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The Implementation of the Human, Organization, and Technology–Fit (HOT–Fit) Framework to evaluate the Electronic Medical Record (EMR) System in a Hospital

Lourent Monalizabeth Erlirianto, Ahmad Holil Noor Ali, Anisah Herdiyanti

Department of Information Systems, Faculty of Information Technology, Institut Teknologi Sepuluh Nopember, Jl. Arief Rahman Hakim, Surabaya 60111, Indonesia

Abstract

The implementation of health information system in a hospital has been widely discussed in the previous research. In terms of evaluation, fewer literature aim at studying three important aspects of technology adoption, namely human, organization, and technology. Following this, this research contributes to fill the gap by implementing the Human, Organization, and Technology-Fit (HOT-Fit) framework in order to evaluate the health information system– that is Electronic Medical Record (EMR) system in a hospital.

To implement the framework, a set of questionnaire was developed according to the model descriptions in the framework. Then, the questionnaire was distributed to the users of EMR system in a type-C hospital and being analyzed by employing the Generalized Structured Component Analysis (GSCA) method and a web-based tool called GeSCA. The relationships between the three aspects of human, organization and technology are discussed and recommendations are given according to this result.

This research proves that (1) only environment dimension in the organization aspect has positive and significant influence to the net benefits; (2) information quality and service quality dimensions in the technology aspect both have positive and significant influence to user satisfaction dimension in the human aspect; and (3) the two dimensions in the organization aspect- that are structure and environment, give positive and significant influence toward each other. It is also interesting to see that all of the dimensions in technology aspect have very little influence to the structure factor in the organization aspect. The research results support that the influence of human and organization aspect is the key success of technology adoption in a hospital.

Keywords: Electronic Medical Record (EMR) system; HOT-Fit; evaluation framework; GSCA

* Corresponding author.
E-mail address: anisah@its-sby.edu
1 Introduction

In Indonesia, each hospital may implement different types of health information systems. According to the Section 1 of the Indonesian Government Regulation Number 46 Year 2014, a health information system is defined as “a set of structures that includes data, information, indicators, procedures, tools, technology, and human resources which is interrelated and managed in an integrated manner to direct actions or decisions which is useful in supporting health development” [1]. One type of the Health Information System (HIS) that has been adopted in many hospitals in Indonesia is an Electronic Medical Record (EMR) system that integrates patient health data [2].

In order to attain long term benefits of EMR system [3], hospitals need to maintain long term user engagements [4]. The engagements shall be supported by organization and technology. This underlines three important factors in successful implementation of health information system, which are human, organization, and technology. To evaluate how these three aspects are interrelated in the adoption of an EMR system, the Human, Organization, and Technology-Fit (HOT-Fit) framework by Yusof et al. (2006) fits this purpose. While the discussion upon a framework to evaluate the implementation of an EMR system is limited, this framework presents a model to help understanding the interrelated aspects of human, organization, and technology. The model originated from the previous works on the Information System Success Model (DeLone and McLean) and the IT-Organization Fit Model [5] [6]. Nevertheless, there has been limited discussion as how the HOT-Fit framework was implemented in evaluating the EMR system in hospitals.

This research focuses on the implementation of the HOT-Fit framework to evaluate an EMR system in a hospital. The case study employed in this research is a type-C hospital that has been long established for more than 65 years in East Java region, Indonesia. The EMR system was first implemented in 2013 to integrate medical records with hospital management system, i.e. financial and accounting. Moreover, it is also a part of the embodiment of the organization's mission in providing health services according to science and technology development [7].

Prior the implementation of the HOT-fit framework, a set of questioners will be prepared serving as the instrument to understand what factors that drive the success of EMR system from the perspective of users of EMR systems. The evaluation may serve a preliminary understanding toward what factors can drive the success implementation of healthcare information system in a hospital.

The rest of the paper will be organized as follows. Section 2 provides more information on the HOT-Fit framework employed in the study while Section 3 deals with a sequence of method conducted to implement the framework. Section 4 describes the research results, while Section 5 underlines several findings from the research.

2 Human, Organization, and Technology-Fit (HOT-Fit)

W. DeLone and E. McLean (1992) developed a model that can be used to evaluate the information system quality, namely the “DeLone and McLean IS Success Model (ISSM)” or the D&M model. According to Delone and McLean, there are six dimensions that determine the information system quality: (1) system quality; (2) information quality; (3) use; (4) user satisfaction; (5) individual impact; and (6) organizational impact [8]. In 2003, Delone and McLean improved that model by adding service quality and replace individual impact and organizational with the net benefits [8].

Meanwhile, the MIT90s is a well-known IT-organizational fit model. This framework describes that success in managing the deployment of information technology in the organization depends on the balance in the following six factors: (1) external environment; (2) organization strategy; (3) individuals and roles; (4) organization structure; (5) technology and; (6) management processes [9].

In 2006, Yusof et al. developed a framework that combined the concept of the ISSM and the IT-Organizational Fit Model. According to Yusof et al. (2006), the framework of health information system evaluation shall consider human and organization. Besides that, the health information system also needs
to be supported and equipped with the technology. Organization in healthcare sector must have an ability to prepare workers or staff to adapt with new technology or changes that may occur. The HOT-Fit has three aspects and different dimensions in every aspect. In technology aspect, there are three dimensions: (1) system quality; (2) information quality; (3) service quality. In human aspect, there are two dimensions: (1) system use; and (2) user satisfaction. In organization aspect, there are two dimensions: (1) structure; and (2) environment. Those dimensions is used to measure the net benefits (see Figure 1) [5].

Fig. 1. HOT-Fit Evaluation Framework [5]

3 Research Method

There are 3 (three) stages in conducting this research: (1) design stage; (2) implementation stage; and (3) discussion of result stage as depicted in Figure 2. The stage is discussed further as followings.

There are 5 (five) processes in the design stage. First, it is necessary to analyze the current condition of the EMR implementation in the hospital, including the users of EMR system, the expected results from the system implementation from the view of management, and its challenges. The users of the EMR system can help to determine the research respondents, while the management view can help to design the indicators that drive the success of EMR implementation. It was found by using the Slovin formula [10] that the number of respondents should at least 67 respondents. Second, a conceptual model along with the research hypotheses is then developed according to the HOT-Fit framwork. Third, a list of indicators shall be developed acording to the dimensions in the conceptual model. Fourth, a set of questionnaire is developed based on the aforementioned indicators in each dimension. Fifth, a reliability and validity test is performed to test the questionnaire. The test involved 30 respondents in the case study, and resulted in a validated questionnaire.

Meanwhile the implementation stage comprises of 3 (three) processes. First, the data gathering is performed by distributing the questionnaire to the respondents of EMR system users. Second, the gathered data shall be validated by employing validity, reliability, and linearity test. Third, the conceptual model is then tested using the GeSCA tool.

The discussion of result stage comprises of 4 (four) processes. First, the results from model testing will be descibed. Second, the results are interpreted by focusing on the inner model. Third, several recommendations are given based on the interpretations.
4 Discussion of Result

4.1 Research Hypotheses

The conceptual framework research can be seen on Figure 2. There are seventeen hypotheses in this research:

- **Hypothesis 1 (H1):** system quality has a significant positive effect towards system use
- **Hypothesis 2 (H2):** system quality has a significant positive effect towards user satisfaction
- **Hypothesis 3 (H3):** system quality has a significant positive effect towards structure
- **Hypothesis 4 (H4):** information quality has a significant positive effect towards system use
- **Hypothesis 5 (H5):** information quality has a significant positive effect towards user satisfaction
- **Hypothesis 6 (H6):** information quality has a significant positive effect towards structure
- **Hypothesis 7 (H9):** service quality has a significant positive effect towards system use
- **Hypothesis 8 (H8):** service quality has a significant positive effect towards user satisfaction
- **Hypothesis 9 (H9):** service quality has a significant positive effect towards structure
- **Hypothesis 10 (H10):** system use has a significant positive effect towards user satisfaction
- **Hypothesis 11 (H11):** user satisfaction has a significant positive effect towards system use
- **Hypothesis 12 (H12):** structure has a significant positive effect towards environment
- **Hypothesis 13 (H13):** environment has a significant positive effect towards structure
- **Hypothesis 14 (H14):** system use has a significant positive effect towards net benefits
- **Hypothesis 15 (H15):** user satisfaction has a significant positive effect towards net benefits
- **Hypothesis 16 (H16):** structure has a significant positive effect towards net benefits
- **Hypothesis 17 (H17):** environment has a significant positive effect towards net benefits

![Figure 2](image-url)

**Fig. 2.** (a) Research Method; (b) Conceptual Framework Research

4.2 Research Instrument

The questionnaire was developed based on the work of Yusof et al. (2006) who proposed the HOT-Fit framework. The questionnaire depicts the three factors of human, organization, and technology. Each aspect has several dimensions from which several variables are explored. A number of indicators for each variable are determined based on the related works from previous research. There are 24 variables and 57 indicators (see Table 1).
Table 1 Research Instruments

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Variables</th>
<th>Indicators Number</th>
<th>Dimensions</th>
<th>Variables</th>
<th>Indicators Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>System Quality</td>
<td></td>
<td>Human</td>
<td>System Use</td>
<td>2. Level of use</td>
</tr>
<tr>
<td></td>
<td>1. Ease of learning</td>
<td>2</td>
<td>1. Level of use</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Ease of us</td>
<td>3</td>
<td>2. Knowledge</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Response time</td>
<td>2</td>
<td>User</td>
<td>1. Perceived usefulness</td>
<td>2</td>
</tr>
<tr>
<td>Information</td>
<td>Accuracy</td>
<td>4</td>
<td>Structure</td>
<td>1. Top management support</td>
<td>3</td>
</tr>
<tr>
<td>Quality</td>
<td>2. Completeness</td>
<td>2</td>
<td>2. Strategy</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Availability</td>
<td>2</td>
<td>Environment</td>
<td>1. Communication</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4. Timeliness</td>
<td>2</td>
<td>2. Competition</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Compatibility</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Quality</td>
<td>1. Responsiveness</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Emphaty</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Effectiveness</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Follow-up service</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Efficiency</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Assurance</td>
<td>2</td>
<td>3. Direct benefits</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

4.3 Research Data

The data analysis in this research is done by employing quantitative method via questionnaire. It is mentioned before in the research method that the respondents shall be at least 67 respondents. There are 87 respondents participated in the study with age distribution of 19-29 years old (37 respondents), 30-39 years old (23 respondents), 39-49 years old (19 respondents), and more than 49 years old (8 respondents). We may conclude that the users of EMR system participated in the study are mostly on their 20s and therefore we could expect users with medium to high skills of technology. The data distribution based on the work unit are 14 respondents from the pharmacy unit, 5 respondents from the physiotherapy unit, 6 respondents from the financial unit, 51 respondents who are nurses, 3 respondents from the radiology unit, and 8 respondents from the medical record unit.

4.4 Research Results

4.4.1 Research Instruments Testing

According to the test result, it is known that all indicators fulfill the threshold of the reliability, validity, and linearity testing. Reliability testing is done by considering the Cronbach’s Alpha. The data is reliable when the value of Cronbach’s Alpha is greater than 0.6 [11]. Validity test is to show how far the value obtained can represent the result of research. It is used to know the worthiness of the statements in the construct that can define a variable. The data is valid if the Pearson Correlation value is greater than r-table [12]. Linearity testing is needed to know the consistency of the relation between variables in the research model. That consistency is represented with significant value of p is greater than 0.05.

4.4.2 Inferential Testing Result

4.4.2.1 Result of R Square

$R^2$ (R square) is used to determine the capability of independent variables that can describe dependent variables such as system use, user satisfaction, structure, environment and net benefits. If the value of $R^2$ is close to 1, it can be concluded that the explained variance of independent variables can help to describe the dependent variables [13]. Based on the test result, it is known that (see Table 2):
• System quality, information quality, service quality, user satisfaction can describe system use in the amount of 19.8%.
• System quality, information quality, service quality, system use can describe user satisfaction in the amount of 40.5%.
• System quality, information quality, service quality, environment can describe structure in the amount of 42.7%.
• Structure can describe environment in the amount of 39.8%.
• System use, user satisfaction, structure, and environment can describe net benefits in the amount of 53.4%.

4.4.2.2 Result of Inner Model Path Coefficients Testing

Based on the inferensial testing using GeSCA, it can be shown the accepted or rejected hypothesis. Hypothesis can be accepted if it has a positive estimate value and significant CR value (it can be determined with (*) symbol). There are 5 of 17 hypoteses that can be accepted: H5, H8, H12, H13, and H17 (see Figure 3 and Table 3).

![Fig. 3.Path Coefficients Testing Result](image)

Table 2 Result of Hypotheses Testing

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Estimate Path Coefficients</th>
<th>CR</th>
<th>Explanation</th>
<th>Hypothesis</th>
<th>Estimate Path Coefficients</th>
<th>CR</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>-0.013</td>
<td>0.07</td>
<td>Rejected</td>
<td>H10</td>
<td>0.237</td>
<td>1.04</td>
<td>Rejected</td>
</tr>
<tr>
<td>H2</td>
<td>-0.250</td>
<td>1.64</td>
<td>Rejected</td>
<td>H11</td>
<td>0.32</td>
<td>1.04</td>
<td>Rejected</td>
</tr>
<tr>
<td>H3</td>
<td>0.009</td>
<td>0.08</td>
<td>Rejected</td>
<td>H12</td>
<td>0.631</td>
<td>7.95*</td>
<td>Accepted</td>
</tr>
<tr>
<td>H4</td>
<td>0.046</td>
<td>0.26</td>
<td>Rejected</td>
<td>H13</td>
<td>0.582</td>
<td>5.64*</td>
<td>Accepted</td>
</tr>
<tr>
<td>H5</td>
<td>0.271</td>
<td>2.12*</td>
<td>Accepted</td>
<td>H14</td>
<td>-0.11</td>
<td>0.87</td>
<td>Rejected</td>
</tr>
<tr>
<td>H6</td>
<td>0.176</td>
<td>1.42</td>
<td>Rejected</td>
<td>H15</td>
<td>0.174</td>
<td>1.23</td>
<td>Rejected</td>
</tr>
<tr>
<td>H7</td>
<td>0.163</td>
<td>0.62</td>
<td>Rejected</td>
<td>H16</td>
<td>0.105</td>
<td>0.61</td>
<td>Rejected</td>
</tr>
<tr>
<td>H8</td>
<td>0.437</td>
<td>2.46*</td>
<td>Accepted</td>
<td>H17</td>
<td>0.625</td>
<td>4.72*</td>
<td>Accepted</td>
</tr>
<tr>
<td>H9</td>
<td>-0.012</td>
<td>0.08</td>
<td>Rejected</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.4.2.3 Overall Goodness of Fit

From the overall goodness of fit result, it can be concluded that the variables in this research can determine the research model in 0.386 point or 38.6%. FIT value gives an information that 38.6% of system quality, information quality, service quality, system use, user satisfaction, structure, environment and net benefits can determine the model and 61.4% can determine by another variables that didn’t use in this research.

AFIT value is similar with FIT. If AFIT value approach to FIT value, so it can support the conclusion of FIT. In this research, AFIT value (0.370) close to FIT value (0.386). It can be concluded that system quality, information quality, service quality, system use, user satisfaction, structure, environment, and net benefits can determine the research model.

The GFI value is 0.943. It means that the model is compatible with this research because the GFI value is greater than 0.9 and close to 1.

4.5 Discussion of Model Implementation

Yusof et al. (2005) developed the HOT-Fit framework to understand the benefits of health information system from three aspects; they are technology, human, and organization [6]. In this research the conceptual model is confirmed because the GFI value is greater than 0.9. Following this, there are two possibilities: (1) if the research data is wrong; (2) if the research data is true.

If the data is wrong, there are some possibilities. First, there are mistakes on the interpretation of the questionnaire statement. Second, there is a factor that indicates the users, who use the EMR system, did not use the system as the core of their work. Third, there is a mistake to interpret the scale of questionnaire research.

If the data is true, there is a conclusion that organization has the biggest effect towards net benefits. In this research, the effect between technology and human can be seen on the relation between information quality and system quality dimension towards user satisfaction. If we look into the effect towards net benefits, the environment dimension from organization aspect influence the net benefits.

In practical, the organization can affect the net benefits from EMR system. The structure of organization gives significant effect towards organization environment. The management of hospital gives support and implement the right strategy based on environment of organization. There is a need of communication and competition that gives significant effect towards net benefits. Despite that fact, it is not true to ignore the technology aspect. The degree of user satisfaction is affected by the information and service that is provided, but user satisfaction cannot affect net benefits. The user of EMR system can satisfy with two way of processes, they are working manual with paper and using system. It is true that operating the EMR system isn’t their main job. It proves that user satisfaction cannot affect the net benefits. According to that condition so it is needed to give attention towards the using of technology (EMR system) to increase the benefits. Organization can support the implementation of system and make policies so thechnology can give the benefits.

5 Conclusion and Future Research

The implementation of HOT-Fit evaluation framework proves that:

- Information quality gives positive significant effect towards user satisfaction.
- Service quality gives positive significant effect towards user satisfaction.
- Structure gives positive significant effect towards environment.
- Environment gives positive significant effect towards structure.
- Environment gives positive significant effect towards net benefits.
Environment affects a positive significant towards net benefits. Technology aspect has close relationship with human aspect. The relation between technology and human can be known from the relation between information quality and service quality towards user satisfaction. The relation between technology aspect and human aspect cannot be proven in this research. Human and technology aspect has no effect towards net benefits.

Based on the result, several recommendations are given
• In environment dimension, organization may communicate on the data of patients who use BPJS and automation reporting
• In structure dimension, it is needed to update the system but it shall count the time duration with the last update, clearing the business process, and make a tutorial to use the system
• In information quality dimension, it is needed to make a policy about the process of writing and the accuracy of input the data
• In service quality dimension, it is needed to give a coaching to all EMR users and make user manual that is easy to understand

Yusof (2006) made the conceptual model but that model had not been tested by quantitative method. The conceptual model only describe its dimensions and variables. But the indicators and statements of research instrument has not been described. Indicators in this research are described by research that has been done by Yusof and others research. But there are some indicators that are not described in those research. So the researcher make some statements based on the description of indicators. According to that case, so it is needed to include more literatures from the previous works and adjust them with the model employed in this study.

In the future research, the model can be expanded to include more variables. The variables can be extracted from interview to developer, provider of IT service, and users. It is needed to get the detail about the system. The detail information of the system can determine more variables that represent the condition of system.

References