CHAPTER IV

RESULTS AND DISCUSSIONS

A. Results

1. Prisma Flow Diagram

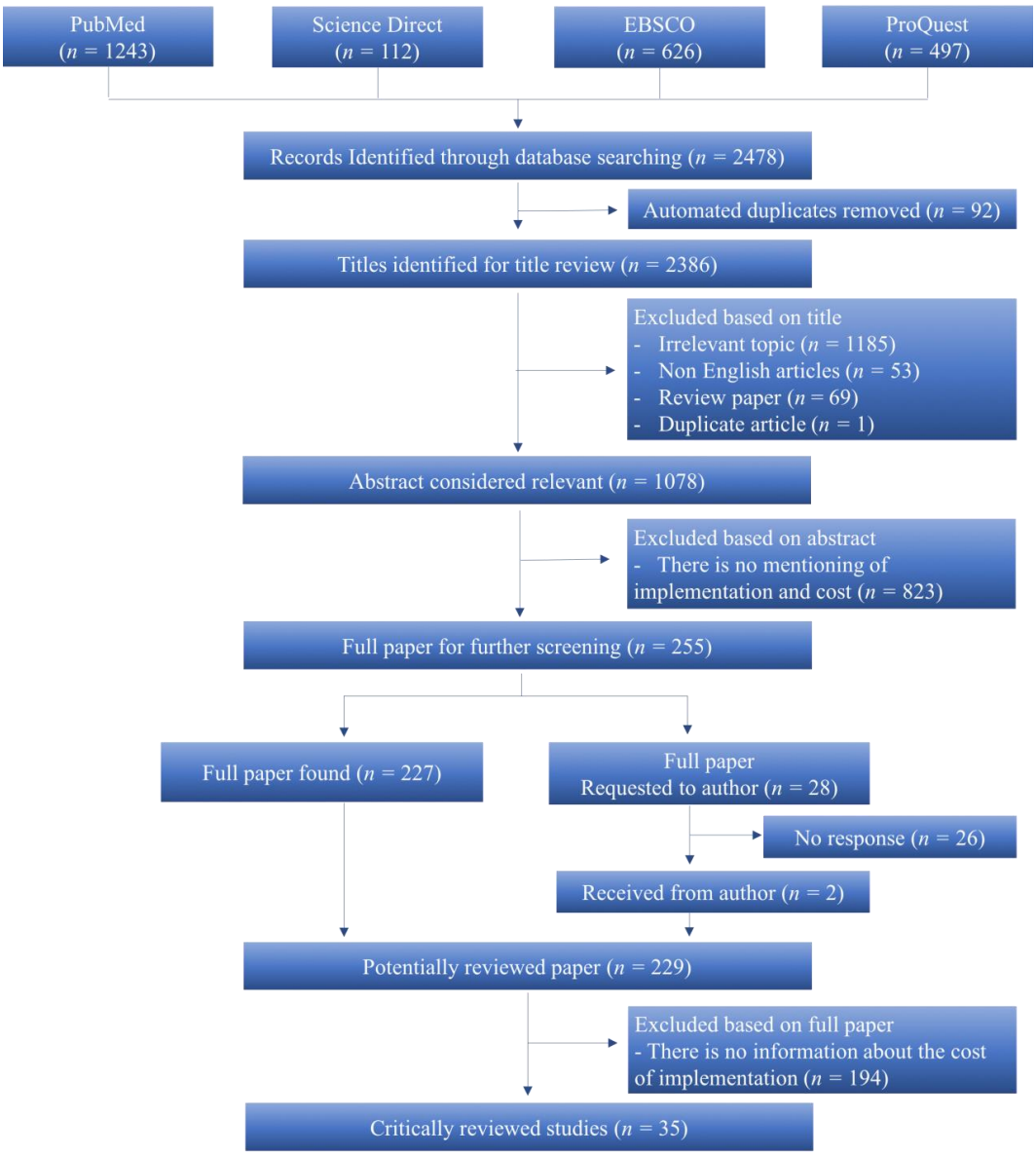

Figure 4. Modified Prisma Flow Diagram

2. Search Result

Our systematic literature searched identified 2478 titles. The search results from PubMed, Science Direct, EBSCO, and ProQuest were 1243, 112, 626, and 497, respectively. After duplicate remove using “duplicate items” feature in Zotero, 2386 titles remained. A manual review of titles and abstract, removed 1185 irrelevant topics, 53 Non-English papers, 69 review papers, and 1 duplicate paper. 225 papers remained to be reviewed in full text format. We were unable to find 28 full-text papers out of 225 papers. PI contacted the paper authors and 2 authors responded and sent the articles. In total, there were 229 potential full papers to be reviewed.

PI and Co-Author review the papers individually, and excluded 194 papers that didn’t mentioned the cost of implementing a HIS. At the end of the screening process, there were 35 papers to be reviewed. Two reviewers extract the data from the papers using rubrics (appendix 01) that were created based on initial literature review and keywords that found in potentially reviewed papers.

Table 2. Summary of the reviewed paper (n=35)

First Author	No	Country	implementation area	HIS type / system	HIMSS Stages	cost	cost variable
Augestad, K. M	[28]	Norway	Surgical Wards	CDSS	0	$94,965	personnel development
Banas, C. A	[29]	USA	Whole Hospital	Whole system	4		undefined
Bishop, R. O	[30]	Australia	Emergency Department	ED system	0		design
Callaway, E. C	[31]	USA	Radiology	Speech Recognition	0	$3,000	hardware; software
Canon, S. J	[32]	USA	Pediatric Urology/ Inpatient	Whole system	0	<$25,000 - >$200,000	initial setup cost
Castilho, V	[33]	Brazil	Whole Hospital	CDSS	0	R$752,618	personnel development
Choi, J. S	[34]	South Korea	Whole Hospital	EMR	0	$1,241,000	software; hardware; development; maintenance
Choudhury, M. H	[35]	Kuwait	Whole Hospital	PTFS	0		undefined
Clayton, P. D	[36]	USA	Whole Hospital	Whole system	4	$23,000,000	network; workstations; applications
Fargo, K. L	[37]	USA	Whole Hospital	Cost tool	0	$32,213	undefined
Field, T. S	[38]	USA	Ambulatory	Whole system	7	$76,314	personnel development

Han, J. M	[39]	South Korea	Whole Hospital	Whole system	0	$7,107,975	hardware; database; software; system infrastructure; system audit; maintenance
Hardin, L	[40]	USA	Whole Hospital	CCM	0		undefined
Herbst, K	[41]	South Africa	Whole Hospital	Whole system	0	$26,104,418	undefined
Kay, J. D	[42]	UK	Whole Hospital	Intranet	2	$10,000	undefined
Kazemi, A	[43]	Iran	Inpatient wards	EMR, CPOE	0		undefined
Kim, H. H	[44]	South Korea	Whole Hospital	Whole system	6		Hardware; software; network; maintenance; depreciation
Lin, J.-W	[45]	Taiwan	Whole Hospital	CDSS	0	$6,000	development; maintenance
MacKay, M	[46]	USA	Whole Hospital	CPOE	0		personnel development
Marasovic, C	[47]	Australia	ICU	CIS	3		undefined
Miniati, R	[48]	Italy	Whole Hospital	SISMA	0		development
Nakamura, M. M	[49]	USA	Whole Hospital	Whole system	0		undefined
Okumura, L. M	[50]	Brazil	Surgical Wards	CPOE, CDSS	0		personnel development
Pereira, J	[51]	Spain	Whole Hospital	PACS	2		software; hardware; personnel; maintenance

Raut, A	[52]	Nepal	Whole Hospital	Whole system	3	$218,900	development customization, rollout; travel (analysis and rollout); post production support; servers and networking; chromebooks
Riahi, S	[53]	Canada	Whole Hospital	Whole system	0	$4,876,320	initial investment and implementation; staffing; maintenance
Rossi, L	[54]	Lebanon	Whole Hospital	Whole system	0	$100,000	training courses; local personnel; equipment
Shah, K. G	[55]	Malawi	outpatient wards	EMR	0		software
Siracuse, J. J	[56]	USA	Whole Hospital	Whole system	0	$40,000	development and implementation; maintenance
Sultan, F	[57]	Pakistan	Whole Hospital	Whole system	4	$1,597,915	Salaries and benefits; hardware; maintenance; licensing and professional services; supplies, stationary, insurance, etc.
Teufel, R. J	[58]	USA	Whole Hospital	Whole system	0		undefined
Vermeulen, K. M	[59]	Netherland	Whole Hospital	EMR	0	$20,000/word	hardware; software; personnel; ICT support

							and software license; implementation; housing and overhead
Wisniewski, M. F	[60]	USA	Whole Hospital	CID	2		hardware; software; personnel
Yasunaga, H	[61]	Japan	Whole Hospital	EMR, OES	0	$10-20,000/bed	undefined
Zimlichman, E	[62]	USA	Whole Hospital	CPOE	0	$7,130,894; $19,293,379	Hardware/software; network/integration; implementation/consultants; training; IS staff; maintenance

3. Study timing

The majority of the studies (n = 26, 75%) were conducted during or after 2008. The earliest study included was published in 1992. The high concentration of studies published during 2008 and 2017 indicates that there is an increase in the adoption of hospital information system during these last decade.

4. Study Setting

Table 2 shows an overview of each study we analyzed. It can be seen that more than half of the studies n=27(77%) were conducted in high-income economic countries based on World Bank classification in 2017 [28–32,34–40,42,44–49,51,53,56,58–62], with 5(14%) done in upper-middle-income economies [33,41,43,50,54], and a few 3(9%) in lower-middle and low-income economic countries [52,55,57]. 31 (89%) hospitals located in the urban area [28–45,47,48,50,53,54,56–62], while the rest 4 (11%) were located in the rural area of the country [46,49,51,52]. More than half of the hospitals in the studies (n= 20 (57%)) were teaching hospital [28,29,31–34,36,37,41,43,44,46,48–50,53,56,58,59,61] with the remaining consisted of public non-teaching hospitals or private hospitals [30,35,38–40,42,45–47,51,52,54,57,60,62]. Out of 35 studies, 26 were

general hospitals [28–31,33,34,36–40,42–45,47,48,50–52,54–56,60–62] , 6 were specialty hospitals [35,46,49,53,57,58] and 3 studies conducted both in general and specialty hospitals [32,41,59].

5. Implementation of Hospital Information System

Of all 35 studies, only 11 studies explained each step, while the rest of the studies (n=24) only mentioned some of the steps.

In terms of the hospital system information, as can be seen from table 2, we found 11(31%) studies implemented the whole system [29,36,39,41,44,49,52–54,57,58], while the rest 24(69%) implemented the system partially [28,30–35,37,38,40,42,43,45–48,50,51,55,56,59–62]. This is especially important to distinguish because the size of the system affect how much it will cost in the end. A whole system means it includes not only EMR, but other components such as CPOE and CDSS. According to HIMSS analytics, a hospital information system adoption is divided into 8 stages, starting from stage 0 to stage 7. A whole system implementation in the studies doesn’t always refer as the hospital being on a stage 7 adoption, because we studied only whether the system was complete or not. While HIMSS have a more specific criteria for each stage, such as how many percent the system is integrated, and whether the hospital is still using paper documentation

or not. We identify the stage of implementation on each paper based on the system that they described inside the paper. The interpretation of these stages were analyzed and discussed by PI and co-author. As can be seen on table 2, the majority of the stages were below stage 5, 31(89%).

Apart from the size of the system, the place where it is being installed also affect the cost. Looking into table 2, we identified that 26 (74%) of the studies implemented the system in the whole hospital [29,33–37,39–42,44–46,48,49,51–54,56–62], while some other studies implemented the system specifically to certain departments such as ICU [47], ED [30], surgical wards [28,50], inpatient wards [32,43,55], ambulatory care [38], and radiology [31].

Other findings related to cost is how the hospital build the HIS, 16 (46%) of the studies were using a home-grown system [30,31,35,36,38,40,42,44–46,48,50,51,56,57,60], 11 (31%) were a commercial system [28,32–34,41,43,47,53,54,61,62] with 2 (5%) of the studies consisted of both home-grown and commercial system [29,59], and 3 (9%) were an open source system [39,52,55], while 3 (9%) of the studies didn't mentioned the source of the system [37,49,58].

6. Cost of Implementing Hospital Information System

Regarding the cost, there are various differences in the amount of costs spent to implement a HIS, ranging from several thousands to several millions USD. The reporting component of the cost also varied starting from only mentioning the implementation cost to the one reporting from the beginning of the analysis in the pre-implementation phase until evaluation post-implementation.

From 35 studies, we found that 20 studies [28,31–34,36–39,41,42,45,52–54,56,57,59,61,62] mentioned the amount of cost to implement HIS, with 7 studies [36,39,41,52–54,57] mentioned the cost of the whole system, and 13 [28,31–34,37,38,42,45,56,59,61,62] studies mentioned only the cost of a partial system. The rest of the studies mentioned the cost of implementation narratively [29,30,35,40,43,44,46–51,55,58,60].

With 20 studies that mentioned the amount of cost to implement the system, 6 merely explained the implementation cost without any details [32,37,41,45,56,61], 5 only explained certain aspects of the cost (i.e; hardware, software, or personnel cost) [28,31,33,42,54], while 9 explained the cost factors in thorough detail[34,36,38,39,52,53,57,59,62].

In this paper, we converted each national currency into US dollars based on the year's currency exchange rates in accordance to the time of the research stated on the publication. The information of the currency exchange can be found in https://fx-rate.net/historical/

7 of the studies that mentioned the amount were conducted in USA [31,32,36–38,56,62]. One study in Columbia Presbyterian Medical Center, NY [36] mentioned that it cost them $23 million dollars during 1987 to 1991 to install an integrated system between their 18 buildings. In 2009, Ontario Shores Centre for Mental Health Sciences, invested $4,876,320 for EMR implementation [53].

Another study in the USA [31,37,56,62] only mentioned the cost of implementation of a partial system. An earlier study in David Grant USAF Medical Center, CA [31] reported a cost of $30,000 to implement a complete self-designed speech recognition interface inside HIS for 11 PCs and all accompanying software. This is relatively cheaper if compared to the implemention of a commercial vendor product that may run as high as $5,000 to $15,000 per station.

Later during 2011, a study in Cambridge Health Alliance, Massachusetts [56] estimated a cost of $200,000 to $300,000 for implementing a Web-based Surgical Booking and Informed Consent System in a 250-bed hospital.

At the same year, two other studies were reported [37,62]. One in Ohio State University Wexner Medical Center, Ohio [37], with an implementation of a Cost Visibility Tool inside the EMR on antibiotic prescribing at a cost of $32,213.

The other was a comparison study in two groups hospital with group A implemented a vendor-developed CPOE system and group B implemented an internally-developed CPOE system with custom-built DSS [62]. Each group consists of two small-to-medium-size community hospitals with 100 to 300 hospital beds that implement the same system. In the study, Zimlichman et al. reported that group A spent $7,130,894 while group B spent an amount of $19,293,379 to implement the system. The difference in implementation costs were said mostly due to the higher fees for IT consultants and building a clinical support team (train-the-trainer) at hospital group B.

Two other studies in USA [32,49] were a survey that focuses both on pediatrics, one survey focusing more on EMR use in Pediatric Urology and the other on the HIS adoption in Children's Hospital. The first study found that the majority of the hospitals spent an initial cost of greater than $50,000 with 45.2% of them reported an initial conversion cost of greater than $200,000 [32]. The second study showed the rates of HIS adoption with only 2.8% of children's

hospitals have a comprehensive HIS system, whereas an additional 17.9% have a basic HIS. The study indicates that, although HIS adoption rates are low among children's hospital, they are slightly better than those of adult hospitals because they have greater financial resources which is essential for meeting the substantial cost of implementing and maintaining HIS [49].

Five studies in USA [29,40,46,48,58,60] were implemented a partial system within their hospital and mentioned that the cost for implementation was "minimal" and relatively "affordable".

Two studies in Korea were analyzing benefit to costs ratio for implementing a HIS [39,44]. Out of the two, one study by Han et al. mentioned that it cost the hospital $7,1 million to implement the whole system in 2011 [39]. On the other hand another study in Korea were analyzing benefit to costs ratio for implementing an EMR system, according to Choi et al. to implement the EMR system it cost them $2,7 million in 2006 [34]. Meanwhile to implement an add on surgical referral within an EMR system, hospitals in Norway spent a total cost of $94,965 [28].

A study in National Taiwan University Hospital built and implemented a CDSS-embedded screening program system for $6,000. Another study in the Netherlands also implemented a

CPOE/CDSS for a cost of $28,730 (USD, 2009) per ward [59]. While a study in Brazil who built their own CPOE/CDSS reported that the system was substantially cheap, due to the nature of the system that was built within the hospital with support from the hospital's information staffs [50].

A survey targeting medical institutions in Japan regarding the use of EMR was done in 2007, this study found that many medical institutions in the country said that implementing EMR is high costs for them [61]. The study found that it cost $10,000 - 20,000 per bed for a hospital to introduce an EMR.

Two studies were done in the lower-middle and low income countries [52,57]. In Nepal, a study reported an estimated amount of $218,900 in 2015 to implement an open source EMR system [52]. While in Pakistan, the hospital spent $1,527,915 in 2001 to implement an in-house HIS [57].

Five studies were done in upper-middle income countries [33,41,43,50,54]. In Lebanon, 6 hospitals of Palestine Red Crescent Society (PRCS) started to implement HIS on all of its branches in 2003 [54]. They stated that they spent $100,000 for the implementation of the system. Meanwhile in the Northern Province, South Africa, it is reported that they spent $26,104,418 (USD, 1998)

to implement a comprehensive integrated HIS in all of its 42 hospitals [41].

Furthermore, there are also many variations regarding the component of the HIS, starting from simple system to the more complex one.

7. Cost of Software and Hardware

In the USA, according to Clayton et al. the hospital spent $7.4 million for hardware and software packages, $3.9 million for network (wires, bridges, getaways and fiber), and $2.1 million for workstations to fully implement the system [36]. For workstations it included 797 personal computer (PC) based workstations. Each PC's net cost was $3,300, consists of $1,900 for the computer, $600 for the software (word processing, scriptwriter, communication, and terminal emulation) and $700 for a token ring connector card.

Meanwhile in Korea, Han et al. reported that they spent $1.78 million for hardware and $4.7 million for software, and $38,500 for system infrastructure. For hardware it consisted of hardware system for $145,395, network equipment for $472,150, security equipment for $63,972, disk storage for $341,683, and other devices including PC for $762,495. For software it consisted of development costs for $3,2 million and commercial software costs for $1,5 million [39].

In 2003, hospitals in Lebanon implemented a custom-based HIS system. They reported that they spent $23,000 for their hardware and software [54].

In 2001, a hospital in Pakistan whose built an in-house HIS spent an approximate of $1,299,594 to develop the information system, roughly $5,022 per year ($50,221 over the ten-year time span) for licensing, and $11,480 per year for hardware [57].

To build a partial system such as CPOE, one study reported that it cost them $652,990 for hardware and software packages and $260,391 for network, while buying the system from a commercial vendor cost them $897,610 and $299,203 respectively [62]. Vermeulen et al. [59] reported a total $30,812 for hardware, in which $28,730 were spent for the server and network, and $2,082 were spent for equipment while the software cost them $432,260.

Different to CPOE, a study on implementation of EMR system mentioned that it cost them $1,2 million for a one time purchase of the software and $306,000 for hardware [34]. Interestingly to build an internally-developed add-on system inside EMR, one study mentioned that it only cost them $40,000 [56]. In contrast to internally-developed add-on system, a study in Norway that hire commercial vendors to

custom build their add-on system spent an approximate of $46,229 for the software development.

Another study in Oxford Radcliffe hospital, UK mentioned that their intranet EMR software was developed at low cost, however the total replacement cost of the hardware and software added to their existing systems was approximately $10,000 [42]. A similar study in Kuwait also saying that their Clinical Information System (CIS) has been developed at a relatively low cost [35] while a study in sub-Saharan Africa with open-source EMR mentioned that their system was free and available on the internet [55].

8. Cost of Personnel

The cost of personnel in [36] was $9.8 million, with $2 million spent for personnel to design and implement the network and $7 million for the applications of the system, within those expenditure it included salaries, fringe, overhead and indirect costs. While it costed a hospital $9.8 million for personnel to design and implement a whole system, a study by Field et al. [38] showed that it cost them only $76,314 for personnel to developed and implement a partial HIS system, which is an automated alert system for ambulatory physicians in 2011.

An estimated of $3.1 million were spent in Canada for staff training following an EMR implementation within their hospital [53]. Meanwhile in Lebanon, the hospital spent $42,000 for staff training courses [54].

A comparison study was conducted between a vendor CPOE system and home-grown system in the USA [62], the hospitals using the vendor system reported a cost of $1,770,341 for implementation and consultants, $62,431 for IT department staffs and $319,178 for training staffs. While the hospitals using the home-grown system reported a cost of $5,688,907 for personnel to design and implemented the network, $6,604 for IT department staffs and $2,288,298 for training staffs.

Another study in Netherland reported that the hospital spent $367,600 for IT staffs on their CPOE system. Although the expenditure was included with a yearly software license [59]. Meanwhile in Brazil, a teaching hospital who implemented a custom-built CPOE/ CDSS stated that they spent $432,092 (USD, 2009) for its personnel costs, in which $310,156 (71.78%) were spent on computer consulting professionals, and the remaining $121,936 (28.22%) were spent for Hospital and University resources [33]. One interesting study that custom-built their CPOE system reported that

they couldn’t estimate the exact cost of developing and implementing their system because the multidisciplinary team either donated their time or were salaried [46].

A similar partial implementation but of a vendor EMR system spent $166,000 for medical transcriptionist (MT) support [34]. Another study that was implementing an add on electronic surgical referral service within the hospitals EMR [28] spent a total cost of $48,679 in which $15,290 were spent to reach a guideline consensus of the referral between surgeons and general practitioners (GP) and $33,389 spent to pilot and implement the software for 139 GPs.

9. Cost of Maintenance

A hospital that implemented an EMR system spent an approximate of $207,951 per year for its whole system maintenance and support. While in-house HIS system in Pakistan, spent roughly $6,011 per year for the maintenance of the hospital system [57]. Another study on implementation of EMR vendor-based system mentioned that the purchase of the system came with a 5-year warranty maintenance included.

Clayton et al. [36] divided their maintenance cost into network maintenance, workstations and applications. For network, it cost them $5.1 million for 5 personnel maintenance in 16 years. For

workstations it cost them $0.5 million for 797 PC maintenance in 4 years. Lastly for applications it cost them $3 million for 3 personnel maintenance fees in 6 years.

A study on implementation of CPOE system mentioned that there were substantial difference of maintenance cost between a vendor system and built-in system cost [62]. Although the initial cost of commercial system is higher, maintenance is significantly lower with $3,782,131 per year compare to $10,544,165 per year in a built-in system.

Contrary to other studies, a study by Callaway et al. [31] reported that their partial system does not require special maintenance or support. A similar study in Korea [39] also stated that their maintenance cost was zero and therefore resulted in lower implementation cost.

10. Barriers in Implementing HIS

One barrier, that is very much highlighted in many studies in implementing HIS is the high initial costs [34,43,53,56,61]. Yasunaga et al. [61] explained in his study that the increasing amount of HIS implementation in Japan happened mostly in either universities or public hospitals that are supported by public money. Although during 2002 and 2003, government also distributed subsidies to 249 large

private hospitals. Difficulties rose in private or smaller hospitals in Japan that did not received a funding support to be able to implement HIS. The high initial costs did not only come from the expensive software and hardware [61], but also from the additional support personnel and initial staff training [51].

Marasovic et al. [47] pointing another cost barrier in implementing HIS, which is the maintenance cost. The author explained that initial capital outlay will not be sufficient to maintain an efficient HIS. This problem happened in one of the hospitals in Australia who withdrew their EMR system after two and a half years implementation because the hospital could not secure funding for software and hardware upgrades. A similar statement was found in the USA which stated that the updating and maintaining of HIS came as a financial burden as the incentives from the government are declining over time [58].

Human resource management and training were also said to be core challenges, with most users having had only minimal exposure to computers and no prior experience with EMRs [52]. This leads to additional training costs for hospital workers.

Other than cost, there are psychosocial barriers such as perception of usefulness within the health practitioners [53], and

skepticism about the utility of EMR, such as concerns about the advantages relative to the increased amount of work [56]. The increased amount of work came from the increased time investment per patient that are needed for the practitioners to type and fill the electronic record [52]. Another barrier related to time include the time required to install and learn a new system [56].

There are also barriers on development such as lack of consumer support from vendors, the complexity of a new system, and the inability to customize or integrate a commercial system with a hospital's existing platform [56].

11. Benefits of HIS Implementation

A direct benefit which is very evident is the improvement of patient care. This can be achieved from the improvement of medical records handling and shorter turnaround time on diagnostic information such as laboratory result, that resulted in increased accessibility of patient related information to health care professionals during the treatment process [41]. Improved access information were said to be the core to improve efficiency, it also reduces the time wasted on miscellaneous factors such as lost results, misplaced patient charts, etc. [36].

From the perspective of health professionals, they also described the HIS as a tool that will make their work easier and improve overall service in the hospital [52].

From the managerial perspective, there are benefits such as improvement of management efficiency through the availability of an integrated management information [41]. Cost reduction is also said to be expected as the benefit of HIS, this comes from the reduction of supplies for paper-chart, rental costs of the outside storage space, and personnel costs of delivering the paper-charts to the clinic rooms [34].

12. Return on Investment (ROI)

Out of 35 papers, 5 papers mentioned ROI [34,37,53,57,62]. Whilst x paper mentioned positive ROI [37,53,57,62], and x papers does not meet the ROI expectation [34,62]. One study that mentioned the failure expected ROI period explained that even with the simplest transition, they calculated that the ROI would have taken 5.45 years at a minimum. While their expected ROI period is within the 5-year period [34].

13. Cost-effectiveness (CE)

Out of 35 papers, 4 papers mentioned CE [34,37,59,62]. One study mentioned that for their EMR system to be financially cost-effective, they need to use the system for at least 4 or 5 years after full

implementation [34]. Another study on CPOE/CDSS calculated the incremental CE ratio for medication errors prevented and preventable adverse drug events (pADEs) reported a result of an additional cost ($2.5) to prevent one extra medication error with electronic medication ordering system compared to paper based, and an additional $230 to prevent one extra pADE with the electronic medication ordering system [59]

14. Failure of implementation

Not all of the studies clearly state whether the implementation of the system were still being used in the hospital, however one study in Australia explained that after two and a half years of implementation the hospital withdrew the system due to lack of efficiency of the system and the inability for the hospital to fund the software and hardware upgrades [47].

B. Discussion

The most interesting finding in this paper is that the implementation costs turned out to be widely variable. The cost ranges from 3 (three) thousands to more than 16 (sixteen) million US dollars. This condition is a result of the complexity of the system, that can comprise from the smallest system to a wider and more integrated system implemented throughout the whole hospital. Furthermore, there is no clear strategy mentioned in how to implement the HIS, whether it should be started from a small system in one department or jump right to a bigger and more integrated system for all departments.

To conduct an IT project, stakeholders usually will follow a certain model of Software development life cycle (SDLC). In the Incremental model of SDLC there are 4 phases:

1. Requirement Phase
2. Design and Development Phase
3. Testing
4. Implementation

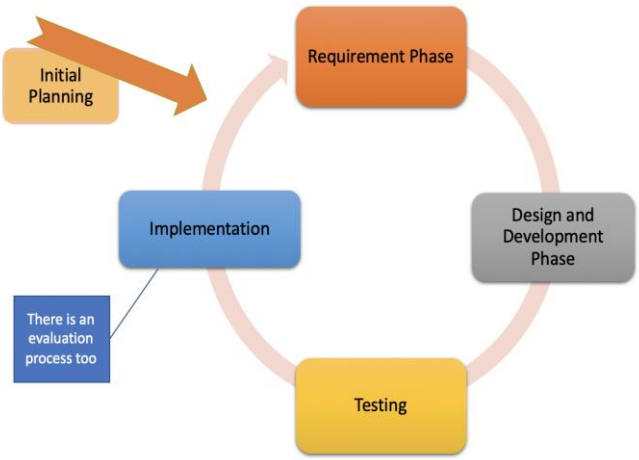

Figure 5. Incremental model of SDLC

Based on this Incremental model, we figured out that only a handful of the papers reported the complete all four phases. Whilst the rest of the papers only reported part of the phases.

These results, therefore, need to be interpreted with caution. The incompleteness of the phase does not mean that during the HIS project the developer team did not go through the processes, but it seems that the paper's authors were not focusing on the IT project development processes.

It is interesting to note that most of the studies we reviewed are focusing only in the design and development cost (i.e. hardware and software). This condition is contradicted with the newer theory of building a HIS, that the main cost is not only for buying software or developing the system. Since nowadays, the requirement phase (i.e. cost

of analysis and design), and the implementation phase could end up being as costly as the cost of the software and hardware itself [63,64]. Stakeholders also tend to forget another crucial factor which is the human aspect. Starting from planning (requirement phase) up to the implementation process, humans also plays an important role. For example, training the staff to get used to the new management process is important in reducing the inefficiency whenever users are being introduced to a new system (insert citation).

Furthermore, the common sense used by the hospital stakeholders that are not very familiar with the management of ITC -- will usually begin with a regular business question : How much money will it cost to implement a new HIS and how much profit they will gain after implementing the system itself?

This is a common misconception for non-IT people, hence the critique to the IT personnel that they cannot give clear explanation of the importance of IT in the whole process of management. IT experts fail to give insight for the management process, and tend to prefer busying themselves with the technical support process that people are used to seeing (e.g. fixing a crash computer, installing office software, repairing internet connection, etc) [63].

In this study, we also found that there is a lack of information regarding the evaluation after the implementation. We found only few papers that discussed or mention the benefit after the HIS implementation. This might be due to the misconception about implementing technology that are seen as something that always gives benefit to the organization, especially computerized processes [65]. However, the latest study also suggest that Information system implementation could bring disadvantage(s) when there is a lack of plan [66,67].

Having discussed the study report from the view of SDLC, we found thatthis paper addresses the cost of implementation of HIS. There are several factors that contribute to the total cost of HIS implementation.

1. The cost of the software itself.
    a. The complexity of the system
    b. Cost of buying the software or building it internally
2. The infrastructures needed for the system to run
3. The cost for every step of SDLC cycle, starting from planning and designing through the evaluation of the system after implementation
4. The scale of the implementation
    a. Single ward/department
    b. Multi or all wards/departments

We found that cost was never explained in detail in the majority of the papers, this means that implementing HIS starting from the designing process up to the implementation phase is actually a complicated process. Some people with no background in IT will think that implementing a HIS is just a simple matter of buying a software (ie: office suites), installing the software, and using it right away. However it is further known that when the system is not well designed, a reluctance of the usage is commonly found [47,68].

Whilst there is no clear agreement from all 35 studies, we found out that the majority of the studies spending are on hardware - software and also personal development. As already mentioned above, the cost of hardware-software could be the top two most cost-spending the hospital management needed to prepare. On the other side, we cannot forget that there is the implementation phase that could be as costly as the hardware-software itself. When the calculation of the preparation cost, in order to support the implementation of HIS, is calculated separately it looks a lot. Not only the software cost, but also the hardware, including the network infrastructures [63,68].

One of the most important factors in using a new system are user training and user support. If this phase is not being prepared since the beginning, there will be a problem in allocating the not-so-small budget.

One thing that management should be made aware of is that user dissatisfaction and unfamiliarity could lead to insufficiency system performance, that can end up in the withdrawal of the system. Or in another word, the new system is failing.

Furthermore, in the modern implementation of an information system, the cost of implementation of a system could be as high as the building of the system itself including the cost of the hardware. This is opposite of the earlier fact that the majority of the cost were mainly focused in the software and hardware cost [63,69].

The underline is, that the variability of the cost components is unpredictable due the different needs of each hospital. Therefore, making a structured strategy when doing an implementation of a system to achieve the organization goals is the more important step to factor in determining the cost component.

Moving now to the barriers, we found in this study that there are four. Those barriers are: cost, human resources, psychosocial, and customer support. Below is the explanation of those barriers.

Firstly, the cost. The implementation of technology including an IT system could become very costly, it contributed until up to 91% of the cost increment in drug, medical devices, and health services in the

hospital. This high initial cost and maintenance cost are most likely be seen as a huge barrier, especially in middle and low-income countries.

In order to manage the HIS in the long term, a well managed IT department within the hospital is mandatory. In this era, the IT department should not be seen as cost-center, but more as a service department. And the IT department should be the success factor for the organization to achieve the goal. Furthermore, in this Industry 4.0 era, the digital transformation is affecting the healthcare industry as well. There are many good innovations that is currently happening in this industry revolution:

1. Improving the quality of care
2. Improving health care delivery
3. Optimized the patient satisfaction

Secondly, the human resources. Implementing HIS could not only be done by pointing the people to run the software, it requires training to familiarize themselves with the system. Study says that when the involved-person does not have adequate training, it will lead to slower work pace and lowering the user's satisfaction to the system. Management also should be giving support and creating related policy to ensure a smooth and well operated HIS.

Thirdly, psychosocial. Many health workers are still feeling skeptical regarding the usefulness of the system and are having certain concerns that the system will only add additional workload for them. Study shows that the management should push the agenda to support business process changes from manual to electronic. Management should motivate the hospital stakeholders, and encourage new behaviors amongst workers in order to increase technological competence to achieve a successful HIS implementation project.

Fourthly, customer support. When we are expecting users to accept the new system, providing help support for the users is important. The key factor is in the user satisfaction.

In terms of failure, it is interesting to note that failure in HIS is possible. And in fact, there is a high failure rate of EMR implementation. Therefore, the management should prepare themselves for the not-favorable contingency plan of failure.

Moreover, management in hospital often have doubt in implementing HIS since they could face a high total cost after the implementation. The first thing that the management are likely to come out is regarding the return of the investment. The calculation of direct cost-benefit in IT investment is often unavoidable, but many times the indirect benefits are ignored and are not calculated (ie: the user

satisfaction due to fast administration process). In this modern era, the implementation of IT is a must. With the focus of increasing patient safety and improving the health care quality in mind, the not-so-cheap implementation cost means that the system needs to be designed/planned carefully ahead in order to maximize the benefit. We should avoid the technology application in health care that increases the cost of the health services.

One of the drawbacks in this analysis is that majority of the studies did not focus on the implementation of the HIS and only mentioned briefly regarding the cost of implementation.