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## Adoption Of Free/Open Source Software Products In Healthcare Industry: An Indonesian Case Study

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### ABSTRACT

The healthcare industry widely uses free/open-source Hospital Management Information System (HMIS) products as an alternative to similar commercial products. The objective of this study was to identify the factors that influenced healthcare institutions to adopt a free/ open-source HMIS product. Technology-Organization-Environment (TOE) framework was applied to examine the phenomenon of product adoption. This study was qualitative research with a case study approach. Data were collected using face-to-face and phone interviews approach. Seven respondents from three institutions participated in this study. The results indicated three main factors for adopting the product, namely (a) the affordability of adoption costs, (b) the completeness of product features, and (c) the supports from product developers.

**KEYWORDS:** Free/Open Source Software; Hospital Management Information System; TOE Framework.

## INTRODUCTION

Information technology (IT) used by health care institutions is very sophisticated because it must accommodate the complex needs of these institutions (Paré, Wybo, & Delannoy, 2009). IT is used not only for administrative needs, but also for integrating all lines of business processes in these institutions, ranging from patient administration, medical records management, records the activity of medical services, infrastructure management to the financial system (Bagayoko, Dufour, Chaacho, Bouhaddou, & Fieschi, 2010). In consideration of the limited organization resources, it is not surprising that many institutions do not develop their information technology and chose to use IT products from other parties.

Information technology solutions that are currently used by many health care institutions are generally commercial and proprietary. These products are generally used as an integrated software package called Hospital Information Management System (HMIS). However, the weakness of the commercial product is the high cost to be incurred (Bagayoko et al., 2010). Therefore, small-to-medium health care institutions such as clinics, health centers, and small hospitals often can not buy that sort of system.

The solution to this problem is the emergence of various initiatives of the health industry itself to develop products that are licensed free/open-source software (FOSS). The license of FOSS products allow users to use, study, modify, and/or disseminate such devices freely (Free Software Foundation, 2017; Open Source Initiative, 2007). The advantage is that each user institution has the right either independently or jointly developed the product at its own needs without the need to pay license fees.

In Indonesia, there are several initiatives to develop FOSS products for the medical industry, among which Generic Open Source HMIS (GOS HMIS), NCI-Medismart HMIS, HMIS of the Center for Health Policy and Management, University of Gadjah Mada (UGM PKMK), and Khanza HMIS. Unfortunately, there is no public data that indicates the exact number of users of each of these products, except PKMK HMIS UGM, that claimed to have been installed in five hospitals. GOS HMIS, as a product of the Indonesian government, claimed to have been used by some hospitals owned by the government and private sector (Kementerian Kesehatan Republik Indonesia, 2015). Khanza HMIS used by hundreds of hospitals and clinics throughout Indonesia (Yayasan SIMRS Khanza Indonesia, 2020), and NCI-Medismart HMIS used by tens of hospitals and clinics (Nuansa Cerah Informasi, 2020). The four products are still actively developed today.

Several factors support the popularity of the four HMIS products. First, the benefits of these products are at a relatively low price. In the case of GOS and Khanza HMIS, hospitals can adopt the product without a license fee or for free. Hospital as users is free to develop and disseminate it to the user-user. Second, users can develop their products following their individual needs.

In addition to these two factors, another consideration is the completeness of features (Table 1) and an active community of developers and users. The users of Khanza HMIS formed an organization called the Association of HMIS Khanza Indonesia (ASKI). The organization facilitates institutions that want to start using HMIS Khanza and supports institutions that already used it. This third factor, which can be termed as community support, is a critical factor and can be a differentiator among other FOSS products. Citing the opinion of Richard Stallman (the founder of the Free Software Foundation), the essentials of free software is freedom because "...they promote social solidarity-that is, sharing and cooperation"(Stallman, 2016, para. 2).

No.	Category	Component
1.	Medical record	Patient registration, treatment history, medical record management
2.	Inpatient	Inpatient rooms data management
3.	Finance and Accounting	Determination of treatment tariff, employee payroll, billing, menu cashier, accounting journals, financial reports
4.	Pharmacy	Drug inventory data management, input the recipe and print the rules of use
5.	Human resource	Employee data management, digital presence
6.	Print files/reports	Print file medical records, referral letters print, print SKL, print sick leave letters
7.	Bridging	Bridging with Aplicare, bridging with INA-CBGs, bridging the SEP BPJS

**Table 1.**  
Completeness Feature  
Khanza  
HMIS

Beyond the advantages mentioned previously, the adoption of FOSS products will not be free of obstacles. In general, these barriers include (a) lack of knowledge of human resources (HR); (b) the difficulty of integration with existing systems; (c) the possibility of forking; sunk investment costs of commercial products in the past; and (d) the immaturity of the technology (Nagy, Yassin, & Bhattacharjee, 2010). Also, research in Quebec, Canada show that the adoption of open source products, particularly in the health services industry, maybe hampered because: (a) political pressure from internal or external; (b) the lack of information regarding the product; (c) conservative management; absence of the other party responsible for the product; (d) the individualistic and competitive culture that inhibit sharing culture; and (e) the hidden costs of a product (Paré et al., 2009).

Contrast with barriers to adoption of FOSS products, on the other hand, commercial products, or so-called proprietary, answering these shortcomings. Surveys of Barracuda Networks proves that companies that prefer proprietary software compared to the FOSS selected the proprietary software vendors due to their professional technical support and easier adoption (Asay, 2007). In the same survey, it was revealed that the main reason for the selection of FOSS is the price factor and access to the source code of the program rather than the professional technical support and ease of adoption of the proprietary software. If the adoption of information technology is hampered due to the low capacity of human resources, why many institutions choose not to adopt commercial products generally that have professional technical supports?

This contradiction is interesting to examine further. In the case in Indonesia, this study takes the context of one of the named Khanza HMIS FOSS product that has the support of an association and claims a broad enough user base. "Why do health care institutions adopt a FOSS Khanza HMIS?" Answers to the question will be revealed in this study, which further examines factors that influenced health care institutions to adopt the FOSS product.

This paper proceeds as follow. Background and Theoretical Framework section explain free/open sources software (FOSS) in the context of research objective. It also explains the theoretical framework used in the study. The Methodology section describes the research approach and data used to answer the research question. It then followed by the Results and Discussion section. The final part i.e., Conclusion section explains the conclusions and limitation of the study.

### ***Free/Open Source Software (FOSS)***

The term open-source software (OSS) was initiated by Eric S. Raymond and Bruce Perens in 1998 (Karopka, Schmuhl, & Demski, 2014). Simply put, open source can be defined as a license to provide access to the source code software. However, the open-source licenses not only means access to the source code alone, but must meet other criteria that virtually ensures users have the rights to use, modify, and redistribute an open-source software (Open Source Initiative, 2007).

Before the popular open-source terms, a similar idea underlying the emergence of the term stated by Richard Stallman in 1986 with the title of the Free Software Definition (Free Software Foundation 2017). Stallman prefers the term free, open-source software than for the word free to depict freedom, while open is not necessarily free (Stallman, 2016). In contrast to the opinion of the Open Source Initiative, the Free Software Foundation (2017) defines the criteria for free software with the following criteria: (a) the freedom to run the program; (b) freedom to study how the program works; (c) freedom to redistribute copies; and (d) freedom to disseminate the modified program.

Although FOSS is intrinsically linked to the nature of freedom, FOSS products are better known because they were cheaper than the proprietary products (Dunn, 2005; Marsan & Paré, 2013). However, it does not mean that the use of FOSS will always lead to lower expenses. FOSS product ownership costs approximately the same as proprietary software if the license fee is excluded (Karopka et al., 2014).

In addition to the more affordable license fee, according to a survey, organizations prefer FOSS than proprietary software because there is access to the source code and the support of the community (Asay, 2007). Access to the source code enables organizations to learn how to work and modify products (Ven, Verelst, & Mannaert 2008). Support from the community is another factor which favored because it is a form of collaboration between users (Scannel, 2015), and it is rarely found in commercial products.

Nonetheless, it does not mean that proprietary software is not better compared with FOSS. Proprietary software has advantages, some of which became significant weaknesses of FOSS. According to the survey, the most significant advantage is the availability of a proprietary software vendor's support from professionals and the adoption process easier (Asay, 2007).

The topic of FOSS adoption in the healthcare industry has been widely studied. First, barriers to the adoption of open-source software have been investigated in health organizations in Quebec, Canada (Paré et al., 2009). At least seven factors are inhibiting the adoption of open-source software, namely: (a) lack of resources and internal IT expertise; (b) political pressure from internal and external; (c) the lack of reliable information about open source products; (d) Chief Information Officer (CIO) conservative; (e) the lack of responsibility of a third party; (f) the individualistic and competitive culture; and (g) the hidden cost of the products of open source software (Paré et al., 2009).

Second, studies that reveal the views of users of the products named Mediboard operations at a hospital in Mali (Bagayoko et al., 2010). Researchers conducted a gradual implementation of the product (i.e., phased-in approach) and then evaluates these products based on several criteria, including time efficiency, increased reliability of the data, and improving the quality of the user's work. The study revealed that the use of Mediboard product, in general, have a positive impact on the hospital (Bagayoko et al., 2010).

A study developed a model based on the TOE framework for measuring the factors that influence the adoption of server and desktop applications based on open source (Przechlewski & Strzala, 2010). The results of the study suggest that organizational factors do not affect the adoption decision of FOSS products. Nevertheless, the study has shortcomings because the sample used is small to generalize the results.

Other studies have suggested a different model (Jaafar & Yahya, 2014) from a technological context. The factors considered were the relative advantage, compatibility, complexity, and trialability. In the organizational context, the selected factors are the top management support as well as knowledge and expertise. Finally, the environmental context factor examined the availability of expertise and technology services' long-term survival. The study found that the factors of the environmental context do not significantly influence the adoption of FOSS in an organization. Limitations of the study were the uneven distribution of the sample used.

This study fills that gap by analyzing the factors that encourage health institutions to adopt FOSS. TOE framework used to capture the phenomenon through semi-structured interview questions. In contrast to Jaafar & Yahya (2014), this study used four variables to measure environmental factors in the context of adoption. The variables are the support of the main developers, support from the user community, peer adoption, and regulation of the government.

### **TOE Framework**

FOSS or information technology adoption topics, in general, can be analyzed using various theoretical perspectives. There are many theories to explain the adoption of information technology within an organization, such as the Technology Acceptance Model (TAM) (Davis, 1985), Theory of Planned Behavior (TPB) (Ajzen, 1991), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003), Diffusion On Innovations (DOI) (Rogers, 1995) and Technology-Organization-Environment (TOE) (Tornatzky & Fleischer, 1990). From those theories, only the DOI and the TOE are at the organizational level, while the rest are at the individual level (Oliveira & Martins, 2004, p. 110-111).

TOE Framework is widely used in research on information technology adoption in organizations (Ahmadi, Ibrahim, & Nilashi, 2015; Solomon & Magaieah, 2014; Venkatraman, Sundarraj, & Seethamraju, 2015). TOE Framework is an organizational level theory that explains the three elements that influence the decision of adoption of technological innovations by organizations, i.e., the context of technological, organizational context, and the context of the environment (Baker & Baker, 2012). The theory was selected as it is more holistic and industry-friendly, have more robust empirical support than other adoption theory, and more contemporary (Awa, Ukoha, & Emecheta, 2016).

### **Technological context**

The technological context includes all the technologies that are relevant to the organization, both technology currently in use and technology that is available in the market but is not being used (Baker & Baker, 2012). This technological context has five attributes that are innovation, relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1995). In addition to these attributes, some other attributes have been studied and proven to significantly influence the adoption of technology, including assimilation system, perceived direct benefits, perceived indirect benefits, and standardization (Gangwar, Date, & Raoot, 2014).

Relative advantage is a factor that had an impact on FOSS adoption decisions (Jaafar & Yahya, 2014). Relative advantages include benefits in terms of cost and reliability (Dedrick & West, 2003). In terms of cost, the acquisition FOSS is considered cheaper than other commercial/ proprietary products, and that becomes an essential factor affecting the adoption decision (Przechlewski & Strzala, 2010). In terms of reliability, FOSS product is considered more reliable than similar proprietary products, although this is debatable (Dedrick & West, 2003).

In terms of the availability of the source code, FOSS licenses give users the freedom to study and modify the source code to fit their needs (Hedgebeth, 2007). The source code is one of the critical factors that influence the decision to adopt FOSS. Although the user does not modify the source code, the availability of source code allows the user to see how the product works (Ven et al., 2008). Besides, the availability of the source code is an investment for a part that supports the organizational learning of FOSS (Ven et al., 2008).

Actors in the health industry, in general, do not provide a large portion of investment in information technology. Low-cost FOSS-based information system products are certainly attractive to healthcare institutions, especially if these products are technically capable of being on par with those of relatively more expensive proprietary products.

### **Organizational context**

The organizational context refers to the characteristics and resources of the organization (Baker & Baker, 2012). Specifically, the organizational context is a descriptive measure of the organization, such as the scope, size, and managerial structures (Oliveira & Martins, 2004). The variables that significantly affect technology adoption decisions in the context of organizational are financial resources, organizational structure, organizational slack, knowledge, operational capabilities, technological resources, quality of human resources, and management support (Gangwar et al., 2014).

The role of employees who have particular expertise in the field of IT to FOSS adoption decisions has been illustrated in several studies (Paré et al., 2009; Ven & Verelst, 2009). IT employees assigned to perform product development and maintenance when the product is implemented (Paré et al., 2009). Both of these tasks can be hampered if the organization does not have employees who can carry it out. On the other hand, the availability of the source code is an essential factor in the adoption of FOSS. It requires adequate IT skills of employees so that the organization can take advantage of these opportunities (Ven et al., 2008).

One inhibiting factor in the adoption of IT in the health care institution is the management attitude that tends to be conservative (McDonald et al., 2003). The healthcare industry is regarded as an industry that is conservative and lacked the courage to face the challenges of IT development (Paré et al., 2009). By their such conservatism nature, the institution would be difficult to accept new things, especially FOSS. It requires the need and courage of management to make IT innovation so that technological innovations such as FOSS can be received well. If the conservatism attitude is an inhibiting factor of FOSS or IT adoption, on the other hand, innovative attitude supports the adoption of FOSS.

### **Environmental context**

Environmental context includes industrial structures, the availability of technology services provider or vendor, and regulatory (Baker & Baker, 2012). The availability of the service provider becomes an important factor given the cost to acquire the human resources that have specialized skills is high enough. Hence, organizations need to think of solutions to

innovate outside of these resources (Globerman, 1975). Finally, the regulations issued by the government also influence the decision to innovate in IT because the regulation can encourage or inhibit innovation (Baker & Baker, 2012).

The biggest obstacle in the adoption of technology in health care institutions is the lack of expertise in human resources (Paré et al., 2009). Limited human resources expertise is indeed precluded institutions that wish to adopt FOSS as the FOSS implementation requires internal HR experts. Internal HR expertise is essential so that the organization can obtain optimal benefits from the adoption of FOSS derived from the collaboration between users (Scannel, 2015). This limitation can undoubtedly be overcome by recruiting human resources that have specialized expertise, but this kind of HR recruitment costs so high that more organizations choose other alternatives (Globerman, 1975).

The lack of skilled human resources could be addressed specifically with the support of external parties, both vendors, third parties, and the community (Ven & Verelst, 2009). A survey conducted by Hammond (2009) found that external support was one of the most important factors to be considered by the organization to adopt FOSS, besides safety and cost of ownership. Other studies have suggested that the community can be a source of external support that is widely used by organizations (Ven & Verelst, 2009).

On the other hand, the adoption of FOSS by other similar organizations is one of the significant factors influencing the adoption decision by an organization (Przechlewski & Strzala, 2010). Organizations that have adopted FOSS encouraged other organizations to adopt or not adopt a similar product. This is due to the perception caused by the adoption of FOSS will subjectively affect the normative beliefs of decision-makers (Macredie & Mijinyawa, 2011).

In addition to the normative beliefs, the pressure to adopt is also caused by competition between organizations. Competition in health care institutions can give rise to efficiencies and better services to patients (Cooper, 2011). In this competition, if one of the institutions is adopting cheaper IT solutions such as FOSS, other institutions will consider adopting a similar solution.

## METHOD

This study used a qualitative approach (i.e., case-study). The approach used to investigate contemporary phenomena that can not be separated from its context (Yin, 2014). The object of this study is three institutional health services located in Kebumen, Klaten regency, and Pinrang.

Face to face interview technique used to obtain data from key informants who are in Kebumen and Klaten, while telephone interviews conducted for informants of Pinrang. Telephone interviews conducted with consideration of cost efficiency research (Persaud & Salkind, 2012). Seven key informants participated in this study. The informants were considered to understand and or actively involved in the decision to adopt Khanza SIMRS product.

This study uses a semi-structured interview method with research questions developed from the TOE Framework. First, the main list of questions is compiled based on three contexts in the TOE Framework, namely technological context, organizational context, and environmental context. Additional questions were raised at each interview session to explore the unique experiences of each respondent further. Each interview session lasts about 20 minutes. Next, the interview transcript goes through the coding process according

to the factors in the TOE Framework. The validity of data at each institution is ensured through the cross-checking method among respondents within the institution. Each respondent's answer was confirmed to other respondents in the same institution. Data reliability was also ensured through the member-checking method by matching the answers of each respondent with their role in deciding to adopt Khanza HMIS. Finally, all data are summarized, and conclusions are drawn based on the factors that most often appear in the results of this study

## RESULTS AND DISCUSSION

### Demographic profile

Key informants in this study came from three medical institutions, the hospital A in Pinrang, South Sulawesi, Hospital B in Klaten, Central Java, and Hospital C in Kebumen, Central Java. All three institutions are a hospital with Type D. There are seven informants, four from the IT department, one from the medical record department, one from the finance department, and one from the principal director.

### Hospital A (RS A)

The new institution began to adopt Khanza HMIS in early 2018. At the time this study was conducted, the institution still runs the old system along with the new one. The old system still runs a commercial system. Migrating data from the old system to the new system is still an issue. Therefore, the institution runs the two systems in parallel.

This institution wished to adopt the new system that was driven by the limitations they face in the operation and development of its legacy system. The legacy system was made using old technologies, making it harder for the institution to develop it to suit the needs of government regulations, such as connecting to the Ministry of Health and BPJS Healthcare. Further, the support of the old system developers was considered inadequate. Citing the informant (IT employees) complaints against the old system:

*“Perhaps because of the development of bridging features and other links that are easier (in Khanza HMIS) than with what we have now. Moreover, the product is already open source, while the old system is still common, standards, using Microsoft Visual Basic and Microsoft Access. It is still standard.”*

On the financial side, the use of the old system can not be maximal while it costs significant money for the institution. One of the features of the old systems is the pharmacy program, which cost of tens of millions of rupiah but can not be used because the specifications are not following the needs of this institution. In the end, the pharmacy program was abandoned.

In terms of human resources, the institution has two employees in the IT field who do not have an educational background related to the field. Both of them were still holding concurrent positions in other parts, i.e., in the administration department. Therefore, the employee can not carry out their duties in the IT department optimally.

Based on these conditions, there are several reasons for Khanza HMIS product adoption. First, the price is affordable. After failing to implement expensive commercial products, the institution is more selective in choosing IT vendors. Of the several incoming proposals, all of them still offer a relatively high price. IT departments eventually look for other alternatives that are cheaper with better features on the Internet. Later, they found that Khanza HMIS offers a much lower price.

Firstly, from a price point of view. If we use other vendors, the cost would be tens of millions, even hundreds of millions of rupiahs. (Khanza HMIS) is a free, open-source. That is the competitive value of the software.

Secondly, the underlying consideration of the Khanza HMIS election was a large number of users of the product. According to one of the informants, if the software quality is not good, the product may not be used by many hospitals. Product quality has been proven by many users who have diverse needs.

*“... we see that other hospitals may not use the software if it does not help them, you know. Therefore, we try to run it in our hospitals. If it can be adjusted (according to the hospital's need), why not using it? If it can, yes. ... it has been proven by others.”*

*“My hope, we can adjust it to our hospital needs because every hospital has their management style. Starting from its management, employees, payroll, undoubtedly different. The hospital can be the same type, but the application of the system may differ between hospitals.”*

Thirdly, the full features such as bridging to the online service of the Ministry of Health, BPJS Health insurance, and others were also key considerations. Of all incoming bid proposal, there was no proposal which offers features similar to those offered by Khanza HMIS. Referring to the problems faced by the institution, completeness of features, including connections with external information systems, is a requirement that must be met by the new system.

Besides the three main reasons mentioned previously, two other reasons underlie the Khanza HMIS election. The first was the availability of the source code of products that could help them develop the product independently in the future. Based on the first consideration, the IT department will propose hiring new employees in the position of programmer in order to develop the product. Secondly, the support of the main developers of the product and its community was considered quite good. This is particularly important considering that the institution does not have a competent IT staff.

However, it seems there was a lack of support from management on the adoption decision. The management was considered to be conservative and less innovative in dealing with problems in the old system. The management was perceived to have an attitude in which adopting a new system is not an urgency for the institution. This conclusion is based on the opinions of the informant as follows:

*“The management here, if anything that needs to be addressed, they quickly respond to it. If there are no pressures from the above, the government, certainly they respond slowly. Unless if it is urgent and must be held, the management will be responsive. (The management assumes) it is not urgent, but (I think) it is something to be aware of. The progress has been remarkable, and we have to follow it. Like it or not, we must follow.”*

### **Hospital B (RS B)**

Almost the same condition also occurs at this institution at a time before adopting Khanza HMIS. The institution adopted the product in 2016. Previously, the institution has used commercial software, but the product was only limited to the functions of the management of medical records. The old software was run by non-IT employees and sometimes assisted by students from vocational apprenticeship. The institution did not have an IT department, as expressed by the following informant:

*“Before we have an IT employee, we, from finance and friends of vocational apprenticeship, were in charge of IT. They (the students of the vocational school) can not stay here. Finally, we recruited one IT employee.”*

Some HMIS product offers proposed to the hospital at that time; one of them even give a lifetime warranty. However, due to financial limitations, management eventually sought other solutions on the Internet that matched their abilities. In the end, they found Khanza HMIS.

*“Board knew it from the web. Then, we look for the contact person, and we contact him (Mas Windi). He was willing to come here and making a presentation. In the past, along with Khanza, there were other bids from people in the area Jatinom (Klaten). He offers to make an application program for the hospital. He gives a lifetime warranty for the product. However, the board considered that “if there is free software, why to choose a paid one?”*

For the institution, there were three primary considerations in the selection of the Khanza HMIS. First, the price of the product license is free of charge. The adoption fee only includes the cost of consumption, hotel accommodation, and the purchase of computer hardware. These costs were considered quite affordable. Also, the monthly fee scheme, which was paid as a donation was not burdensome, and the perceived benefits were higher than the fee.

*“For the initial implementation, we procured servers and hardware in some of the expenditures. ... (The total) was not reached 50 million, less than Rp30 million. ... The second procurement there were about seven units, spent about Rp17 million to Rp21 million. (For the procurement of software) was only to pay for accommodation for the developers, not too much. Personally, there is (a payment) per month to the developer, (while) to (licensed program) Khanza no payment.”*

Second, the completeness of the features, such as bridging to INA-CBGs service of the Ministry of Health and Vclaim of BPJS Healthcare. These features are not always available in other products. On the other hand, feature additions and improvements (updates) are routinely provided by the primary developer and user community to help the institution to develop, therefore, growing together along with other Khanza HMIS users. Those features always are emphasized by one of the informants, as follows:

*“Over time, the development of Khanza HMIS turned out better than other hospital programs. Khanza can follow the latest development; for example; It can already bridging INA-CBGs of the Ministry of Health. Then, (Khanza HMIS) can be a bridging for V-claim of BPJS. Khanza also has been able to facilitate the registration via the web. That means the development of Khanza, in our opinion, is better than other hospital programs. Almost every month or every other week, there are additional features, updates to follow the needs of patients and other parties.”*

Third, the support from fellow users in the user community forum is considered very beneficial to the institution. The IT employee who was recruited after the Khanza HMIS adoption, had an only vocational educational background in IT. However, the employee can learn and discuss together with other users-users who have a variety of educational backgrounds and professions. Any problems faced by him can be easily solved due to the support of the community.

*“If you can not get an S1 graduate, the developer recommended, “Well, just hire from a vocational school graduate. It will be easier for him to learn.” Thus, the vocational school graduate recruitment was based on the developer's recommendation ...many people are ready to help. When there is any problem, they are quick to respond. Thus, they facilitate the learning process, although only (graduate) from a vocational school.”*

Beyond the three factors, other factors were supporting the adoption decision. First, the institution considered that the relationship between users Khanza HMIS is the mutualism. All users get benefits; for example, when there is an institution requesting or implementing a new feature, all the other institutions will get the same benefits. Second, the encouragement of government regulations requiring institutions to implement standardized practices, such as providing data Hospital Associated Infections (HAIs), which has been facilitated by Khanza HMIS.

### Hospital C (RS C)

Of the three institutions studied, this institution is one of the earliest institutions that adopted Khanza HMIS. This institution began to adopt the product in 2014 through ignorance. At first, the director of the hospital downloaded a free HMIS product from the internet, which was provided by a vendor. When he was going to implement it, the vendor can not help the hospital to run the product, which eventually leads to a failure of the product implementation. Later, the director found out that the vendor was not the developer of the software. In the end, the original developer comes and offers development cooperation, as told by the director of the institution:

*“Once, at that time, I used a free download software, later I found out that it belongs to the other developer (the original one). The man (the first vendor) just took the software, applied it, but not succeed. Then, he (the original developer) monitored that I used it without succeeding. Finally, he volunteered to supervise the implementation; we feel it was a good deal. There was an agreement for the supervision, in the sense that we do not buy the software, but it is like capitalization. For every visit (per patient), there is a fee for Khanza.”*

Before the adoption of Khanza HMIS, there were two employees in the IT department. One of them has an IT education, and the other has a nursing background. The employee whose background in IT works mainly in the IT department, while the other employee concurrently works in the administration as well.

The main reason for the Khanza HMIS adoption scheme was the cost affordability. There is no cost incurred to purchase the license, and the monthly fees incurred as donations were not regarded as a burden. Investment for computer hardware did not consume high costs due to the low specifications required by Khanza HMIS.

*“We (pay) per month flat package. 1.500.000. Actually, free, totally free. Donation only. There are no withdrawal fees (from developers). (For the hardware requirements) I think the price Rp11.000.000 for the server is not expensive.”*

The second reason is the completeness and compatibility features with the needs of the institution. Given that this institution is one of the first institutions to use these products, the features used matches the needs of the institution as they are the results of joint development. The product they use is customized software, rather than generic products in general. Based on the statement of the director:

*“It started in 2014. Perhaps I was one of the first ten consumers of Khanza. They (the developers of Khanza HMIS) learned from me about the hospital organization. Please try to ask the developer; he came here (in the state of) and did not understand anything about the hospital. He asked me about many things.”*

*“We see the need for our business. Update on which part, if we do not need that, we do not implement it. It is flexible. What we need, we will update based on the hospital (need).”*

A further reason, the director, emphasizes the quality of the relationship between institutions and developers, which are pretty good. Although communication between the two sides is not intensive enough, the response from the product developer is still in line with his expectations. As one of the first institutions to adopt this product, the institution has the full support of the main developer. This was revealed by the director as follows:

*“It is a good relationship, excellent communication. Although (today), he already had many consumers, a bit hard, but still comfortable. We, Javanese people, promote communication. If that was branded (a proprietary product), we buy, but after that, it is difficult for communication. Thus, the advantage is more flexible; there is communication; therefore, mutual learning.”*

The factors that were not taken into consideration by the institution are peer and community support user adoption. In 2014, before the hospital adopted the system, there was only one other hospital that has been implementing the product. The hospital was a mother and child hospital, so it was not used as a reference due to the different types of services. Additionally, the features of the product were still incomplete, according to the needs of this institution. Community support was not available at that time as well, although lately it has been developed and deemed helpful for the institution in implementing the HMIS.

### General Analysis of Results

Based on the explanations of the specific results above, the general results of the analysis of the three objects of research can be seen in Table 2.

In general, three main factors are considered by the three institutions to adopt Khanza HMIS. The first factor is the affordable adoption costs. The adoption of Khanza HMIS is considered not to burden the financial institutions of the three institutions because the costs are far cheaper than similar products. Second, even though the price is relatively cheap, Khanza HMIS is considered to have complete features and is equivalent to other products. Third, in addition to its complete features, good support from the main developers is considered to provide a guarantee that Khanza HMIS's operations will run smoothly in the future.

No.	Supporting Factor Adoption	RS A	RS B	RS C
A. Technological				
1.	Adoption costs affordability	✓	✓	✓
2.	Availability of source code	✓	-	✓
3.	Feature completeness	✓	✓	✓
4.	Collaborative development	-	✓	✓
B. Organizational				
1.	Knowledge of IT employees	-	-	-
2.	Innovative management	-	✓	✓
C. Environment				
1.	The support of the major developers	✓	✓	✓
2.	Support from the user community	✓	✓	-
3.	Peer adoption	✓	-	-
4.	Government regulation	✓	✓	-

**Table 2.**  
Results of  
General  
Analysis

On the other hand, the results of the study also showed that employee IT knowledge factors were not a consideration for the three institutions in the adoption of Khanza HMIS products. All respondents thought that IT competence was not the main factor because the support from the main developer and the community was considered to be sufficient. Any problems related to the operation of Khanza HMIS can be dealt with directly from the main developer or members of the user community in the group chat. However, this condition makes the institution very dependent on external assistance. External assistance will take longer when compared to the internal response of competent IT employees. The length of response to each problem will certainly have a direct impact on the operations of the institution, considering that SIMRS is a vital component.

## CONCLUSION

In general, in the context of the three institutions studied, three main reasons are underlying the adoption of Khanza HMIS, namely: (1). Adoption fees are affordable. The developer of Khanza HMIS released the product with an open-source license and non-commercial use (not to be sold). Other related costs, such as monthly financial costs and investment of supporting devices, are considered quite affordable; (2). Complete features. Although it is not sold at a price which is expensive as a commercial product, Khanza HMIS perceived to have features that are complete than other products and following the needs of the institution; (3). External support either from the developer and the community.

Besides the three main factors above, there are two other emerging factors supporting the adoption, namely: (1)—collaborative development. The collaboration between product developers and users will benefit all stakeholders and has the potential to provide significant benefits for the long term and (2)—the influence of government regulations. Khanza HMIS facilitates the user institution to meet the regulations issued by the government, such as the provision of services BPJS.

The results of this study provide an overview for other health service institutions that want to adopt an open source-based information system. In addition to these three main factors, other factors need attention, namely employee IT knowledge/competency. The adoption of open source-based information systems requires an active role from within the institution. Institutions are required to have competent employees in the IT field because dependence on key developers and communities can have a direct impact on the operations of the institution.

The main limitation of this study was the difficulty of accessing case study objects. First, the complete data about the user Khanza HMIS was not available. Secondly, the permission process for researching several institutions took a long time, and there was no time certainty for data collection. Finally, due to the limited time available from the top management of the research objects, this study used some informants who might not be fully aware of the situation in the respective institution. Future studies are expected to overcome these limitations. Preparation of research, especially correspondence with the health institutions, should be implemented long before the data collection carried out so that the informants can be prepared and willing to be interviewed in a more appropriate time. Other data collection methods, such as observation and documentation, can also be done to strengthen the research findings.

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