Other IE tools that have applied and succeeded in the improvement of healthcare management in Thailand are Plant Layout (Kritchanchai and Hoeur 2017), Analytic Network Process (ANP) (Kritchanchai et al. 2017), DEMATEL (Supeekit et al. 2016), and BPMN (Chanpuypetch and Kritchanchai 2018).

3.2 Operational level and System Level

The healthcare management system can be separated into two levels; operational level and system level. The operational level is the management of operation sectors in healthcare system including inventory, transportation, queueing and capacity planning. While the system level is the management of information or data in the healthcare system that can be divided into two sections; product data and fragmented system (Kritchanchai and Kritchanchai 2016). According to the existing researches on healthcare management in Thailand, the researchers quite focused on an operational level. Among of literature reviews in operational level, 11 papers aimed to focus on inventory and 10 papers emphasized the capacity planning. While transportation and queueing were done as 6 papers. On the other hand, the study on the system level is less popular than the operational level. Currently, there were few researches in this perspective. The researches of system level aim focus on applying IT technology in order to improve and develop the information network including drug information, patient information, etc. (Kritchanchai and Suwandechochai 2010; Muangchoo and Kritchanchai 2015; Kritchanchai 2012). The classification data of operational level and system level was presented in Figure 2.

A typical healthcare system network or healthcare supply chain is a complex network consisting of many different parties at various stages of the network. According to Rossetti (2008), there are four major types of players in the healthcare network that consists of manufacturers, distributors, healthcare providers, and consumers. In accordance with the existing research, we classified the existing researches into four major types of players that shown in Figure 3. The result found that the healthcare provider is more popular than the other players, while consumer and logistics distributor are the second and the third, respectively. Only manufacturer is a player that no researcher focuses on this stage. Some studies determined many different players simultaneously in which it would be more beneficial (Chanpuypetch and Kritchanchai 2018; Kritchanchai 2012; Muangchoo and Kritchanchai 2015; and Kritchanchai 2012)

From the hospital perspective, the pattern of hospital operation management is able to be classified into three aspects that consist of the structure of nodes and links, information management, and material flow management (Kritchanchai, 2016). According to the categorization of existing researches in Thai hospital operations that shown in Figure 4, we found that most researches emphasized the structure of nodes and links and material flow management. Several IE tools were applied to both aspects for resource management and smooth workflow processes including patients and material (drug, medical supplies, medical supplies, etc.). In information management, 10 papers focused on this aspect in order to improve healthcare service and operations management information in the hospital. The drug information and patient information are the main topics in this perspective (Wanlopworakit 2012, Meungsu et al. 2012, and Chanpuypetch and Kritchanchai 2017).

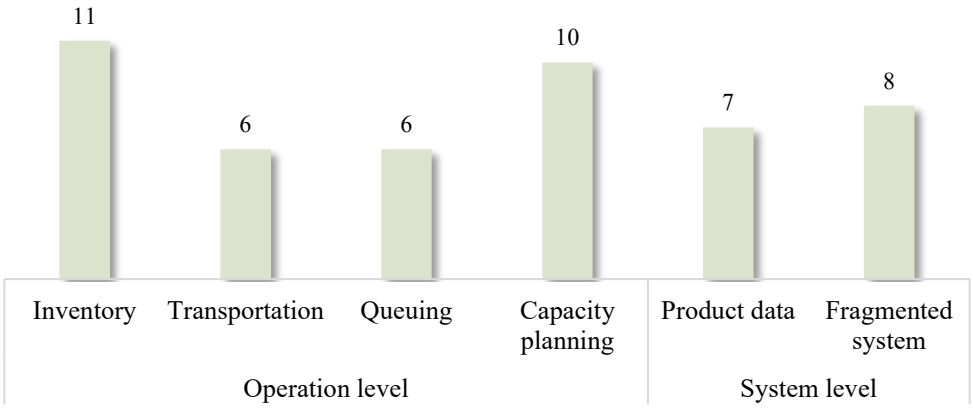

Figure 2. The review of the operational level and system level

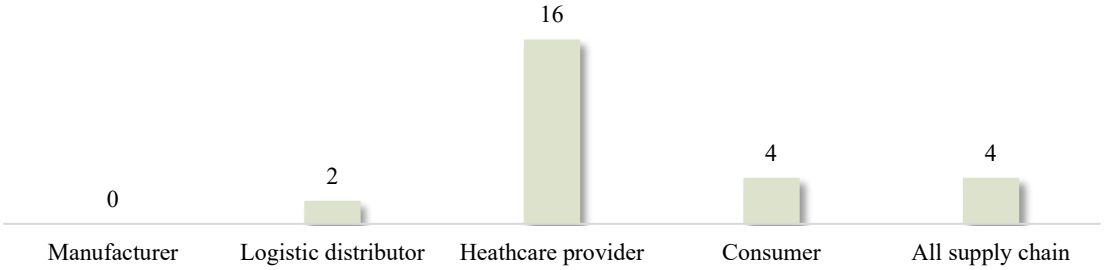

Figure 3. The review of players in the healthcare network

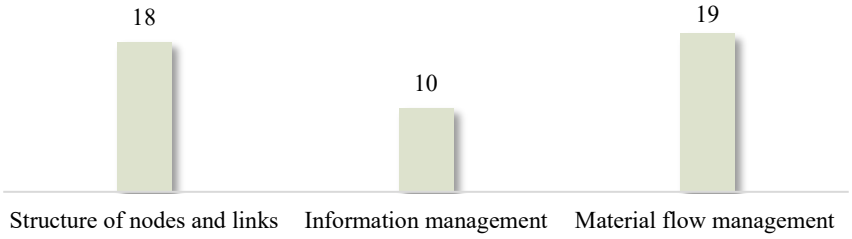

Figure 4. The review of hospital operation management

Table 2. The review of the case study and department type of research in healthcare management in Thailand

Studies	Case study	Department
Chanchai (2007)	Khon kaen hospital	Drug inventory
Chanpuypetch and Kritchanchai (2017)	15 hospitals in Thailand	Drug
Chanpuypetch and Kritchanchai (2018)	4 Thai hospitals	Drug
Chungsiwapornpong (2007)	720 hospitals in Thailand	Drug inventory
Khunngio (2012)	Srinakarin Hospital	Outpatients at the emergency unit
Kosayanon et al. (2018)	Maharaj Nakorn Chiang Mai Hospital	Radiotherapy service
Kritchanchai (2012)	A state-owned hospital	General
Kritchanchai and Hoeur (2017)	University Hospital	Outpatient department
Kritchanchai and Meesamut (2015)	Public hospital in Bangkok	Drug inventory
Kritchanchai and Suwandechochai (2010)	N/A	Medicine inventory
Kritchanchai et al. (2017)	5 countries including Thailand	All supply
Laeiddee (2010)	Ramathibodi hospital	Drug inventory
Meungsu et al. (2012)	Ramathibodi, Srinakarin, and Songklanagarind hospital	Drug
Muangchoo and Kritchanchai (2015)	N/A	Drug information
Sooksriwong and Bussaparoek (2009)	720 hospitals in Thailand	Cold storage drugs
Supeekit et al. (2016)	General case	N/A
Tepjit (2006)	Siriraj hospital	Appointment systems, medical units, outpatient department
Thongsukdee (2009)	A private hospital	Drug inventory
Wanlopworakit (2012)	Prachuap Khiri Khan hospital	Outpatient department
Wiboonrat (2011)	6 public hospitals	All process
Worawong (2012)	Queen Sirikit Naval Hospital	The manufacturing development process of cytotoxic drug admixtures

3.3 Case study

Many case studies in Thailand were enhanced and developed. Not only hospitals but also the related medical facilities were researched. Table 2 presented the review of the case study and department type of research in healthcare management in Thailand. According to Table 2, the main case study was hospital since the hospital is the center of the healthcare network. Also, the drug department was the main department of research in Thailand in which those researches aim to focus on the drug flow, drug inventory management, and drug information. Not only the drug department but also the outpatient department, radiotherapy service department, appointment systems department, and medical units have done in the improvement of healthcare management in Thailand as well.

4. Future research direction

In future research, other IE tools could be employed in the improvement of healthcare management in Thailand. Many IE tools are lacking in publications. The framework of future research direction is presented in Figure 5. To analyze and control the problem in the healthcare system, 7 QC tools can be used in order to monitor the overall operation and continuous process improvement in healthcare management. Moreover, Material Flow Cost Accounting (MFCA) could apply to assess the physical material flows in the medical manufacturers. For the improvement of operational level, most existing researches is mainly considering a Lean technique for the improvement. The IE tools such as 5W-H questions, 5S, Kaizen, SWOT, Fuzzy logic, ECRS, motion and time study, flow process chart, swim lane diagram, cross function flowchart, Just In Time (JIT), line balancing technique, supply chain score model, pull and push system, Kanban card and trigger board are also able to apply or integrate to Lean concept. To manage and support the increasing demand, the forecasting technique could be applied for predicting the demand in each day. According to the classification of the operational level, we found that few researchers studied transportation and queueing. To support those problems, traveling salesman problem, vehicle routing problem, scheduling problem and milk run problem based on optimization technique can be applied for improving the transportation as well as queueing theory should be employed for supporting service or patient queue in hospitals. To select the suitable location for a distribution center or warehouse, optimization technique based on facility location problem and allocation problem or multiple criteria decision making (MCDM) can apply to this problem. Besides, an optimization technique is able to apply to the problem of constraints in beds and operating room in the hospital as well. In the system level in healthcare management, the information is quite important. However, few researchers emphasized on the information system. Therefore, the healthcare system in Thailand should more focus on information flow and database management including drug information, equipment information, resources information, producer information, patient information, purchasing information, inventory information.

Among four players of the healthcare network should be determined with respect to material flow and information flow simultaneously. The material flow consists of the drug, medical supply, medical devices, blood, food, money, Staff, and fabrics while information flow consists of drug information, producer information, patient information, purchasing information, inventory information, equipment information, and resources information. According to the literature review, we found that most of the researches in Thailand published their works on the healthcare provider in Thailand, while the work on the consumer and logistic distributor are few researches. Moreover, there is no research considering the medical manufacturer in Thailand. In order to develop the sustainable healthcare management, all healthcare supply chain network or all four players should be simultaneously determined. Presently, the public hospital is a main issue of the research in healthcare management in Thailand. Many researchers aim to focus on the drug department and outpatient department since there are a complicated process and uncertainty condition. Nevertheless, the other departments such as the inpatient service section, medical units, and the general support section should be studied and improved in order to become an efficient hospital.

Not only drug management and service management but also resource management and others material management including waste, medical supplies, medical devices, blood, food, money, Staff, and fabrics should be focused. The big data or machine learning should be applied to IE tool in order to support efficient management in macro scale. Currently, the healthcare management in Thailand is lacking the interconnection in the macro scale, hence the system should be enhanced by using an advanced technology such as QR code, RFID, Barcode, data matrix, etc. Not only IE tools but also other tools should be employed in this field in order to reach the sustainable development in healthcare management of Thailand.

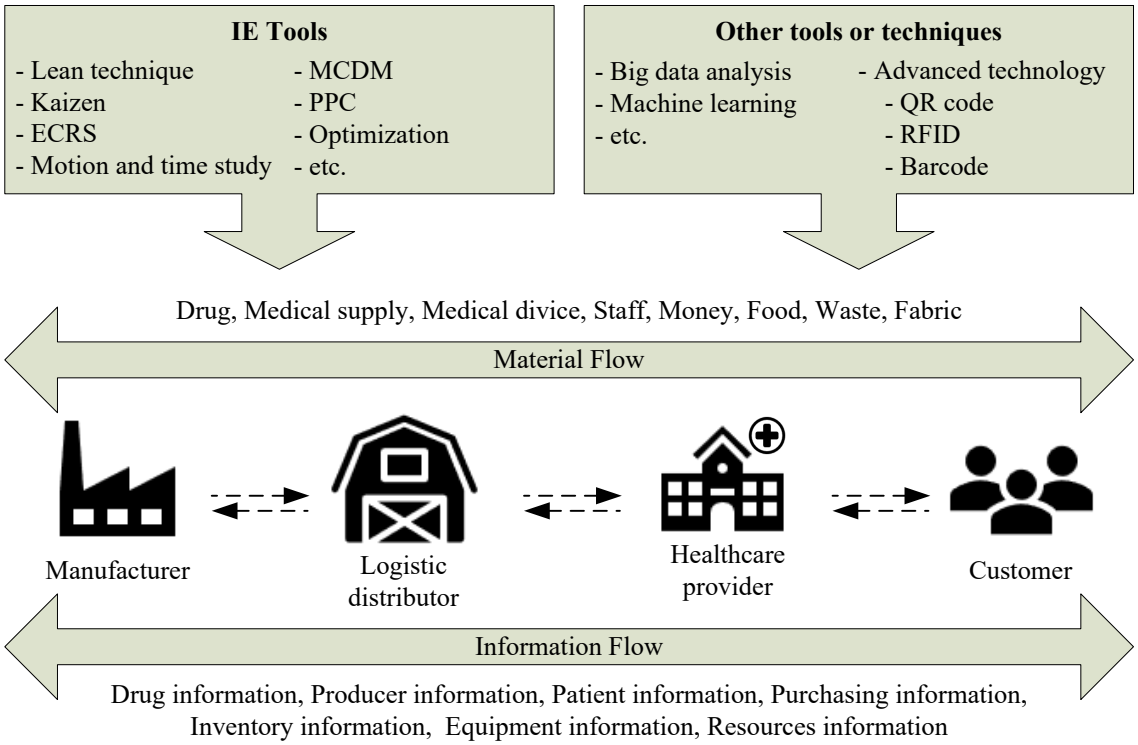

Figure 5. The framework of future research direction

5. Conclusions

This study proposed a survey on the improvement of healthcare management in Thailand based on using IE tools. The existing studies were reviewed and classified based on IE tool type, operational level, and system level, and case study. We found that the main IE tool that the researchers usually employ in the improvement of healthcare management in Thailand is a Lean concept. Not only Lean concept but also simulation, inventory control model, and ABC classification have been applied in this field as well. In operational level and system level, our literature survey found that most researchers published their works on the operation level in Thailand, while the works on the system level are few researches. In accordance with the case study of existing studies, most papers aimed to focus on a hospital in Thailand, especially public hospital. Also, we found that the drug department and outpatient department are the main department of research in Thailand. Finally, research gaps and future research were identified as assisting in developing future healthcare management.

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