# Internet of Things Technology Selection for Psychotherapy Services in Psychiatric Hospital

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## Abstract

Psychotherapy which are intended for patients with mental health issues face problems in terms of limited duration and intensity of therapy. This occurs due to several conditions, such as a lack of psychiatric resources, required communication with several multidisciplinary groups, complex procedures, and lack of patient discipline. This study aims to choose the right alternative Internet of Things (IoT) technology that can be implemented in psychotherapy services in psychiatric hospital by taking into account the criteria of Internet of Things implementation. IoT for psychotherapy can help a psychiatrist to provide intensive care with minimal supervision, improve quality measurements with real-time evidence of results, and identify faster recovery. The Best Worst Method (BWM) is used to obtain the weight of each criteria and sub-criteria for applying IoT. The Complex Proportional Assessment Method (COPRAS) is used to determine the priority technology that can be applied. This research results four priority of IoT technology that can be implemented in psychotherapy services in psychiatric hospital

## Keywords
Psychotherapy, Internet of Things (IoT), Multi-Criteria Decision Making (MCDM), Best Worst Method (BWM), Complex Proportional Assessment (COPRAS)

## 1. Introduction

According to the records of Basic Health Research (Riskesdas) from the Ministry of Health of the Republic of Indonesia (2018), the prevalence of emotional disorders in people aged 15 years and over increased from 6% in 2013 to 9.8% in 2018. The prevalence of mental disorders, weight, schizophrenia also increased from 1.7% in 2013 to 7% in 2018 (Jiwa, 2020).

Disability in people with depression is caused by impaired cognitive function and other factors, such as conditions in the environment (opportunity, social support, negative stigma, poverty), health status, functional capacity, physical fitness, and symptoms of depression that disrupt the patient's function in society, difficulty solving problems, decreased success in rehabilitation programs, and inability to keep a job. In contrast, cognitive abilities in a person play an important role in function in all aspects of life (Harvey & Strassnig, 2012).

There are many ways and methods to handle mental disorders, one of which is psychotherapy. Psychotherapy is a method of treating mental disorders with a mechanism where the patient will talk to a psychiatrist safely. Through these conversations, the psychiatrist will explore the triggers for mental disorders, understand the patient's feelings and behavior, and have a new perspective. All psychotherapy social cognition interventions designed may involve group or individual-based therapy using roleplay, repeated learning, and empirical evidence to improve daily functioning (Penn et al., 2005; Tan et al., 2018).

Substance Abuse and Mental Health Services Administration (SAMHSA) shows that only a portion gets the necessary health services of all people with mental disorders. Of those who received treatment, only a few were handled

optimally. In Indonesia, the national coverage indicator for mental disorders who receive treatment and are not neglected is only 38.14%. This occurs because the duration and intensity of psychotherapy in Indonesia are quite limited due to several conditions, such as a lack of psychiatric resources, communication with several multidisciplinary groups, complex procedures, and minimal patient discipline.

On the other hand, psychotherapy services in Indonesia use manual methods to assess the results of monitoring psychotherapy so that answering the question of whether the patient is being served effectively or if there are changes to the plans made takes time. These measures assess many relevant stakeholders, such as caregivers and doctors, who could potentially influence the outcome because their responses may not accurately reflect individual experiences or biases. As a result, it is difficult to draw accurate conclusions about a patient's results (Outcomes and Progress Monitoring in Psychotherapy, 2018).

In addition, psychiatrists may misdiagnose, act out of inappropriate interventions, demean the patient's communication, or even lack recognition of the patient's achievable goals (Maggio et al., 2019). Actual results may take a long time to achieve. For this reason, tracking the psychotherapy process is needed to make the patient know more quickly what movements are happening to him and allow the psychiatrist to determine the focus or intervention of the psychotherapy session that should be.

Developments in technology are expected to be able to help health services to innovate in order to improve their quality. Today, the world has been introduced to a technology called the Internet of Things (IoT), which has the potential in the healthcare revolution because the integration of IoT functions in medical devices can improve the quality and effectiveness of medical services, help heal patients in chronic conditions, and help with real-time monitoring (de la Torre Díez et al., 2019).

### 1.1 Objectives

This study aims to help psychotherapy and psychiatric hospitals to find out the factors that need to be considered in implementing IoT-based technology and designing the right choice of IoT technology priorities for psychotherapy services.

## 2. Literature Review

### 2.1 Validation of Internet of Things Adoption Criteria

Rehabilitation is a series of coordinated efforts consisting of medical, social, educational, and vocational efforts to retrain someone who is disabled to achieve functional abilities at the highest possible level. This type of psychological rehabilitative service for patients with mental disorders, especially schizophrenia, is called psychotherapy. The goal of having a rehabilitation unit in a mental hospital:

1. Restoring and developing physical, mental and social functions of sufferers.
2. Carry out medical, social, educational, and vocational measures to retrain the patient towards the highest possible recovery from the level of functional ability.
3. Satisfactory adjustment in personal and social relationships can again function as members of society who are self-sufficient, self-sufficient, or independent and useful.

### 2.2 Psychotherapy Process

Psychotherapy has 3 main processes that every psychiatrist must follow and perform, namely Diagnosis, Planning, and Intervening (Dincin, 1975).

1. Diagnosis ; the diagnostic phase begins by helping the patient develop psychotherapy readiness by setting overall psychotherapy goals and evaluating the patient's current condition/skills. In this phase, the psychiatrist focuses on the patient's readiness to receive therapy with all the skills they have and support from outside parties (family, caregivers) to achieve patient satisfaction in facing normal life.
2. Planning ; Diagnostic information allows the psychiatrist to develop a rehabilitation plan. The planning phase determines how to develop patient skills to achieve rehabilitation goals that are mostly focused on symptom

reduction. In this stage, the psychiatrist identifies potential activities/programs and makes specific interventions for each goal to be achieved.
3. Intervention ; At the intervention phase, a rehabilitation plan is implemented to achieve overall rehabilitation goals, either through developing the patient's skills and/or developing the patient's support environment.

### 2.3 Internet of Things

The Internet of Things (IoT) was first created in 1999 by a technology pioneer from the UK, namely Kevin Ashton (Gubbi et al., 2013). The concept of IoT came together with the development of Radio Frequency Identification (RFID). IoT helps an interconnected object whose data it contains will be regularly collected, analyzed, and used to make decisions, providing a wealth of intelligence for planning and management. IoT is a computer network and has developed into a network of devices of all types and sizes that are interconnected with one another.

The primary idea of the Internet of Things is to connect existing physical objects to the internet. IoT can be used anywhere, anytime, with anything, and for anyone through any line/network and service (Saragih et al., 2019). The concept of IoT is sending data via the internet network without any human-to-human or human-to-computer interaction. This concept requires that everyday objects be connected to the internet (Dachyar & Azizia, 2019) so that this technology can facilitate communication between devices with the minimum possible human assistance (Lin et al., 2014). Around 60% of healthcare organizations have installed Internet of Things (IoT) in their facility and recognized its benefit (Dachyar & Nattaya, 2020).

The application of IoT in psychotherapy that is required according to the expert's description can be provided by particular IoT technology; Virtual Reality, Brain-Sensing Headband, Electronic Game, and Robot Therapy (see Table 1).

Table 1. IoT Technology That Can Be Used for Psychotherapy Services

| No. | Technology | Reference |
|---|---|---|
| 1 | Virtual Reality | (Šalkevičius et al., 2019) |
| 2 | Brain Sensing Headband | (Bollapragada et al., 2019) |
| 3 | Electronic Game | (Duarte et al., 2014) |
| 4 | Robot Therapy | (Simoens et al., 2018) |

## 3. Methods

This method integrates BWM and COPRAS in completing IoT technology selection, which consists of four phases. The first phase is to get the IoT implementation criteria from a literature review. The second phase is to validate the criteria for applying IoT to experts. The third phase calculates the relative weight of each criterion based on expert judgment using BWM. The fourth phase gets the significant value and utility of each alternative to IoT technology with the COPRAS method. Through the COPRAS method, the ranking of IoT technology can be found.

## 4. Data Collection

### 4.1 Validation of Internet of Things Adoption Criteria

The literature study was conducted to determine the criteria for adopting IoT technology based on the Technology-Organization-Environment (TOE) integration framework, including security criteria and the Technology Acceptance Model (TAM). 31 sub-criteria were obtained based on literature review. The sub-criteria were then validated by six experts using a questionnaire with a Likert scale of 1-5. The criteria that had an average value below the threshold of 3.5 would be rejected and not used in this study (Dachyar & Risky, 2014). The selected criteria can be seen in Table 2.

Table 2. The Selected Criteria and Dimension of IoT Adoption

| Criteria | Sub-criteria | References |
|---|---|---|
| Technology (K1) | Compatibility (T1) | (Schmitt et al., 2019), (Abdekhoda et al., 2019), (Ahmed, 2020), (Rajak & Shaw, 2019) |
| | Reliability (T2) | (Hogaboam & Daim, 2018), (Dimitrioglou, 2017), (Improta et al., 2019) |
| | Complexity (T3) | (Abdekhoda et al., 2019), (Ladasi et al., 2019), (Dimitrioglou, 2017) |
| | Availability (T4) | (Darwish et al., 2017), (Qayyum, 2020), (Chul & Shin, 2016), (Abdel-basset et al., 2018) |
| Organization (K2) | Top Management Support (O1) | (Hsu & Yeh, 2017), (Abdekhoda et al., 2019), (Ladasi et al., 2019), (Ahmed, 2020) |
| | HR Competencies (O2) | (Ladasi et al., 2019), (Hsu & Yeh, 2017), (Ahmed, 2020) |
| | Training Needed (O3) | (Hogaboam & Daim, 2018), (Abdekhoda et al., 2019), (Tsai et al., 2019) |
| | Organization Strategy (O4) | (Yang et al., 2018), (Hwang et al., 2016), (Zheng, 2014) |
| | Financial Readiness (O5) | (Ahmed, 2020), (Hogaboam & Daim, 2018), (Ladasi et al., 2019) |
| | Cost Effectiveness (O6) | (Hogaboam & Daim, 2018), (Liao & Qiu, 2016), (Lin et al., 2017) |
| Environment (K3) | Competitive Pressure (E1) | (Abdekhoda et al., 2019), (Schmitt et al., 2019), (Hsu & Yeh, 2017) |
| | Regulatory Policy (E2) | (Schmitt et al., 2019), (Ahmed, 2020), (Olushola & Systems, 2019) |
| | Trading Partner Support (E3) | (Abdekhoda et al., 2019), (Ladasi et al., 2019), (Ahmed, 2020) |
| | User convenience (E4) | (Papa et al., 2018), (Gao, 2014), (W. J. Lee & Chong, 2016) |
| Security (K4) | Authentication (S1) | (Qayyum, 2020), (Chul & Shin, 2016), (Irshad, 2016), (Matheu-garc, 2019) |
| | Authorization (S2) | (Qayyum, 2020), (Irshad, 2016), (Matheu-garc, 2019) |
| | Privacy (S3) | (Darwish et al., 2017), (Chul & Shin, 2016), (Abdel-basset et al., 2018) |
| | Confidential (S4) | (Qayyum, 2020), (Darwish et al., 2017), (Chul & Shin, 2016), (Irshad, 2016), (Abdel-basset et al., 2018) |
| | Non-Repudiation (S5) | (Chul & Shin, 2016), (Qayyum, 2020), (Abdel-basset et al., 2018) |
| | Integrity (S6) | (Qayyum, 2020), (Darwish et al., 2017), (Chul & Shin, 2016), (Abdel-basset et al., 2018) (Nadhira & Dachyar, 2020) |
| Perceived of Usefulness (K5) | Quality of Care (PU1) | (Mobinizadeh et al., 2016), (Mudavadi et al., 2016), (Baran-Kooiker et al., 2018) |
| | Sharing (PU2) | (Mudavadi et al., 2016), (Mobinizadeh et al., 2016), (Liao & Qiu, 2016) |
| | Time Saving (PU3) | (Mudavadi et al., 2016), (Crescenzio & Augmented, 2020), (Lhotska & Sukupova, 2018) |

| | | |
|---|---|---|
| | Error Identification (PU4) | (Mobinizadeh et al., 2016), (Lhotska & Sukupova, 2018), (Mohamamad & Yunus, 2017) |
| | Productivity Impact (PU5) | (Hogaboam & Daim, 2018), (Nguyen et al., 2020), (Rehman et al., 2016) |
| Perceived Ease of Use | Search Ability (PE1) | (Mudavadi et al., 2016), (Rehman et al., 2016), (Hogaboam & Daim, 2018), (Rajak & Shaw, 2019) |
| | User Interface (PE2) | (Mudavadi et al., 2016), (Nguyen et al., 2020), (Rehman et al., 2016), (Almojaibel et al., 2019) |
| | Usability (PE3) | (Hogaboam & Daim, 2018), (Ahmed, 2020), (AlHogail, 2018), (Almojaibel et al., 2019) |
| | Responsiveness (PE4) | (Rajak & Shaw, 2019), (Almojaibel et al., 2019), (Dimitrioglou, 2017) |
| | Customization (PE5) | (Crescenzio & Augmented, 2020), (Almojaibel et al., 2019), (Khan et al., 2019) |

### 4.2 Weighting Criteria for IoT Adoption in Psychiatric Hospitals

The weighting of the criteria and sub-criteria for IoT implementation is done using the BestWorst Method (BWM). The weighting is based on expert judgment by filling out a questionnaire. Following the BWM method stages, each expert is asked to choose the best (most important) criteria and sub-criteria and the worst (least important) criteria and sub-criteria for each level of criteria. The results of data processing using BWM in the form of local weights for each criterion and sub-criteria. To get the global weight for each sub-criteria, the criteria' local weight's value is multiplied by the sub-criteria's local weight value. The priority weight obtained will be an input for assessing alternative Internet of Things technology. The results of the weighting and ranking can be seen in Table 3.

Table 3. Final Weight of IoT Adoption for Psychotherapy Measures

| Criteria | Weight | Sub Criteria | Local Weight | Global Weight | Rank |
|---|---|---|---|---|---|
| Techhnology (K1) | 0,145 | Compatibility (T1) | 0,274 | 0,040 | 4 |
| | | Reliability (T2) | 0,254 | 0,037 | 5 |
| | | Complexity (T3) | 0,076 | 0,011 | 27 |
| | | Availability (T4) | 0,231 | 0,033 | 9 |
| Organisasi (K2) | 0,183 | Top Management Support (O1) | 0,247 | 0,045 | 3 |
| | | HR Competencies (O2) | 0,195 | 0,036 | 7 |
| | | Training Needed (O3) | 0,092 | 0,017 | 20 |
| | | Organization Strategy (O4) | 0,133 | 0,024 | 15 |
| | | Financial Readiness (O5) | 0,124 | 0,023 | 16 |
| | | Cost Effectiveness (O6) | 0,079 | 0,015 | 21 |
| Environment (K3) | 0,042 | Competitive Pressure (E1) | 0,112 | 0,005 | 30 |
| | | Regulatory Policy (E2) | 0,280 | 0,012 | 26 |
| | | Trading Partner Support (E3) | 0,143 | 0,006 | 29 |
| | | User convenience (E4) | 0,289 | 0,012 | 25 |
| Security (K4) | 0,160 | Authentication (S1) | 0,087 | 0,014 | 23 |

| | | | | | |
|---|---|---|---|---|---|
| | | Authorization (S2) | 0,126 | 0,020 | 19 |
| | | Privacy (S3) | 0,131 | 0,021 | 18 |
| | | Confidential (S4) | 0,195 | 0,031 | 10 |
| | | Non-Repudiation (S5) | 0,090 | 0,014 | 22 |
| | | Integrity (S6) | 0,227 | 0,036 | 6 |
| Perceived of Usefulness (K5) | 0,223 | Quality of Care (PU1) | 0,240 | 0,054 | 1 |
| | | Sharing (PU2) | 0,153 | 0,034 | 8 |
| | | Time Saving (PU3) | 0,118 | 0,026 | 14 |
| | | Error Identification (PU4) | 0,100 | 0,022 | 17 |
| | | Productivity Impact (PU5) | 0,204 | 0,046 | 2 |
| Perceived Ease of Use (K6) | 0,128 | Search Ability (PE1) | 0,207 | 0,026 | 13 |
| | | User Interface (PE2) | 0,070 | 0,009 | 28 |
| | | Usability (PE3) | 0,224 | 0,029 | 12 |
| | | Responsiveness (PE4) | 0,233 | 0,030 | 11 |
| | | Customization (PE5) | 0,107 | 0,014 | 24 |

### 4.3 IoT Technology Assessment

The third questionnaire is filled based on the subjective opinion of experts on alternative technologies. The data will then be processed using the COPRAS method to determine the right technology priorities for psychotherapy in adopting IoT technology.

One of the stages in the COPRAS method is to classify the criteria for benefits and costs. The benefit criteria are the criteria with the greater value, while the cost criteria are the criteria with the smaller value. The total value of the criteria for benefits and costs will then be processed to obtain a relative significance value (Qi) and then calculate the level of utility (Ni). These two values will indicate the alternative priority order. The calculation results in Table 4 show the performance value of each alternative compared to the other alternatives. The results of COPRAS calculations show that the main priority in adopting IoT technology for psychotherapy is virtual reality.

Table 4. Calculation of Total Benefit and Cost Criteria, Relative Significance and Degree of Utility of each Alternative

| Alternative Technology | Pi (Benefit) | Ri (Cost) | Qi | Ni (%) | Rank |
|---|---|---|---|---|---|
| Virtual Reality | 0,02448 | 0,00077 | 0,02538 | 100% | 1 |
| Brain Sensing Headband | 0,02431 | 0,00068 | 0,02533 | 99,8% | 2 |
| Electronic Game | 0,02399 | 0,00094 | 0,02473 | 97,4% | 3 |
| Robot Therapy | 0,02346 | 0,00098 | 0,02416 | 95,2% | 4 |

## 5. Results and Discussion

From the previous data processing, the selection of IoT implementation for psychotherapy measures is virtual reality. This study uses three scenarios to see if there is a change in the priority of technology application. The first scenario is a scenario where interoperability problems occur, where the device used cannot exchange information on a stable network. Therefore, the weight on technology criteria will be increased by up to 50%. The second scenario is the scenario when the ransomware virus attacks the hospital information system. This scenario causes the weight of the security criteria to be increased by 50%. The third scenario is when the government supports IoT in the health sector and improves human resources quality in psychiatric hospitals. In this case, the weights of environmental and

organizational criteria will be increased by 50%. In Table 5, it can be seen that in scenarios 1 and 3, two scenarios have the same priority. Whereas in scenario 2, there is a change in technology priorities.

Table 5. Alternative Technology Priority Changes After Scenario Analysis is Conducted

| Alternative | Initial Condition | | After Scenario 1 | | After Scenario 2 | | After Scenario 3 | |
|---|---|---|---|---|---|---|---|---|
| | Ni (%) | Rank | Ni (%) | Rank | Ni (%) | Rank | Ni (%) | Rank |
| Virtual Reality | 100 | 1 | 100 | 1 | 99,91 | 2 | 100 | 1 |
| Brain Sensing Headband | 99,8 | 2 | 100 | 1 | 100 | 1 | 100 | 1 |
| Electronic Game | 97,4 | 3 | 97,2 | 3 | 97,69 | 3 | 97,1 | 3 |
| Robot Therapy | 95,2 | 4 | 94,5 | 4 | 95,6 | 4 | 93,8 | 4 |

However, of the three assumed scenarios, virtual reality and brain-sensing headband technology are often the alternative technology with priority implementation. Apart from being widely used in various countries and the system being sold commercially, these technology's acquisition and maintenance costs are quite low. Thus, hospital management tends to choose this technology as a priority for adoption because it is also in line with the organizational strategy of making psychotherapy services more comfortable for patients and making it easier for psychiatrists in the monitoring process to match the hospital's implementation costs.

## 6. Conclusion

This research proves that the research objective to select the best IoT technology application using a combination of the BWM and COPRAS methods was achieved. This study resulted in 30 sub-criteria selected in 6 existing criteria. The BWM calculation results show that the Quality of Care (PU1) sub-criteria is the sub-criteria with the greatest weight, which means that this sub-criteria is a top priority. COPRAS calculates technology ratings because virtual reality technology has a 100% utility rate, which means that this technology is the priority in considering IoT technology adoption for psychotherapy measures. After several scenarios are applied, the final results show that virtual reality and brain-sensing headband are the top priorities for the technologies that can be adopted because these two technologies tend to be top priorities in most scenarios.

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## Biographies

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