of 6 indicators that have a factor loading 0.744-0.911, and AVE is 0.679, which is acceptable. CR is equal to 0.926, which is acceptable. Indicating that they are consistent with the empirical data, able to measure ITC components with a goodness of fit indices as follows: *Chi-Square* = 2.24, *df* = 3, *Chi-Square/df* = 0.746, *p* = 0.525, *CFI* = 1.000, *GFI* = 0.998, *AGFI* = 0.986, *RMSEA* = 0.000. SELS consists of 6 indicators that have a factor loading between 0.731-0.951, AVE is equal to 0.702, which is acceptable, and CR is equal to 0.933, which is acceptable. Indicating that they are consistent with the empirical data, able to measure the SELS components with a goodness of fit indices as follows: *Chi-Square* = 2.45, *df* = 4, *Chi-Square/df* = 0.613, *p* = 0.653, *CFI* = 1.000, *GFI* = 0.998, *AGFI* = 0.989, *RMSEA* = 0.000.

The result of harmonization and correlation analysis of structural equation modeling, by allowed the discrepancy of variables to interact according to the theory, and adjusted the correlation accordingly, to a structural relation modeling which affected the SELS. It was found that the correlation in the model was harmonized with the empirical data which were *Chi-square* = 280.60, *df* = 182, *Chi-square/df* = 1.541, *P*= 0.000, *CFI* = 0.995, *GFI* = 0.944, *AGFI* = 0.900, *RMSEA* = 0.038. The analysis of the causal influence and *t-statistic* is shown below in Table 1 and Figure 2 as follows.

Table 1: The estimation of the direct and indirect effect, and the overall effect of the causal components which influence Smart Emergency Logistics System.

Causes	Effects								
	SCL			ITC			SELS		
	DE	IE	TE	DE	IE	TE	DE	IE	TE
KM	0.535***	-	0.535***	0.371***	0.165***	0.536***	0.173**	0.367***	0.540***
SCL				0.309***	-	0.309***	0.212***	0.147***	0.359***
ITC							0.477***	-	0.477***
SELS									-
R-Square		0.286			0.355			0.533	

**Statistically significant level was 0.01, ***Statistically significant level was 0.001.
ITC: information technology capabilities; KM: knowledge management; SCL: safety climate; SELS: Smart Emergency Logistics System

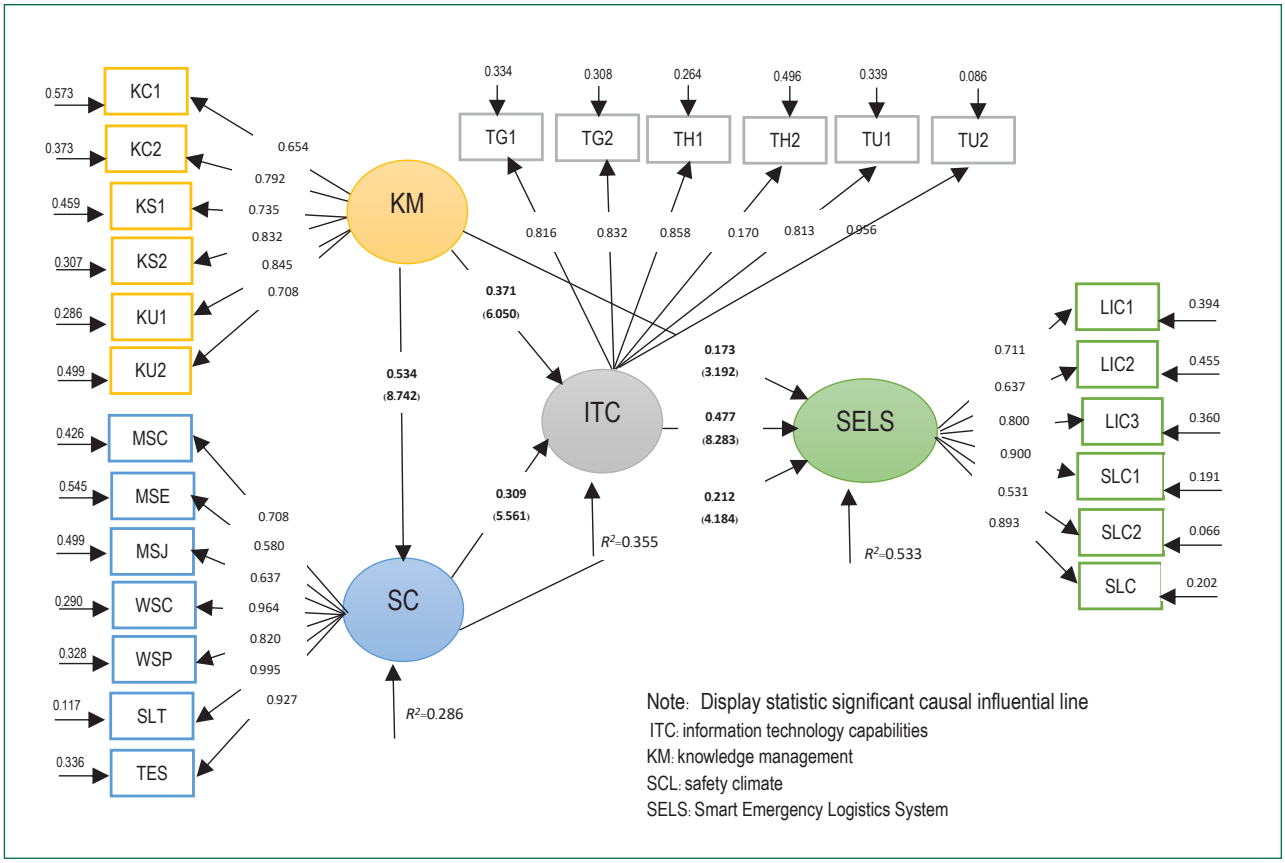

Figure 2: The structural equation model of structural relationship, which influences Smart Emergency Logistics System.

From Table 1 and Figure 2, the estimation of the path coefficient value of causal influence of external variables consisted of 3 influential lines that can be explained as follows. The first line, KM had a positive influence on SCL at a significant level of 0.001, the path coefficient value was 0.535. The second line, KM had a positive influence on SELS at a significant level of 0.01, the path coefficient value was 0.173. The final line, KM had a positive influence on ITC at a significant level of 0.001, the path coefficient value was 0.371.

The path coefficient value of causal influence of internal variables consisted of 3 influential lines as follows. The first line, SCL had a positive influence on ITC at a significant level of 0.001, and the path coefficient value was 0.309. The second line, SCL had a positive influence on SELS at a significant level of 0.001, the path coefficient value was 0.212. The final line, ITC had a positive influence on Smart Emergency Logistic System at a significant level of 0.001, the path coefficient value was 0.47.

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In consideration of the causal influence path coefficient of KM which has the causal significance found that KM had an indirect influence on ITC and to SELS at the highest influential level at 0.177. It was clearly shown that ITC had a significant influence on establishing SELS quality and safety in line with the policy of the National Institute of Emergency Medicine.

Discussion

KM had a positive influence on SCL, the path coefficient value was 0.535 and the t-statistic was 8.742 at a significant level of 0.001. These results were in line with the concept, theory, and research result of the study of Kao et al.[17] It was found that safety knowledge affected safety behavior and safety attitude. Moreover, when supervisors have a positive attitude towards safety, this results in a direct relationship between operator safety attitude and safety behavior. Indirect relationship between safety knowledge and safety behavior had a more positive effect compared with supervisors who had negative safety attitudes. According to a study by Bevilacqua and Emanuele,[18] human factor management is important for strategic management within the organization and economy. Defining operational procedures contributes to the systematic and automated management of the human factor. It can significantly improve workflow and decision-making processes, although employees in the organization are careful in their work and think about safety in the early days. Therefore, the support of multidisciplinary decision-makers in giving advice is essential in managing human factor risks. Through the process of combining the theoretical knowledge of scholars with the daily problems of high-risk organizations, an in-depth investigation of the incident was then undertaken to derive all possible connections and causes, and to find a practical solution to solve the problem. Increased knowledge of the organization's products, goals, objectives, and customers leads to safer working behavior. Increased knowledge influences social commitment and influences to work safely through the increased connections between members of the organization. In addition, other types of knowledge that are not directly related to safety knowledge may be important for improving safe working behavior. Safety knowledge can be used as an employee's understanding of procedures and activities that enhance safety. Safety literacy is the understanding and drive of practice that leads to safety. Learning is built on systematic and formal concepts, mechanisms, and practices, such as training, development, and coaching, directed by the organization to enhance the capabilities of its employees. This contributes to knowledge and experience.[19] There are factors, however, that appear to have a negative effect on safe working behavior. These factors can be caused by a decrease in confidence and ability to work safely. This is in line with the study of Huang&Yang [20] which found that the transferring of safety knowledge in an excellent environment can lead to good safety behaviors, as well as the application of safety knowledge and inspiration. Employee mindset in the workplace significantly affects safety behavior. The more favorable safety behavior of on-site workers the better the conditions to create a safer working environment on a site. Moreover, although the application and aspirations of safety do not directly affect the safety of the working environment, it does have an indirect effect on safety behavior. When the service unit was analyzed, it was found that the EMS units studied had both KM and SCL at a very good level. This unit encouraged staff to learn, train, and share their experiences among staff. The safety goals and policy were clear. Staff were able to participate in safety decisions. The safety issues were brought up and openly discussed. A lot of knowledge was used for solving the problem and improving the working process through developed IT which led to better safety behavior across the whole system. To confirm the hypothesis, in-depth interviews were conducted with executives, who had practiced, stored, transmitted, and used EMS, and who had helped encourage employees in the EMS system. The personnel were skilled in caring of patients and themselves throughout the process. The ultimate goal is that everyone, and society at large, is kept safe. Investment in safety is a relatively high cost whether sending personnel to train both domestically and internationally to bring the acquired knowledge to store and share. The inclusion of safety standards inevitably promotes the entire system to be more secure and always at the ready to deal with risks and emergencies successfully for the benefit of patients and personnel.

KM had a positive influence on SELS, the path coefficient value was 0.173 and the t-statistic was 3.192 at a significant level of 0.001. The results were in line with the concept, theory, and research results of the study of Cooper et al.,[21] and Lim et al.,[22] and knowledge is still an important component of any logistics operations and shows that organizations can increase productivity. When learning is promoted, KM and learning culture can be catalysts for improved organizational performance and have a positive influence on human capital development. In addition to the direct positive relationship between learning culture and outcome variables, Support was also found for a partially mediated relationship between KM and human capital through learning culture, as well as for a fully mediated relationship between KM and organizational performance through learning culture. This is also consistent with the views of Kucharska[23] that experiential learning leaders influence the learning of others, affecting organizational climate and culture. Leaders must support knowledge processes. Learning organizations also have skills in building knowledge acquisition and transfer, and organizational behavior change. Although it had a positive effect at a significant level of 0.01 it also had the lowest influence, and thhe low influence was caused by the policy to use IT to help KM and increase security. Although there was a significant positive effect at the 0.01 level, it was the least influential, namely low influence resulting from IT utilization policies to assist KM and increase security. Given this policy, staff were encouraged to use more IT to manage knowledge, share knowledge, and to act safely using technological platforms. However, since KM was in the transition period from conservative learning to E-learning along with knowledge development, it took quite some time before each subject was developed, therefore, the average score was quite low for the

question of 'sharing information between emergency staff'. Therefore, the administrators of the emergency medical service system should increasingly support emergency staff to educate and share their knowledge through IT. This will lead to increased safety for the whole system. Nevertheless, the KM could still affect the safety operation which allows them to manage, operate, and update EMS in a qualified manner, connecting the whole system. To confirm the hypothesis, we conducted in-depth interviews with executives. It was found that the KM process of implementing ITC in the EMS system inevitably affects usage levels. The dissemination of knowledge, training, and development is more conducive to the security of the entire system, leaving it better equipped and ready to manage risks and to be able to change operations in new ways as needs emerge.

KM had a positive influence on ITC, the path coefficient value was 0.371 and the t-statistic was 6.050 at the significant level of 0.001. The results were in line with the concept, theory, and research results. A study by Alshahrani et al.,[24] found that IT assists organizations in the knowledge generation process by generating information into knowledge repositories and that knowledge storage is also supported by consistent IT tools with the management system. Finally, the knowledge transfer process is also facilitated using IT through applications as well as the use of cloud computing. Consistent with this study, Philsoophian et al.,[25] found that two characteristics of IT, namely transparency and security, have a strong influence on knowledge sharing on supply chain efficiency, which in turn accelerates IT knowledge transfer for supply chain efficiency. IT also manages all knowledge libraries within its scope and automatically generates knowledge blocks. This is in line with the study of Akhavan et al.,[26] that the knowledge is needed to develop a knowledge service framework to create and share knowledge in the organization. In addition, safety requirements of authentication, integrity, and privacy are critical to maintaining knowledge in the system. KM is also used as a competitive advantage, and when the service unit was analyzed, it was found that the EMS units studied had KM and ITC at a very good level. This was the result of the organization's policy regarding innovative technology. Bringing investment into information technology to develop, promote and encourage working in EMS within the organization yielded excellent results in the positive effect of KM on ITC. In addition, ITC was an intermediary in connection between knowledge change and knowledge protection. IT also helps all the departments in the organization to access new knowledge. The security of information is also important for preventing fraud and preventing misuse of knowledge and to conform to legal obligations. To confirm the hypothesis, in-depth interviews were conducted with executives with IT skills who bring IT to help encourage the team of medical personnel to treat patients more effectively and in a more quicker fashion. Timely access to hospital treatment in the network is vital and the need to be accurate in communicating through the system and to pay attention to every detail of patient treatment so the team of medical professionals can provide the best service. This in turn creates more satisfaction for patients. This is considered an important foundation for expanding services to the international level, which is in line with the country's policy that aims to make Thailand the center of regional health services for Asia Pacific. Ensuring the security of personal data for both users and personnel within the organization is imperative if we are to reach this goal.

SCL had a positive influence on ITC, the path coefficient value was 0.309 and the t-statistic was 5.561 at the significant level of 0.001. The results were in line with the concept, theory, and research result of studies by Karnouskos[27] that found that safety has a strong influence on technology adoption decisions. This is consistent with a recent study by Siu et al.,[28] which found the first and most successful study to support a knowledge theory on the influence of SCL on the acceptance of personal protective equipment technology. When the service unit was analyzed, it found that the EMS unit studied had both SCL and Information Technology at a very good level. This was because EMS had good management in health and safety within the organization to provide the supporting team as quickly as possible. Up-to-date technology was used to integrate the data to solve issues regarding safety and to help it to be safer. Effectiveness and safety were the important driving factors for the decision-making process in applying IT in the organization. In addition, applying international standards such as CAMTS, which operated under safety guidelines, helped to support the safety of the whole system. To create a strong SCL and safety culture, the participation of the top management and all staff are needed. IT will help to connect real-time safety data which assists the organization to take proactive action in safety. Timing is also very critical in this service, if time management cannot be done well, the loss of life, loss of a working day, or demands in related issues might devalue our services and negatively impact patients and staff. To confirm the hypothesis, in-depth interviews were conducted with executives. It was found that SCL is the basic process where the executives set policies, promote, and support infrastructure, and train employees to understand and implement until a safe culture becomes the norm, and this can be applied to every hospital. For although there are different management constraints in each region, the basic safety atmosphere is the simplest thing to start with and will create the foundation for a safe working environment.

SCL had a positive influence on SELS, the path coefficient value was 0.212 and the t-statistic was 4.184 at the significant level of 0.001. The results were in line with the concept, theory, and research results. This is consistent with Wishart et al.,[29] where SCL or safety culture is a fundamental factor of safety in an organization. Having a positive SCL or safety culture encourages employees to subsequently exhibit safety behaviors, reduces the risk of injury, death, and safety violations in the workplace as well. A study by Fiorentino et al.,[30] found that sustainable business operations show that the organization must have safety, security, and respect for social and environmental criteria in the supply chain. Through intelligent technology, it can be accepted from both inside and

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outside the organization. This is consistent with Mikalef et al.,[31] suggesting that research on intelligent technology and explaining the importance of sustainable business models is paramount. Past research has found that the concept of business value and the strategic relevance of smart technology is still underappreciated in the adoption of smart technology. Take elements of sustainable business operations, and see also in line with the study of Lyu et al.,[32] that the SCL is a predictor of safety outcomes, and the SCL is a predictor of the safety of the logistics system. When analyzing service units, it was found that the EMS units studied had SCL and SELS at a very good level. Because of its clear safety policy, EMS's SCL is used to predict safety outcomes and is also used to predict safety logistics. Encouragement of staff to show their safety behavior and safety activities, which will be performed before the patient's transportation for the readiness of staff, the readiness of vehicles, and the readiness of equipment makes for a more efficient system. In addition, the patient and safety environment will be reviewed to make sure that everything is in place. These activities conform with the service quality indicator. To confirm the hypothesis, an in-depth interview was conducted with executives. It was found that managing information more effectively encourages safety management, risk management, and more efficient risk trapping. This leads to the formulation of policies, procedures, practices, or lessons learned from various learnings in the EMS system in practice, making everyday work easier. In addition, risk management is an important element of good corporate governance. It is believed that risk management is an important mechanism and administrative tool to help an organization to achieve its objectives and goals. Risk management also helps to reduce obstacles or unexpected turns of events that may occur in terms of profitability, performance, and trust from investors or other stakeholders in the organization.

ITC positively had a positive influence on SELS, the path coefficient level was 0.477 and the t-statistic was 8.723 at the significant level of 0.001. The results were in line with the concept, theory, and research results. According to a study by Bag and Teams,[33] ITC has a strong positive influence on smart logistics, which has a significant impact on the operations of the organization in the health service system. Global healthcare systems face challenges from rising healthcare costs, expectations of high-quality care, coupled with an aging population and more complex treatments, making healthcare more expensive. Therefore, there is increasing pressure to maintain high quality at a lower cost. One of the alternatives to reduce healthcare costs is to deal with hospital logistical costs. Logistical activities account for more than 30% of hospital costs, half of that can be eliminated by using best practices. Management can draw on best practices for manufacturing-based supply chain management and business process management concepts such as automation.[34] Whether or not to use the technology is up to individual hospital decisions and may vary according to the location and target of the hospital.[35] A study by Feibert et al.,[36] found that 17 factors affected the adoption of technology in the logistics system. And the most important impact factor in the use of technology in healthcare logistics processes is related to quality of employee work. When analyzing service units, it was found that the EMS units studied had ITC and SELS at a very good level. This was because the organization has the policy to transform and to be an innovative organization. IT has been invested in the organization and there is a clear policy regarding cyber security. As mentioned earlier, the development of IT and using it in healthcare logistics systems to support EMS, also meets qualified indicators, supports the accessibility of patients, and connects the patient care system including the transportation process and service in whole service system. To confirm the hypothesis, in-depth interviews were conducted with executives. Executives who pay attention and focus on investing in the development of communication and IT systems for the benefit of emergency operations are considered very important. The system can help manage patient movements effectively. IT capabilities promote the safety of the entire system, the movement and delivery of products, patients, goods or services on time. There is a systematic inspection of service quality standards and this promotes learning through IT in both virtual and online situations. Management foresees and places great importance on IT investment budgets. And all of them must also take into account the safety of the entire system, including patients, employees, society, environment, and information security or cybersecurity.

Conclusion

The research results are empirical evidence that the innovation of smart logistics and EMS development schemes is divided into short-term, medium-term, and long-term development plans (Figure 3) depending on the context of each hospital. There are limitations, as IT investments are expensive. That said, personnel can still use the system to send or share information. It can also adapt to changes and the choice is there for the system to be used appropriately. Considering the results of this research from the causal influence path coefficient model of KM, it was found that KM had an indirect effect on ITC SELS with the highest influence equal to 0.177, indicating that KM and ITC resulted in the quality and safety of the intelligent logistics system for EMS (SELS). This is in line with the most important type 1 medium-term plan. Therefore, the joint development of KM with ITC results in SELS compliance.

Limitations of This Study

Although the study was conducted in a group of hospitals that have received CAMTS standards, it should be studied in a group of private hospitals that have not yet been accredited with CAMTS standards for comparison to establish a policy for the development of an EMS system.

Recommendation

An innovative approach to developing an intelligent emergency logistics system (Krisawarot Model) from this research is consistent with the direction of the 4th National

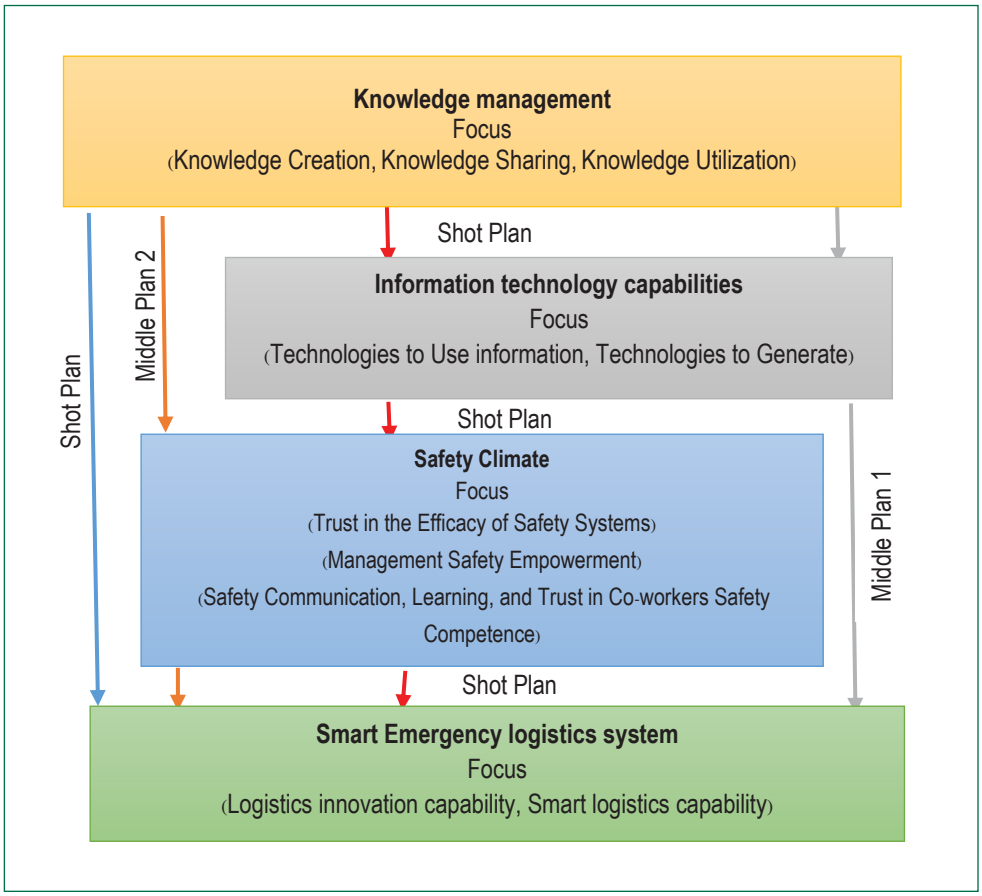

Figure 3: Innovative guideline for Smart Emergency Logistics System Development

Emergency Medical System Development Plan, 2023-2027. The 3 strategies are included, a component of SCL, which is in line with the 1st strategy, embed and create value in the public sector, which appropriately creates a safety culture in EMS in Thailand. A component of KM and SELS, which are in line with the 2nd strategy, promote, supports, develops, and organizes the EMS system and raises the service standard to meet up quality standards and international standards (EMS Standard, EMS Quality and EMS System Design of Service Oriented). And a component of KM, ITC, and SELS, which are in line with the 3rd strategy, develop and drive the governance knowledge and create innovative oriented. KM is critical for an EMS development plan. In addition, ITC has a strong influence on SELS, therefore, the hospital management team may need to give attention to KM, staff development, setting policy, and monitoring education in basic knowledge and further knowledge regarding EMS. This will help to develop the skill, technique, skill attitude, and drive thinking processes of staff to be able to operate in EMS standards. Up-to-date IT can also continuously support practicing skill sets. IT is the catalyst for patient safety transportation and also promotes innovation for KM. The knowledge can be differently applied to each hospital by its context. This includes sharing critical information within the network to hospitals which have limited resources. KM and knowledge sharing are important for safety in overall EMS. Referring to the above research results, the study found that patient treatment outside the hospital is becoming more and more important. Quality development is a critical mechanism to continuously improve the healthcare service system and be able to face changes. From the study, the researcher hopes that Thailand EMS will expand its knowledge and transform to create a safety culture in hospitals. Knowledge and safety management are managed to be 3P Safety, which is safe for patients, safe for personnel, and safe for the general public. Furthermore, changes in ITC and cyber security can lead to the safe practice of the EMS system which meets 4 components namely 3P1C, Patients (P), Personnel (P), People and Public (2P), and Cybersecurity (C).

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