



Article

# Integrative Factors of E-Health Laboratory Adoption: A Case of Indonesia

Dwiza Riana <sup>1,\*</sup> , Achmad Nizar Hidayanto <sup>2</sup>, Sri Hadiani <sup>1</sup>  and Darmawan Napitupulu <sup>3</sup>

<sup>1</sup> Magister of Computer Science, Sekolah Tinggi Manajemen Informatika dan Komputer Nusa Mandiri (STMIK Nusa Mandiri), Jakarta Timur 13620, Indonesia; sri.shv@nusamandiri.ac.id

<sup>2</sup> Faculty of Computer Science, Universitas Indonesia, Depok 16424, Indonesia; nizar@cs.ui.ac.id

<sup>3</sup> Research Center for Science, Technology and Innovation Policy and Management, Indonesian Institute of Sciences, Jakarta 12710, Indonesia; darwan.na70@gmail.com

\* Correspondence: dwiza@nusamandiri.ac.id

**Abstract:** Around the world, the adoption of digital health applications is growing very fast. The use of e-health laboratory systems is increasing while research on the factors that impact users to use e-health laboratory systems in Indonesia has not been done much. The objective of this study is to analyze the behavioral factors of e-health laboratory users. This study includes a survey conducted on Indonesian users, and data analysis was carried out thoroughly. Based on the Technology Acceptance Model, this research framework explores a combination of variables consisting of task-driven, technology-driven, human-driven, and adoption variables to form the model proposed in this study. This model was verified using the Structural Equation Modeling (SEM) method for factor analysis, path analysis, and regression. A total of 163 respondents were collected to evaluate this research model empirically and the level of this study were individuals. These three problems are all essential in affecting usage intentions in adopting an e-health laboratory system. Specifically, task technology fit, information quality, and accessibility show a direct effect on both perceived usefulness and perceived ease of use factors perceived by the user, and have an indirect influence on the adoption of an e-health laboratory system through these two factors. The design of an online laboratory system affects perceived ease of use and personal innovativeness factors affect the perceived usefulness that users feel when adopting a laboratory system, while task technology fit and personal innovativeness factors do not affect the perceived ease of use. However, overall technology characteristic and perceived usefulness followed by design are the main predictors of adopting an e-health laboratory system on e-health systems in Indonesia.

**Keywords:** e-health laboratory; task technology fit; technology acceptance; adoption intention



**Citation:** Riana, D.; Hidayanto, A.N.; Hadiani, S.; Napitupulu, D. Integrative Factors of E-Health Laboratory Adoption: A Case of Indonesia. *Future Internet* **2021**, *13*, 26. <https://doi.org/10.3390/fi13020026>

Received: 15 December 2020

Accepted: 20 January 2021

Published: 24 January 2021

**Publisher's Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



**Copyright:** © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

The development and the use of the internet are increasing in many countries along with the development of Information and Communication Technology (ICT) nowadays. In Indonesia, the use of the internet is also growing rapidly. In 2019, Indonesia became one of the countries with the most internet users in the world as it ranked third after China and India and defeated Nigeria, Japan, Russia, and many other countries [1]. In Indonesia, internet users have increased from 2 million in 2000 to 143.26 million in 2019 or 53.20% of the total population in Indonesia [2,3].

Digital health software applications increasingly become the choice of people in Indonesia, one of which is an e-health laboratory system service that applies a new approach to the health service system. The e-health laboratory system is a new approach to the health service system facilitated by electronic processes, internet communication, and other related technologies [4]. Doctors, laboratory assistants, nurses, patients, and guardians of patients are examples of e-health users. The use of e-health includes the provision of health services related to data, management, and interactions between health professionals

and patients [5]. E-health laboratory system can be defined as an application that offers customers with online access to get clinical information that includes laboratory test results. By collaborating or partnering with other trust clinical lab, e-health laboratory can provide various clinical laboratory examination and make the services available at many locations [6].

The e-health laboratory system in Indonesia covers all of them. The e-health laboratory system is part of eHealth in Indonesia. Generally, e-health also includes various digital applications, processes, and platforms such as remote medical consultation (TeleHealth), electronic medical record systems, smartphone applications, remote monitoring devices, biosensors, computer algorithms, and analytic tools to inform decision making [7]. In addition, other researchers state that eHealth elements include users, devices, and servers [8]. EHealth also allows legal access to health services through devices such as cellphones or certain e-health devices [5], including the patient's health status and history, or what is commonly known as an electronic health record system, which has been implemented in America since the 1990s [9]. At present, many countries have adopted the concept of e-health. This is in line with the World Health Organization (WHO) through the Global Observatory for e-health (GOe) in encouraging countries that are members to include eHealth in the health care system [10].

In Indonesia, the development of e-health is very promising. It is known that e-health can provide better health services not only at hospital level but also for primary health services and public health services [11].

The e-health system is even developed in the form of electronic health record system that is used in outpatient clinics or inpatient clinics in hospitals in developing countries to document patient data related to insurance claims, document retrieval by scanning images, laboratory results, and clinical use [6].

The application of various health services through e-health is so important in this era. Several studies on the adoption of various e-health services such as [10,12] state that by 2020 online health services will make it easier for patients to visit their doctors, and this is provided by tertiary hospitals. The use of technology in e-health has increased significantly with several new functions that enable patient-doctor interaction in virtual consultations and telemedicine. Technology is used in the process of documenting clinical work by many organizations in e-health applications, serving doctors in primary care, expertise (specialization and subspecialty) in hospitals, private laboratories, insurance companies, and patients themselves [5].

The e-health system has also begun to develop in Indonesia mainly related to the implementation of ICTs to support the management of healthcare facilities [13]. One of the health services that has also begun to develop is an e-health laboratory examination service which is marked by the emergence of various e-health laboratory service sites such as Pesan lab, Caya Laboratorium, Lab test online, Lab-on-line, Laboratorium Patologi Veteran, Prodia.co.id, and Lab Cito.co.id. This service is expected to continue to grow along with the increasing percentage of internet user growth in Indonesia by 10.12% per year [3].

However, studies related to the adoption of e-health laboratory services have not been found, including in Indonesia. Most researchers focus more on the internal perspective of health facilities (administrative officers and medical personnel) such as the adoption of e-health in healthcare facilities to improve service efficiency, to reduce duplication of services, to improve data confidentiality, to improve the quality of care among populations [14], to increase the speed of medicine delivery, and to prevent excessive use or dangerous medicine interactions [15,16]. Other studies were conducted on eHealth adoption for coordination between health organizations, ranging from the smallest units such as public health center to hospitals [17]. E-health adoption research is used for information exchange among health organizations [18]. Another example of e-health adoption is related to electronic records for medical documentation in primary health care that allows doctors to access patient records in a fast and simple way [19] on health record [9,20]. Another e-

health adoption study summarizes the experience of e-health cases related to organizations, business models, operations, competencies, and other unexpected functions [15].

Furthermore, the studies related to e-health in Indonesia are still largely from the internal perspective of health facilities [21]. These studies mostly rely on theories such as Technology Acceptance Model (TAM) [22–27] Unified Theory of Acceptance and Use of Technology (UTAUT) [28,29], Technology-Organization-Environment (TOE) [30], Human-Organization-Technology (HOT)-Fit [31], and so on. Unfortunately, e-health adoption research (especially e-health laboratories) from a patient's perspective is still not widely found in the literature. Some studies on issues from the patient's perspective, such as hospital service quality that focuses on responsiveness, assurance, professionalism, reliability, empathy, and tangibility, are only analyzed from a technological perspective [32]. From these conditions, several gaps have been found: (1) Research related to online adoption of laboratories has not yet been conducted in Indonesia, (2) Integrative studies related to the factor of e-health adoption by patients including in Indonesia are still few. Therefore, we are interested in conducting research primarily to analyze the characteristics of e-health laboratory systems and their correlation with behavioral adoption of technology, especially the factors related to the task, technology, and humanity that encourage the adoption of e-health laboratories.

Some research questions that will be answered in this study are: (1) What are the determinants that influence e-health laboratory adoption, perceived usefulness, and perceived ease of use for users in Indonesia? (2) Do Task Technology Fit (TTF), technology-driven, and human-driven have a direct effect on perceived usefulness and perceived ease of use on e-health laboratory adoption? (3) Do perceived usefulness and perceived ease of use affect the adoption of e-health laboratories? To answer these questions and provide a better understanding of the integrative factors of e-health laboratory adoption in Indonesia, we developed a theoretical model that combines the DeLone & McLean (D&M) model and the TTF model.

Based on that, our contribution with this research is that to the best of our knowledge, this is the first time the D&M model and the TTF model have been combined in e-health laboratory adoption. Because our research is based on two well-established theories, integration into a single model contributes to the discipline of information systems (IS). We hope this research offers insight into the ideas of e-health laboratory owners so that they apply the right policies to attract prospective adopters of e-health laboratories.

The systematics of this paper is compiled in Part 2, presenting e-health laboratories in Indonesia. Part 3 presents the adoption and technology acceptance theories. The methodology is in Part 4. Part 5 contains result, data analysis, and hypothesis test using Structural Equation Modeling (SEM), while factor analysis, path analysis, and regression were done using SmartPLS 3.2 software. Section 6 shows the discussion of this study including theoretical and managerial implications. Section 7 presents the conclusions of this research.

## 2. Literature Review

### 2.1. E-Health Laboratory in Indonesia

E-health laboratory is a new approach in online laboratory where the concept of online laboratory was widely used in the various context such as education, training, life sciences, industry, and research [33]. An online lab enables users such as student or employee to carry out experimentation over the Internet, which is normally performed in the traditional laboratory [34]. Online experimentation has been increasing more and more its relevance in all areas since it offers remote access, enabling control and monitoring of the process [33,34]. Similarly, an online laboratory projects starts from building the application to control online experimentation [35]. However, the research of online lab and online experimentation mostly used in the education context such as online teaching and learning [34–37]. There are still limited studies related to e-health laboratory adoption.

E-health laboratory systems in Indonesia vary greatly, from the traditional systems using measurement documents and coming directly to laboratories to the online service systems where people can register and fill the forms online, even receive the result either by email or web download.

Several e-health laboratory systems in Indonesia were observed in this study. The first e-health laboratory system is Pesan Lab [16] that offers customers the convenience and usefulness of having a trusted partner where the system collaborates with trusted clinical labs to incorporate medical checkups. Information about the initial price and information about the lab can easily be found on the web. From the online examination results, users will get a dashboard and comprehensive lab results historically in various clinical labs in one account. This online lab system collects services from many other laboratory partners.

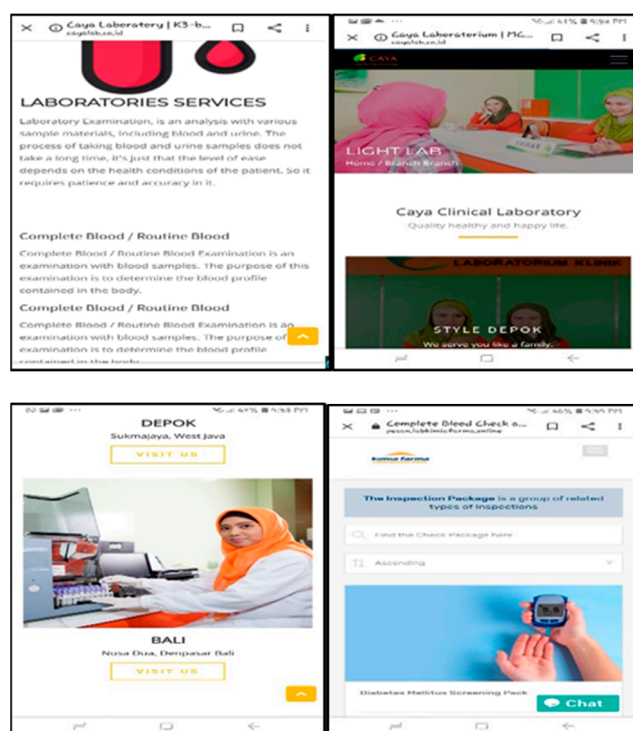
The second laboratory system is the Veterans Pathology Laboratories [38], one that provides online services for the examination of lab samples from patients sent by doctor partners or other laboratories. This e-health laboratory system has a mission to carry out the work optimally, carefully, informatively, and communicatively. In addition, it creates a systematic, effective, and efficient work system, and it forms internal and external work teams that are strong, professional, and friendly by always paying attention to the interests of patients. The online services include histopathological examination, cytopathology examination, body fluids, Pap smear, and biopsy examination [38].

The next type of online lab service is the Caya Laboratorium [39] providing home service. This e-health laboratory provides health laboratory services for all Indonesian people. This laboratory system provides clinical laboratory examination services, medical check-ups, X-ray photographs, panoramic and cephalometric, 4D ultrasound, treadmills, electrocardiogram, audiometry, spirometry packaged in a one-stop service. This service actively provides free inspection services, free medication, quality management system training, health education for healthy lifestyles, and others.

The display of an e-health laboratory in Indonesia is as seen in Figure 1. Talking about the types of e-health laboratory services is certainly inseparable from the standards set by WHO for primary health care [40,41]. In the main health care, the standard types that are usually assessed include [42]:

- Record standards for identification of the patient's basic demographics and diagnose clinical information at the first visit;
- Standard update notes to correct problems and to update medicine lists, and to arrange progress notes, laboratory reports, consultations, and other documentation in the notes;
- Recording standards for major complaints, related symptoms, treatment plans, follow-up plans, provider signatures, and dates of subsequent visits;
- Preventive care planning standards including immunization and patient education; and
- Standards of care planning for follow-up referrals to hospitals and laboratory results and expert consultants.

It can be seen that in e-health laboratory systems, the standards assessed must be considered in the provision of online services. E-health laboratory results determine assessments in laboratory reports and coordinated treatment planning.



**Figure 1.** The E-health laboratories Web in Indonesia.

## 2.2. Task–Technology Fit

Among the factors driving the adoption of technology is the ability of technology to provide efficiency and effectiveness of tasks performed by humans. One of the most popular theories to represent this situation is the Task Technology Fit (TTF) [43]. In this TTF theory, there are three main drivers that drive technology adoption, namely, technology characteristics, task characteristics, and task–technology fit. Research in information systems has advanced technology-to-performance as a model for connecting information technology and individuals, encouraging individual perspective of users to make the use of information systems more effective [43]. In other words, the proposed model is a technology attribute that refers to the technology consumed by individuals to perform their tasks and the characteristics of the tasks that refer to the activities taken by individuals in influencing user adoption.

The TTF model acts in an important role in the area of use of information technology and has been commonly applied in previous studies [44–46]. Conditions where technological features can help someone in carrying out the task and in accordance with the requirements of the task are called suitability of task technology. The function of the three components, namely, individual properties, technological attributes, and task characteristics is the task–technology fit proposed in the TTF model. In turn, task–technology fit directly impacts user adoption, and through TTF, technology indicator variables and task characteristics are proposed to indirectly influence adoption.

The research has been carried out for the intention to use information systems or the sustainable use of information systems based on the TTF model including knowledge management [47], adoption of e-books [48], e-learning [45,49,50], adoption of wireless technology [46], mobile banking services [51], and data mining tools [52]. We deliberate them in our research model to comprehend the problem driven by the task behind the user’s adoption intention in e-health laboratories.

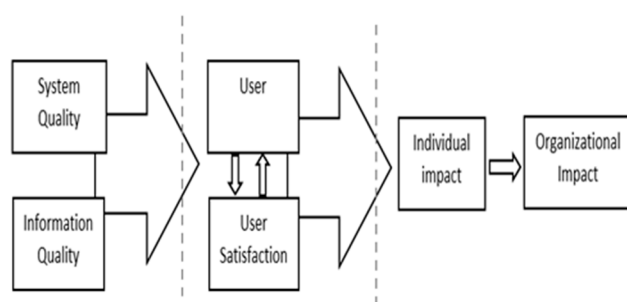
## 2.3. DeLone and McLean IS Success Model

The DeLone and McLean (D&M) model as an attribute of technological quality was originally derived from the mathematical modification of Harrison and Weaver’s commu-



nication theory [53]. The level of effectiveness such as the impact on the recipient is one of the initial models to identify the level of information.

The other two initial models are the technical level of the accuracy and efficiency of the system that produced it and the semantic level model, namely, the capability to transfer the message [53]. On subsequent developments, Mason [54] applied the initial theory to Information Systems (IS) by developing the effectiveness of the three sub-categories into (1) information reception, (2) influence on recipients, and (3) influence on systems. Figure 2 is an initial D&M model that contains the connection between system quality and information quality. In the picture there are six components in the information system that are the success points of the application of information systems. They consist of user satisfaction, individual impact, organizational impact, system usage, system quality, and information quality. This statement is known as the general theory of IS success. Changes to the initial D&M model were made after research emerged [55]. The study stated that service quality was found to also have an impact on measuring system quality. Therefore, the D&M success model includes the quality of the system, the quality of information, and the quality of service.



**Figure 2.** Original DeLone and McLean (D&M) IS Success model [45].

The development of IS success taxonomies continues to be pursued by researchers. Petter, DeLone, and McLean conducted a review spanning fifteen years (1992–2007) of analysis level, different types of IS, and different contexts to expand a taxonomy of IS success [56].

Motivated by the need to understand the success of IS and its effects, this study adds critical success factors in addition to information quality with accessibility factors [57] and design factors [58]. All three are the driving indicators of technology-driven issue. However, the focus of task characteristics has so far been applied to activities supported by organizations, so in this study we are interested in analyzing at individual level, as was done in the study in [43]. Researchers develop the D&M IS success model as a theoretical base such as in the addition of successful websites [59], Knowledge Management Systems (KMS) [60], learning systems [61,62], the success of the employee portal [63], and the implementation of a resource planning (ERP) system [64].

The D&M success model allows it to be combined with several other theories. Some researchers combine it with the unity theory of acceptance and use of technology, as in research on electronic patient registration systems [65] or in other studies of online services and repurchase intentions [66] or intentions to continue cellular payment services [67]. In addition, the D&M basic model has also been used in the evaluation of electronic health records [68], but to our knowledge there is no literature on the D&M model in e-health laboratory adoption.

#### 2.4. Technology Readiness Index

User readiness is an important part of increasing the possibility of e-health laboratory adoption in successful e-health. User readiness is an important factor in the development and innovation in the health sector. The acceptance of an individual's new technology is influenced by the structural and psychological aspects of innovation in technology. The

definition of readiness to adopt and use new technology is the tendency of individuals to try and use new technology in achieving goals in their daily activities [69].

Individual readiness for the adoption of new technologies can already be measured by the Technology Readiness Index (TRI) method [69]. This technology was developed to assess the individual's thinking and general belief in new technology. It is clear that an individual's assessment of the adoption of new technology results in two judgments that are positive if the individual agrees to use new technology so that the individual can become a pioneer. While negative views or assessments of new technology will result in individuals being skeptical or even rejecting the presence of new technology. Assessment of positive and negative responses from users leads to the emergence of thinking about four dimensions namely insecurity, optimism, discomfort, and innovation [69]. In this study, the innovative dimension was used.

The dimension of innovativeness can influence the increase in user readiness in using the latest technology which refers to the extent to which someone will experiment with technology and is very eager to try the latest technology-based services.

The emergence of an e-health laboratory as a new system is currently considered as one of the breakthroughs or new innovations that serve users in the health sector in Indonesia. Health checks that have been conducted conventionally have changed with the ease of offering health examination services through e-health laboratory services. It thus becomes interesting to know how users adopt new innovations in the health field such as this e-health laboratory. This becomes the basis for selecting the innovativeness factor from the technology readiness index in this study to find out whether individual obstacles in adopting an e-health laboratory system are influenced by personal innovativeness factors.

Barriers related to personal innovativeness to users can cause slow adoption of new health information technologies such as e-health laboratories. Although there has been a previous research that discusses the adoption of individuals and organizations [43], we believe that there is no research focused on the adoption of e-health laboratories that focus on human factors. Therefore, we are interested in taking personal innovativeness [70,71] as indicators of human driven in this study to determine the effect on the adoption of e-health laboratory intentions.

### 3. Research Model and Hypotheses

In understanding the adoption of individuals in new technology, personal traits certainly cannot be ignored. The current individual or customer adoption model has considered these important factors to explain customer adoption behavior [72].

Personality factors, behavioral beliefs, and social influence in several studies [73,74] show the varied effects on the purpose to use information systems from the initial implementation until the information system runs. Therefore, because e-health laboratories are a type of system whose use is based on users' decisions for their health checks, three main problems arise to understand users' intentions towards the ongoing use of e-health laboratories such as task-driven, technology-driven, and human-driven. Thus, four theoretical concepts namely the task-driven, the technology-driven, the human-driven and the technology acceptance model were used to examine the behavior of this sustainable use. The illustration in Figure 3 gives an overview of this research model. Hypothesis development is discussed in the next section.

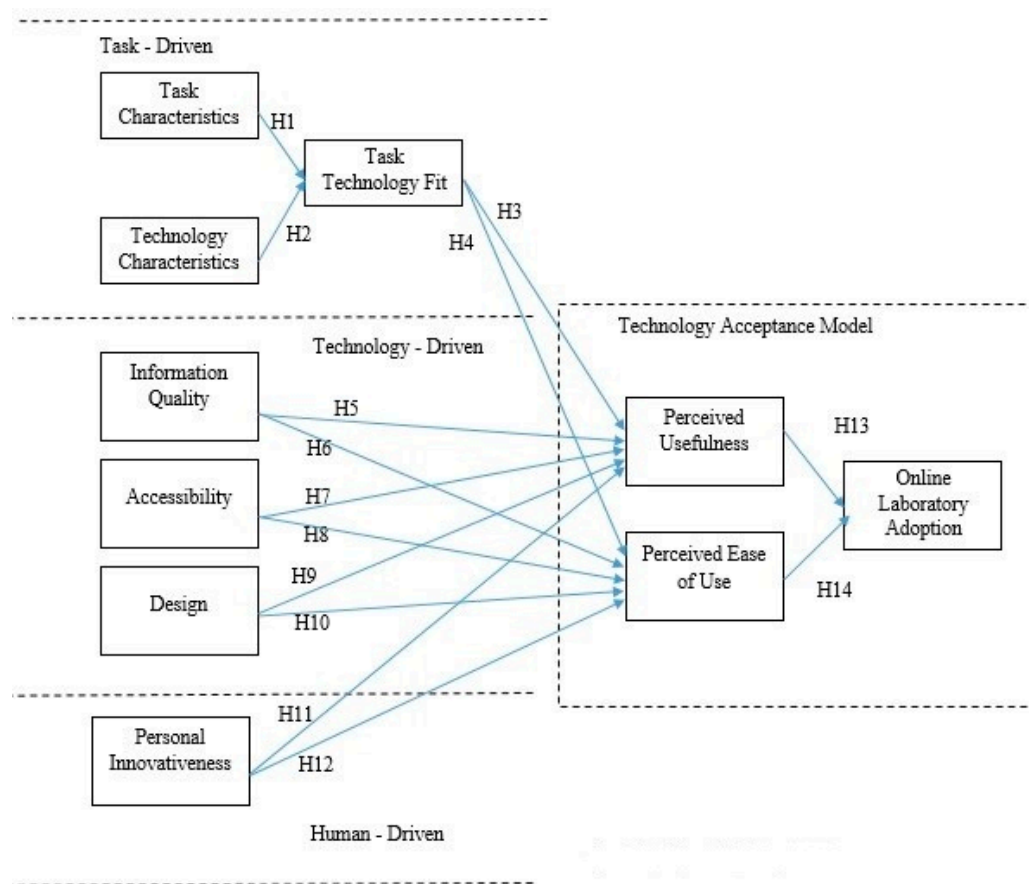


Figure 3. Conceptual model.

### 3.1. The Task-Driven Issue

In the context of the IS, the TTF model is often used. Previous studies using TTF models such as testing the intention to use KMS proposed by [44] used the TTF model in which the tasks and characteristics of KMS were positively related to task–technology suitability.

Task characteristics and technology characteristics in this study refer to [43,46]. Other researchers propose a mixture of the TTF and TAM models for the use of cellular devices [75]. Other researchers find that task characteristics play an important role in determining task–technology suitability in statistical modeling and project management tools, the task modeling in the DMTs [52] integrates TTF with TAM to investigate the determinants of user acceptance of m-commerce [76].

Thus, by involving the TTF model in this study it is expected that users will find e-health laboratories useful when the system helps users in their health screening activities [69]. In particular, if an adequate e-health laboratory can meet the information needs of users in an effective health screening activity, users will consider the e-health laboratory as a suitable system for their routine health checks. As discussed above, this research proposes the following hypotheses:

**Hypothesis 1 (H1).** *The task characteristics of e-health laboratory have positive impact on the task–technology fit.*

**Hypothesis 2 (H2).** *The technology characteristics in e-health laboratory have a positive impact on the task–technology fit.*



In information systems theory, the relationship between task–technology suitability and its use has been well established [49,52,77,78]. Previous research [49] has expanded the post-acceptance model with the combination of TTF and ECM to inspect the intention to IS continuation. The results show that task–technology suitability is clearly related to perceived usefulness.

Task–technology fit is listed in several articles [77,79–81]. It is a proposed model to examine the connection between the perceived task–technology suitability and system factors in the goal of encouraging students to use e-learning systems [78]. In particular, the study [52] has found that the fit among task and technology had a positive influence on perceived usefulness in the use of DMTs. Overall, the results of the study indicate that the task-matching technology positively influences the perceived benefits. This study offers the next hypotheses:

**Hypothesis 3 (H3).** *The task–technology fit has a positive impact on perceived ease of use.*

**Hypothesis 4 (H4).** *The task–technology fit has a positive impact on perceived usefulness.*

### 3.2. The Technology Driven Issue

Information quality can contribute to user satisfaction because users can find out information about the quality of the system [58]. The quality of the system is in the form of the use of the most advanced technology, advantages in system functions and key features and software that is easy to use, easy to learn, easy to maintain, and user-friendly [82]. Users target quality information system content in the format, understanding, relevance, accuracy, accessibility, completeness, adequacy consistency, consistency, and timeliness, as described in the research [58,83–85].

The relationship between information quality and perceptions about ease of use and system usability has often been used as a research model [70,86–90] where the research shows that the relationship of information quality positively influences perceived usefulness and perceived ease of use. E-health laboratories are predictable in providing information that is appropriate to the needs of the users, accurate, up-to-date, complete, clear, and in a good format, so users can consider adopting systems in e-health laboratories. To find out the relationship between the quality of e-health laboratory information and perceptions of ease of use and system usability, the supporting hypotheses are proposed:

**Hypothesis 5 (H5).** *Information quality in e-health laboratory system positively influences perceived usefulness.*

**Hypothesis 6 (H6).** *Information quality in e-health laboratory system positively influences perceived ease of use.*

Accessibility in this research follows Dinev et al. [57]. E-health laboratories can be well adopted by users if they have a system that is accessible and can be used as easily as a conventional health check.

Systems that experience problems when accessed mean that they have obstacles in the use. Whereas, a system that is easily accessed and has no constraints in the use will be the user's choice to be more frequent and easier to use [91]. The system can be accessed without a hitch if there is a fast internet connection and the right technical infrastructure, so that accessibility is not hampered. Users tend to ignore the system if there are obstacles to the network connection and internet speed [92,93]. The reliability of system accessibility is an important factor.

The model used to predict the adoption of the use of systems related to TAM in studies [91,94–96] states that system accessibility has been considered a significant external factor. In e-health laboratories, it is suspected that the technical aspects of accessibility such as e-health laboratories can be accessed anytime and anywhere. E-health laboratories can be

accessed under any conditions and can be accessed through various media (smartphones, laptops, etc.) This technical accessibility is a critical success factor that determines the usefulness of the system and the usefulness felt by users in adopting an e-health laboratory. Then the following hypothesis is formulated:

**Hypothesis 7 (H7).** *Accessibility in the e-health laboratory system positively influences perceived usefulness.*

**Hypothesis 8 (H8).** *Accessibility in the e-health laboratory system positively influences perceived ease of use.*

The design in this research follows DeLone and McLean, 2016 [56,58,97]. Design becomes an important thing if it is associated with user adoption in a system. Design is prepared with careful consideration. Many studies on design evaluations such as Allen et al. [98] present an evaluation designed to assess the quality level on mockup design of medical web application. The Design Usability Evaluation (DUE) technology can be used to find problems that affect navigation and ease of use of web applications [99]. The aim of this research is to improve the usability and usefulness of the system perceived by users. User-friendly design will provide usefulness and usability perceived by users [100].

Among the attitude factors, aesthetics and design have the most significant effect [101,102]. Various aspects can determine attitudes towards online systems such as the availability of product information, the existence of convenience, time optimization, and effort provided [103]. Even further, web design that is made according to aesthetics and experience is a factor that is taken into account by the user. Other studies [104] have examined the use of websites about the benefits and intentions felt indirectly, perceived ease of use, and cognitive absorption of design effects.

Users want an e-health laboratory system design that has an attractive appearance and has the features and functions that users need. The structured appearance of e-health laboratory system affects perceived usefulness and perceived ease of use in adopting this system. Based on this, the following hypothesis is formulated:

**Hypothesis 9 (H9).** *Design in an e-health laboratory system positively influences perceived usefulness.*

**Hypothesis 10 (H10).** *Design in an e-health laboratory system positively influences perceived ease of use.*

### 3.3. The Human-Driven Issue

Personal innovativeness in this study refers to [70,71]. Personal innovativeness is one of the variables in human-driven issue. This variable refers to individuals' willingness to try a new type of system in adoption of healthcare, so they do not refuse when a new system is introduced, as proposed by [105]. The study investigates how individuals through personal innovativeness adopt devices that can be used in health care. Personal innovativeness [71] is the desire that arises in individuals as the first person to use new technology.

Individuals feel happy and feel important to be the first to have a new technology and always want to use technology products. Previous researchers [70,71] stated that the willingness of individuals to try new technologies is a personal innovativeness in technology. Different innovations in each individual will differentiate the way individuals react to new technology. In general, users who have innovative technology tend to quickly accept the new technology offered [106].

An e-health laboratory system has high innovations such as easy access to every process in the system. High innovation in e-health laboratories will certainly facilitate users in adopting e-health laboratories.

Users who have higher innovativeness towards new IT certainly need to be linked to the usefulness and uses perceived by the individual. In detail, we hypothesize that there is an influence of personal innovativeness in e-health laboratories on the usefulness and uses perceived by individuals in adopting e-health laboratories.

**Hypothesis 11 (H11).** *Personal innovativeness positively influences perceived usefulness.*

**Hypothesis 12 (H12).** *Personal innovativeness positively influences perceived ease of use.*

### 3.4. The Technology Acceptance Model Issue

Behavioral intention aspects of the TAM, namely, perceived usefulness and perceived ease of use [107] in literature and studies are often used. Many successful studies show the relationship of these factors in the use of information systems. In this study, perceived usefulness and perceived ease of use follow the works in [107,108], and adoption refers to the study in [36]. In the context of e-health laboratories, the ease and usefulness of using e-health laboratories will certainly have an influence on the user's intention to use e-health laboratories.

In this study, perceived usefulness can be described as the relative usefulness perceived from an e-health laboratory system. The easier the e-health laboratory technology, the greater the usefulness to consumers. E-health laboratories are easy to learn and easy to use because of the simple way of use. Users find it easy to use e-health laboratories because they are easy to navigate. Users adopt and desire to use e-health laboratories in the future. Thus, two hypotheses are formed:

**Hypothesis 13 (H13).** *Perceived usefulness has a positive impact on the adoption of the e-health laboratory.*

**Hypothesis 14 (H14).** *Perceived ease of use has a positive impact on the adoption of the e-health laboratory.*

## 4. Methodology

The research methodology used in this research is divided into three stages, namely, instrument development, data collection and data analysis (Figure 4). This stage is intended so that this research is carried out systematically.



**Figure 4.** Methodology of research work.

### 4.1. Instrument Development

This e-health laboratory research used a quantitative approach. The survey instrument used was based on the indicators of each variable in accordance with the conceptual model in Figure 2. The indicators were based on existing supporting theories. Preliminary test was conducted on survey instruments in the form of validity and reliability tests. This was done to check the validity and reliability of research instruments. To check the internal validity and reliability of the instrument, Cronbach's Alpha and Corrected Item-Total Correlation were used. A pretest was also carried out to see whether the respondent understood each question [109].

In the test, the results for each variable met the reliability test with a Cronbach's Alpha value above 0.8. With this instrument condition, it was ready to be shared online with e-health laboratory users in Indonesia.

This study used a pretest sample of 50 people. The results of our analysis confirmed that all of our instrument indicators have met the validity test for the total items of the corrected correlations of each indicator above 0.2353. A value of 0.2353 was produced from the r-table with the value of degree of freedom (df) N-2 or 48 by considering the pretest sample of 50 respondents.

The questionnaire in this study was developed using a 5-point Likert scale which had a range of (1) strongly disagree and (5) strongly agree [110].

The indicators used from each variable in this study were adapted from previous studies. The task-driven model included three constructs such as technology characteristics and task characteristics whose measuring items were adapted from Tam and Oliveira's study, [75] while the task technology fit was adapted from [48,79–81]. Consequently, technology characteristics, task characteristics, and task technology fit comprised 4 items, 3 items, and 4 items each.

The technology-driven model also included three constructs which were information quality, accessibility, and design. The measurement items used were taken from studies such as information quality from DeLone and McLean, 2016 [58], accessibility [57], and design adapted from the DeLone and McLean's study, 2016 [58]. As a result, information quality, accessibility, and design contained 5 items, 3 items, and 3 items each.

The technology readiness index had only one construct, namely, personal innovativeness where the personal innovativeness measurement items were adopted from [70,71] so personal innovativeness contained 4 items and 3 items each.

The technology acceptance model had three constructs, namely, perceived usefulness, perceived ease of use, and adoption. Perceived usefulness and perceived ease of use were adapted from the measurement items of research [107,108]. For adoption constructs, the measuring items were adopted from [36], so the total survey instrument was composed of 11 variables which were interpreted into 39 questions in the questionnaire which can be fully seen in the Appendix B.

#### 4.2. Data Collection

In this study all users who have used an e-health laboratory site to order online lab services, review costs, or just search for information were set as the target respondents. The distribution of questionnaires to respondents was carried out in the form of a link to Google Doc through WhatsApp Groups that have access to discussions with prospective respondents in two months. Questionnaire links were also distributed via social media such as Facebook, Line, and Telegram.

To make it easier for respondents to understand the type of e-health laboratory that is the object of this research, the questionnaires included the links from online Lab website. This research focuses on three e-health laboratory sites in Indonesia, namely, Pesan Lab [16], Veterans Pathology Laboratories [38], and Caya Laboratories [39].

The e-health laboratory types were chosen because they were considered to represent the e-health laboratory system in Indonesia. Respondents were also questioned if they had accessed at least three of the online lab sites. These e-health laboratory systems were chosen because they were easily accessible and well-known as a start up in e-health in Indonesia. In addition, the questionnaire was also delivered directly to the laboratory to get respondents who were customers of the three e-health laboratories.

The questionnaire collection was completed in two months with 163 respondents. This sample size was sufficient and had exceeded the minimum requirements to be dealt with using SEM with the Maximum Likelihood Estimation (MLE) procedure which indicated 100–150 samples [35].

Responses obtained from 163 respondents were valid responses from different individuals. This amount was sufficient and also representative in e-health laboratory examinations, because respondents who filled out the questionnaires at least really knew and had tried e-health laboratory applications in Indonesia. The distribution also included large cities in Indonesia where e-health laboratory services could reach respondents. Therefore,

it could be stated as sufficient to provide an overview and represent e-health laboratory users in Indonesia. The sample was very representative because the number of e-health laboratory websites was indeed included as a new service in Indonesia. Thus, the user community was still limited. This was acceptable considering the adoption of the web was still a new service, which was in line with the research by A. Usoro, et al. [37]. According to T.R. Hinkin [111] and E. Stone [112], for a sample size of 150 it was considered sufficient for scale development.

#### 4.3. Data Analysis

In analyzing the data in this study, the PLS-SEM approach was used. Smart PLS version 3.2.8 is used as a tool. The choice of PLS-SEM as an approach in this study is because it is known to be able to overcome problems associated with small samples and sample data that are not normally distributed [113]. In the PLS-SEM, we have conducted the analysis data through two steps: (i) measurement model testing; and (ii) structural model testing based on [114]. Several tests were carried out before testing the structural model, namely, testing the validity and reliability of all constructs in the proposed measurement model. The provisions for evaluating the validity test results are the convergent validity of the outer loading parameter is greater than 0.70 and the Average Variance Extracted (AVE) value has a value greater than 0.50. Whereas, the results of reliability testing (internal consistency) are based on the Cronbach Alpha coefficient and composite reliability parameters equal to or greater than 0.70 [114].

### 5. Results and Data Analysis

#### 5.1. Respondent Demographics

The data accumulation gained 163 respondents consisting of 72 men and 91 women. Collection of demographic data of respondents who participated in the questionnaire in this study can be seen in Appendix A. That table shows that most of the respondents were in the range of 41 to 55. This shows that the respondents were in productive age. The education level of respondents was mostly postgraduate.

In terms of profession, most respondents worked as private employees, and many respondents came from Java (Non Jabodetabek) while for salary criteria, most respondents had income from 5 to 10 million per month. The description of respondents accessing e-health was in line with the consumer description of penetration surveys and behavior of Indonesian internet users [3].

#### 5.2. Analysis of the Measurement Model

Before analyzing and measuring the proposed conceptual model, the first step was to test the survey instrument. This step was completed by testing the validity and reliability of research instruments.

In this section, statistical values are compared to the calculation of the questionnaire results, especially related to the convergent validity of each construct. The first step was testing the reliability and validity. The Composite Reliability (CR) in PLS was used to test reliability. Table 1 is the results of the test where it can be seen that the CR index value on all constructs  $>0.7$  and the Cronbach's Alpha meets the criteria. The determination of convergent validity values follows the criteria [109] where all items are statistically significant and must have values  $>0.60$  or ideally 0.70.

In addition, the Average Variance Extracted (AVE) value must be  $>0.50$  for construction. The discriminant validity was measured using the criteria where the AVE square root for a construct must be greater than its correlation with other constructs.

In line with these criteria, all question items appear to have values of more than 0.60, and all construction items meet the criteria. Table 1 shows the resulting convergent reliability and validity. These indices simultaneously show a high degree of convergent reliability and validity.



**Table 1.** Convergent validity.

Construct	Items	Factor Loading	AVE	CR	Cronbach's Alpha
Technology Characteristics (TCC)	TCC1	0.84	0.711	0.945	0.932
	TCC2	0.858			
	TCC3	0.843			
	TCC4	0.882			
Task Characteristics (TC)	TC1	0.927	0.887	0.959	0.936
	TC2	0.953			
	TC3	0.945			
Task Technology Fit (TTF)	TTF1	0.866	0.734	0.943	0.926
	TTF2	0.894			
	TTF3	0.886			
	TTF4	0.906			
Information Quality (IQ)	IQ1	0.819	0.764	0.942	0.922
	IQ2	0.887			
	IQ3	0.877			
	IQ4	0.886			
Accessibility (AC)	AC1	0.844	0.723	0.839	0.617
	AC2	0.856			
	DE1	0.887			
Design (DE)	DE2	0.912	0.801	0.923	0.876
	DE3	0.886			
	PI1	0.884			
Personal Innovativeness (PI)	PI2	0.886	0.718	0.91	0.868
	PI3	0.847			
	PI4	0.768			
Perceived Usefulness (PU)	PU1	0.768	0.678	0.894	0.842
	PU2	0.85			
	PU3	0.803			
Perceived Ease of Use (PE)	PE1	0.691	0.722	0.885	0.801
	PE2	0.924			
	PE3	0.914			
Adoption Intention (AI)	AI1	0.897	0.811	0.928	0.884
	AI2	0.911			
	AI3	0.894			

The diagonal line in Table 2 clearly shows that the value on the diagonal line had a greater discriminant value than the discriminant value below it, so it was declared valid. This means that the indicator was able to construct the variables formed in this e-health laboratory research. The results show a high level of discriminant validity.

**Table 2.** Discriminant validity.

Construct	AC	AI	DE	IQ	PE	PU	PI	TC	TTF	TCC
Accessibility (AC)	0.85									
Adoption (AI)	0.396	0.901								
Design (DE)	0.448	0.377	0.895							
Information Quality (IQ)	0.4	0.495	0.696	0.874						
Perceived Ease of Use (PE)	0.546	0.449	0.763	0.681	0.85					
Perceived Usefulness (PU)	0.508	0.633	0.476	0.529	0.538	0.824				
Personal Innovativeness (PI)	0.353	0.612	0.46	0.435	0.469	0.539	0.8			
Task Characteristics (TC)	0.392	0.337	0.562	0.631	0.541	0.412	0.4	0.942		
Task Technology Fit (TTF)	0.251	0.246	0.292	0.259	0.233	0.401	0.3	0.403	0.857	
Technology Characteristics (TCC)	0.218	0.234	0.152	0.088	0.169	0.357	0.3	0.257	0.703	0.843

Diagonal value: square root of AVE and non-diagonal value: correlation.

In this study, we also calculated the Variance Inflation Factor (VIF). These values obtained ranged from 1.248 to 4.712 and were still smaller than 10.0 [115,116]. There was no VIF value above 10.0, so it could be stated significantly that there was no multicollinearity problem in the dataset of the e-health laboratory user questionnaire in this study.

### 5.3. Analysis of the Structural Model

Two conditions need to be considered in evaluating the structural model that is formed to gain the path coefficient ( $\beta$ ) and the coefficient of determination ( $R^2$ ).

The first condition in the PLS is that there is no significance test or estimation of the confidence interval, and the second condition, namely that is the coefficient of determination from the PLS analysis is identical to that found in multiple regression analysis. Figure 5 indicates the output of the estimated path coefficient ( $\beta$ ) and explanatory power ( $R^2$ ).

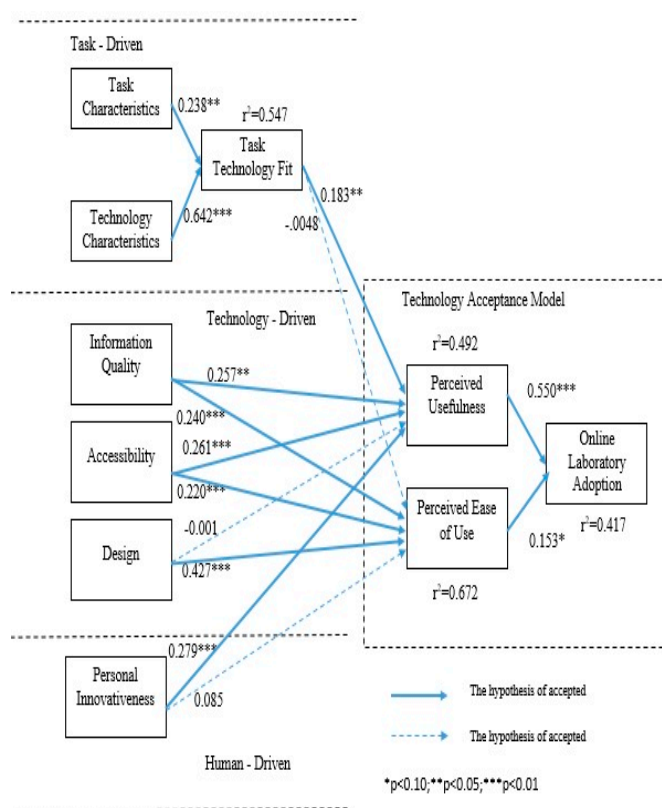


Figure 5. Result of the structural model.

Therefore, the task-driven variable with both the construction of task characteristics and technology characteristics through task–technology fit simultaneously explained 49.2% of the variables in perceived usefulness ( $R^2 = 0.492$ ). Bootstrap procedures were used to obtain path coefficients, t-statistics, statistical significance, and relevant parameters such as averages, standard errors, and loading items [114,117].

All relationships in the conceptual model were supported by data. Task-driven variables were driven by task characteristics, technology characteristics, and task–technology fit. The modeling of task characteristics and technology characteristics had a significant influence on task–technology fit ( $\beta = 0.238$  and  $0.642$ ). Thus, Hypotheses 1 and 2 were supported. Task-driven variables consisting of the task characteristics and the technology characteristics of e-health laboratories had a positive impact on the task–technology fit. The two constructs simultaneously accounted for 54.7% of the variance in task–technology fit ( $R^2 = 0.547$ ). Task–technology fit in e-health laboratories was very important in determining perceived usefulness ( $\beta = 0.183$ ). Hypothesis 3 propped the data. Therefore,

the task-driven variable with both the construction of task characteristics and technology characteristics through task–technology fit simultaneously explained 49.2% of the variables in perceived usefulness ( $R^2 = 0.492$ ). The results of data analysis for Hypothesis 4 were rejected because the task–technology fit of the e-health laboratory system did not have a positive and significant result on perceived ease of use. The relationships were negatively correlated ( $\beta = -0.048$ ). The relationships that occurred were negatively correlated, so the higher the task technology fit indicator in an e-health laboratory, the lower the perceived ease of use felt by the user, or vice versa.

Technology-driven variables were driven by information quality, accessibility, and design. Hypotheses 5 and 6 were also supported by the data. Information quality had a positive and significant impact on perceived usefulness ( $\beta = 0.257$ ) and perceived ease of use ( $\beta = 0.240$ ). Accessibility was the construct of technology driven variables and was an important precursor of perceived usefulness ( $\beta = 0.261$ ) and perceived ease of use ( $\beta = 0.220$ ).

Thus, Hypotheses 7 and 8 were supported. For Hypotheses 9 and 10, the design of the e-health laboratory system negatively affected perceived usefulness ( $\beta = -0.001$ ).

The relationships that occurred were negatively correlated, so the higher the design indicators in an e-health laboratory, the lower the perceived usefulness felt by the user, or vice versa.

The results of data analysis for Hypothesis 9 were rejected because the design of the e-health laboratory system did not have a positive and significant effect on perceived usefulness. The relationships were negatively correlated ( $\beta = -0.001$ ) while the design of the e-health laboratory system had a positive impact on the perceived ease of use ( $\beta = 0.427$ ).

The relationships that occurred were positively correlated, so Hypothesis 10 was supported. Design in an e-health laboratory system positively influenced perceived ease of use. The three constructs simultaneously accounted for 49.2% ( $R^2 = 0.492$ ) of the variance in perceived use of vulnerability and accounted for 67.2% ( $R^2 = 0.672$ ) from the variance in perceived ease of use, and the rest was influenced by other variables.

Human-driven variables were driven by personal innovativeness whose relationship was described in Hypotheses 11 and 12. The results show that Hypotheses 11 was supported by data. Personal innovativeness had a positive and significant effect on perceived usefulness ( $\beta = 0.279$ ). In contrast to Hypothesis 11, the results of data analysis for Hypothesis 12 were rejected because the personal innovativeness did not have a positive and significant effect on perceived ease of use. The technology acceptance model variable was driven by perceived usefulness and perceived ease of use for adoption variables obtained from task-driven, technology-driven, and human-driven variables. In Hypotheses 13 and 14, supported by data, perceived usefulness had a positive effect on adoption ( $\beta = 0.550$ ). Perceived ease of use was a construct of the technology acceptance model variable and had a positive effect on adoption ( $\beta = 0.153$ ). Therefore, the two constructions simultaneously accounted for 41.7% ( $R^2 = 0.417$ ) in adoption.

Table 3 shows the hypothesis test result (t-value) based on the results of the structural model test using SmartPLS. Fourteen hypotheses were tested, eleven were accepted, while three were rejected (in red).

**Table 3.** Hypothesis testing result.

	Hypothesis	( $\beta$ )	tStatistics	Conclusion
H1	Task Characteristics -> Task Technology Fit	0.238 **	2.492	Hypothesis accepted
H2	Technology Characteristics -> Task Technology Fit	0.642 ***	6.912	Hypothesis accepted
H3	Task Technology Fit -> Perceived Usefulness	0.183 **	2.872	Hypothesis accepted
H4	Task Technology Fit -> Perceived Ease of Use	−0.048	0.671	Hypothesis rejected
H5	Information Quality -> Perceived Usefulness	0.257 **	2.79	Hypothesis accepted
H6	Information Quality -> Perceived Ease of Use	0.240 ***	3.785	Hypothesis accepted
H7	Accessibility -> Perceived Usefulness	0.261 ***	3.348	Hypothesis accepted
H8	Accessibility -> Perceived Ease of Use	0.220 ***	3.065	Hypothesis accepted
H9	Design -> Perceived Usefulness	−0.001	0.011	Hypothesis rejected
H10	Design -> Perceived Ease of Use	0.472 ***	5.801	Hypothesis accepted
H11	Personal Innovativeness -> Perceived Usefulness	0.279 ***	3.215	Hypothesis accepted
H12	Personal Innovativeness -> Perceived Ease of Use	0.085	1.493	Hypothesis rejected
H13	Perceived Usefulness -> Adoption	0.550 ***	7.856	Hypothesis accepted
H14	Perceived Ease of Use -> Adoption	0.153 **	2.14	Hypothesis accepted

Path- $\beta$ : \*\* $p < 0.05$ ; \*\*\* $p < 0.01$ .

## 6. Discussion

To our knowledge, this was the first empirical study to investigate integration factors in e-health laboratory adoption, especially for cases in Indonesia. The integration factor in this study was obtained by integrating the TTF and D&M models, and considering additional variables in the form of technology-driven and human-driven technology acceptance models to determine user adoption of the e-health laboratory system. Our results indicate, except for Hypotheses 4, 9, and 12, that our hypothesis was fully supported.

Our research model explained 54.7% of the variation in TTF by task characteristics and technology characteristics. Compared to other investigations exploring TTF in the adoption of m-banking [51,75], m-commerce [76], and social networking sites [81], these results showed good predictive power. The positive effects of technology characteristics and task characteristics on TTF were very clear and confirmed results similar to all previous studies.

The perceived usefulness of online adoption of laboratories in our model was explained by TTF, information quality, accessibility, design, and personal innovativeness. This model explained 49.2% of variations in the perceived usefulness of online adoption of laboratories. Our hypothesis stemmed from TTF, the quality of information, accessibility, and personal innovativeness to explain the significant relationship to perceived usefulness in e-health laboratories.

For positive and significant information quality results, it was in line with the results of the study [70,88,89]. Positive results and significant accessibility to perceived usefulness in this study differed from the results of the study [94,96] which obtained the opposite results. The results of this study differed from studies [106] for personal innovativeness that provided positive and significant results on perceived usefulness. The design did not support this model, as negative and insignificant results were obtained. This result was different from previous studies [71].

TTF results that had a significant effect on perceived usefulness were similar to the results of the study [37,52,77–79], but these results differed from [118]. There were two reasons for the strong relationship between TTF and perceived benefits [118]. The first was that users may feel that the use of e-health laboratories was highly dependent on the compatibility between health checks experienced with e-health laboratory functionality. The second reason might be that users had a better and clearer understanding of their medical examinations, and thus could directly assess the suitability of e-health laboratory functionality with these tasks.

In addition, for the perceived ease of use in e-health laboratories in our model, it was also explained by TTF, information quality, accessibility, design, and personal innovativeness. This model explained 67.2% of the variation in the perceived ease of use in e-health

laboratory adoption. The difference in this hypothesis came from the quality of information, accessibility, and design to explain the perceived ease of use in e-health laboratories. The results obtained were positive and significant on the quality of information, and these results were similar to the results of previous studies [70,88]. Positive and significant results of accessibility to perceived ease of use in this study were similar to the results of previous studies [94,96]. The design showed positive and significant results on perceived ease of use; these results were in line with the research in [100].

Whereas TTF and personal innovativeness did not support this model, the insignificant results on personal innovativeness were contrary to the results of the study [70,71,106] which showed significant results on the perceived ease of use.

A focus on the insignificant results between TTF and the perceived ease of use in e-health laboratory adoption showed that these results were different from the results of the study [37,77,79,118]. The four previous studies found that TTF influenced the perception of ease of use. This different result was probably due to the current reason that users did not have many e-health laboratory options to use since this laboratory service was still a new service in Indonesia. This could reveal the relationship between TTF and perceived ease of use which was not significant.

The research model explained 41.7% of variations in e-health laboratory adoption. Based on the results, we believe that perceived usefulness and perceived ease of use supported efforts in e-health laboratory adoption. If e-health laboratory users felt that the service matches their perceived benefits and ease of use is felt by them, then they would voluntarily adopt e-health laboratory services. These results also indicated that adoption in e-health laboratories allowed for further exploration to find out other variations of variables that supported users in adopting e-health laboratories. The implications of research on theory and practice are summarized below.

### 6.1. Theoretical Implications

Finally, the peak analysis of this study resulted in the determinant variables which were significantly correlated and the variables which were not correlated with the perceived usefulness and perceived ease of use in the adoption of an e-health laboratory system especially in Indonesia. These findings could be used to strengthen and underlie previous theories and studies. The findings that strengthened the theory were the variables that had a significant and positive correlation while the findings that were different from the theory were the variables that were not significant and negatively correlated.

From a theoretical perspective, this research integrated D&M and TTF to explain adoption from e-health laboratories. We found that TTF and personal innovativeness did not have a significant effect on the perceived ease of use variable, but TTF showed a significant effect on the perceived usefulness along with information quality, accessibility, and personal innovativeness variables. Whereas, the design did not have a significant effect on the perceived usefulness. However, as a whole, the variables of perceived usefulness and perceived ease of use had a significant effect on e-health laboratory adoption. This research contributed to the theory because it provided insight into the integration factors outlined above that influenced the adoption of e-health laboratories in Indonesia. The results obtained for the relationship of integration factors had two results, most of which supported the results of previous studies in different objects. Some findings gave different results from previous studies. This becomes interesting to be studied in further research.

With this result, there are three research contributions: first, increasing limited knowledge about e-health laboratory adoption. To our knowledge, most of the research has not focused on prospective users of e-health laboratories, especially in Indonesia. This was an area of research that had not yet been explored. This research successfully integrated various popular technology adoption of the D&M model (DeLone & McLean [56,58,97]) and the TTF model (D. L. Goodhue & Thompson, [43]), to the extent that our new knowledge was combined in e-health laboratory adoption. This study examined the importance of TTF in user adoption by also considering the technology driven and human driven



cases of e-health laboratory adoption models, which has not been done by previous researchers. Because our research was based on established theories, the integration of this proposed model contributes to the discipline of information systems theory. Second, this study provides an overview and results regarding the attitude of the adoption of e-health laboratory users, especially in Indonesia, especially regarding the integrative factors of perceived usefulness and perceived ease of use of TTF, information quality, accessibility, design, and personal innovation for e-health laboratory adoption that had never been done in Indonesia. Third, because of the novelty of e-health laboratories in Indonesia, this study was successful in measuring the adoption of e-health laboratories in its users. This research will benefit future researchers who will observe technology adoption. The model proposed in this study can serve as a model for determining the integration factors in technology and can be used as a comparison basis for future research. Therefore, the results of this research can be used to enrich research and scientific studies on e-health laboratories in Indonesia.

### *6.2. Managerial Implications*

This e-health laboratory research is expected to be able to contribute and implicate the knowledge and development of e-health in Indonesia, especially regarding e-health laboratories. E-health laboratory providers can make the results of this study as an alternative input to improve the quality of their systems to improve a good image in the minds of users. Customer trust is very important, and this effort is to foster trust and support e-health laboratories as a health facility for users.

This study has important practical implications as an input to assessing property information systems for e-health laboratory owners to increase user adoption of e-health laboratories.

Our results indicated three dominant factors that directly influenced the user's intention to adopt an e-health laboratory system, namely, the technological characteristics, followed by perceived usability and design factors. This can provide input to this industry. Prospective users will support services and be involved in this industry if the characteristics of e-health laboratories can provide health information services that can be accessed anytime and anywhere, in real-time, quickly and securely. In addition to meeting the needs that are felt to be useful, the owner or manager of an e-health laboratory needs to increase the effectiveness of users in obtaining their health information. It can facilitate users to retrieve their health information faster and, overall, the information provided is very useful for users. The design factor is of particular concern to the user, so the designs suggested from e-health laboratories should have an attractive appearance, and have the features and functions of a complete health screening service. E-health laboratories have a structured appearance that is easy to understand.

Elements that can be redeveloped are information that is accurate, precise, complete, up-to-date, and clear, as well as information that can be accessed anytime, in any situation, and on all mobile devices because this element can affect the level of improvement, comfort, and speed in retrieving health information and can influence the use of an e-health laboratory system. This e-health laboratory research is expected to be able to contribute and implicate for the knowledge and development of e-health in Indonesia, especially regarding the e-health laboratory industry.

### *6.3. Limitations and Future Research*

There are still limitations in this study and they can be improved in further research. First, the filling out of the questionnaire was carried out independently, which needs to be controlled to ensure it is the right respondents who actually fill in the questionnaire. This may result in bias in respondents' responses. To get the attention of respondents and to get more data, offering prizes for respondents would make it easier for researchers to get more data from respondents. In this study, we also offered prizes for selected respondents who have completed the questionnaire given.

Another comment is about the distribution of residential locations of respondents who have not spread evenly. Second, this study only focused on user adoption; further study on the specific adoption of health experts needs to be carried out to provide a comprehensive analysis of e-health laboratory adoption in Indonesia. Third, for the issues regarding the security of users' health data, further study needs to be done to determine the right balance between security, privacy, and traceability, to prevent users' health data from being spread to irresponsible parties.

## 7. Conclusions

This study proposed and examined the model of user adoption intention on the use of e-health laboratories from task characteristics, technology characteristics, task technology fit, information quality, accessibility, design, and personal innovation through perceived usefulness and perceived ease of use. This model can provide an initial step towards implementing an e-health laboratory system in Indonesia. This model is likely to generate preferable data because it requires a user-related perspective to determine the characteristics of e-health laboratory systems by considering the technical aspects so that it allows customers to focus on the visible characteristics of technology in e-health laboratories.

The most dominant factors that directly affect the user's intention to adopt an e-health laboratory system are technology characteristics followed by perceived usefulness and design factors. All three factors have a significant direct impact on users' intentions to adopt an e-health laboratory system. The perceived usefulness factor has positive utility, so it has a significant role in the application of e-health laboratory systems. In contrast, the design factor on perceived usefulness as a negative utility in user confidence does not have a significant impact on the intention of Indonesian users to use an e-health laboratory system. As a result, we can conclude that Indonesian users can be characterized by their own considerations for the perceived usefulness factor that they will get, and then they leave aside designs that may be difficult to use, but they still have the intention to adopt new technologies.

The design problems related to perceived ease of use and technology characteristics have also proven to be determinants of adoption of e-health laboratory payments although their impacts are not immediate. Task–technology fit, information quality, accessibility, and personal innovativeness also have an indirect impact on e-health laboratory adoption through perceived usefulness. Consequently, e-health laboratory service providers must plan awareness programs regarding the benefits of use, quality information, and ease of access to e-health laboratories so that customers are ready to suggest their relatives to use an e-health laboratory system.

Overall, this research shows that the characteristics of e-health laboratory systems have proven their significant influence on the intention to adopt e-health laboratories for consumers in Indonesia. Finally, Indonesian users will be inclined to pay attention to the perceived benefits they receive and accept risks when adopting technology in an e-health laboratory system.

**Author Contributions:** Conceptualization, D.R., A.N.H., and S.H.; methodology, D.R., S.H., and D.N.; data collection, D.R. and S.H.; analysis, D.R., A.N.H., S.H., and D.N.; resources, D.R. and S.H.; discussion, D.R., A.N.H., S.H., and D.N.; writing—original draft preparation, D.R., A.N.H., S.H., and D.N.; writing—review and editing, D.R., A.N.H., S.H., and D.N. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Data Availability Statement:** Not Applicable, the study does not report any data.

**Acknowledgments:** The authors would like to thank the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia (RISTEKDIKTI) for supporting this research through Post-Doctoral Research. This study is a follow-up funded privately as a continuation of the Post-Doctoral grant research "Health Information Technology on Information System Acquisition and Classification of Single Pap Smear Cell Image for Early Detection of Cervical Cancer".

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

**Table A1.** Respondent Demographic.

Items	Frequency	Percentage
Sex		
Male	72	44.17
Female	91	55.83
Age		
<14	0	-
14–20	5	3.07
21–29	21	12.88
30–35	36	22.09
36–40	17	10.43
41–55	79	48.47
>56	5	3.07
Education		
High school	10	6.13
Diploma	13	7.98
Bachelor	55	33.74
Postgraduate	85	52.15
Student	13	7.98
Profession		
Civil Servants	18	11.04
BUMN Employee	9	5.52
Private Employees	51	31.29
Entrepreneur	16	9.82
Lecturer	20	12.27
Housewife	9	5.52
Others	27	16.56
Location		
Java (Jabodetabek)	71	43.56
Java (Non Jabodetabek)	51	31.29
Sumatera	31	19.02
Borneo	1	0.61
Sulawesi	2	1.23
Bali, NTT, NTB	6	3.68
Irian, Papua	1	0.61
Salary (IDR)		

Table A1. Cont.

Items	Frequency	Percentage
<1,000,000 (USD 68,45)	11	6.75
1,000,001–5,000,000 (USD 68.45–342.24)	50	30.67
5,000,001–10,000,000 (USD 342.25–684.49)	71	43.56
10,000,001–15,000,000 (USD 684.50–1026.73)	17	10.43
15,000,001–20,000,000 (USD 1026.74–1368.98)	3	1.84
>20,000,000 (USD 1368.98)	11	6.75

## Appendix B

### Research Instrument

#### 1. Task Characteristics (TC)

TC1 I need to manage my health information in an online laboratory anytime and anywhere.

TC2 I need to access my health information anytime and anywhere.

TC3 I must have real time control of my health information in online laboratory.

#### 2. Technology Characteristics (TCC)

TCC1 Online laboratories provide health information services that can be accessed anytime and anywhere.

TCC2 Online laboratories provide health information services in real time.

TCC3 Online laboratories provide fast health information services.

TCC4 Online laboratories provide safe health information services.

#### 3. Task Technology Fit (TTF)

TTF1 The online laboratory already has the features that fit my needs in managing my health information.

TTF2 The online laboratory is in accordance with my ways of managing my health information.

TTF3 It is easy for me to understand the features of an online laboratory.

TTF5 The online laboratory is suitable for assisting me in managing my health information.

#### 4. Information Quality (IQ)

IQ1 Online laboratories provide information that fits my needs.

IQ2 Online laboratories provide accurate information.

IQ3 Online laboratories provide up-to-date information.

IQ4 Online laboratories provide complete information.

IQ5 Online laboratories provide clear information in a good format.

#### 5. Accessibility (AC)

AC1 Online laboratories can be accessed anytime and anywhere.

AC2 Online laboratories can be accessed under any conditions.

AC3 Online laboratories can be accessed through various devices (smartphones, laptops, etc.)

#### 6. Design (DE)

DE1 Online laboratories have an attractive appearance.

DE2 Online laboratories have the features and the functions needed.

DE3 Online laboratories have a structured appearance.

#### 7. Personal Innovativeness (PI)

PI1 I will be the first to use a new technology compared to others.

PI2 It is great to be the first to have a new technology.

- PI3 Being the first in using new technology is important for me.
- PI4 I always want to use the latest technology products that are safe.
- 8. Perceived Usefulness (PU)
  - PU1 Online laboratories increase my effectiveness in obtaining my health information.
  - PU2 Online laboratories facilitate me to retrieve my health information.
  - PU3 Online laboratories allow me to retrieve my health information faster.
  - PU4 In general, I can say that the online laboratory is very useful for me.
- 9. Perceived Ease of Use (PE)
  - PE1 Online laboratory is easy to learn.
  - PE2 Online laboratories are easy to use because of the simple way to use.
  - PE3 Online laboratories are easy to navigate.
- 10. Adoption Intention (AI)
  - AI1 I plan to use this online laboratory in the future.
  - AI2 I will recommend an online laboratory to my friends.
  - AI3 I intend to continue using online laboratories in the future.

## References

1. Miniwatts Marketing Group. Internet Usage Statistics: The Internet Big Picture World Internet Users and 2019 Population Stats. 2019. Available online: <https://www.internetworldstats.com/stats.htm> (accessed on 27 July 2019).
2. Miniwatts Marketing Group. Indonesia Inter-Net Usage and Telecommunications Reports. 2019. Available online: <https://www.internetworldstats.com/asia.htm#id> (accessed on 27 July 2019).
3. APJII. Hasil Survei Penetrasi dan Perilaku Pengguna Internet Indonesia 2018. 2018. Available online: <https://www.apjii.or.id/content/read/39/410/Hasil-Survei-Penetrasi-dan-Perilaku-Pengguna-Internet-Indonesia-2018> (accessed on 27 July 2019).
4. WHO. Global Diffusion of eHealth-Making Universal Health Coverage Achievable. 2016. Available online: <https://apps.who.int/iris/bitstream/handle/10665/252529/9789241511780-eng.pdf?sequence=1#page=31> (accessed on 27 July 2019).
5. Evans, R.S. Electronic Health Records: Then, Now and in the Future. *Yearb. Med. Inf.* **2016**, *1*, 48–61. [CrossRef]
6. Henricks, W.H. “Meaningful use” of electronic health records and its relevance to laboratories and pathologists. *J. Pathol. Inform.* **2011**, *2*, 7. [CrossRef]
7. Polityka Insight. Transforming eHealth into a Political and Economic Advantage. 2017. Available online: <https://ec.europa.eu/digital-single-market/en/news/transforming-ehealth-political-and-economic-advantage> (accessed on 27 July 2019).
8. WHO. Directory of eHealth Policies. 2016. Available online: <https://www.who.int/goe/policies/en/> (accessed on 27 July 2019).
9. WHO. Electronic Health Records: Manual for Developing Countries. Manila: WHO Regional Office for the Western Pacific. 2019. Available online: <https://apps.who.int/iris/handle/10665/207504> (accessed on 10 August 2019).
10. McKinsey, Can eHealth Solve China’s Healthcare Challenges. 2019. Available online: <https://www.slideshare.net/fle864/20150402-chic-mc-k-e-health-in-china-vf> (accessed on 27 July 2019).
11. Zayyad, M.A.; Toygan, M. Factors affecting sustainable adoption of e-health technology in developing countries: An exploratory survey of Nigerian hospitals from the perspective of healthcare professionals. *PeerJ* **2018**, e4436. [CrossRef] [PubMed]
12. CPC Central Committee State Council. Healthy China 2030. 2017. Available online: [http://www.gov.cn/xinwen/2016-10/25/content\\_5124174.htm](http://www.gov.cn/xinwen/2016-10/25/content_5124174.htm) (accessed on 27 July 2019) In Chinese.
13. Wong, Y. *The New Chinese e-Health Revolution*; Healthcare Bus. Int.: London, UK, 2018.
14. WHO. Innovation to Implementation e-Health in the WHO European Region. 2016. Available online: [http://www.euro.who.int/data/assets/pdf\\_file/0012/302331/FromInnovation-to-Implementation-eHealth-Report-EU.pdf](http://www.euro.who.int/data/assets/pdf_file/0012/302331/FromInnovation-to-Implementation-eHealth-Report-EU.pdf) (accessed on 27 July 2019).
15. Kutia, S.; Chauhdary, S.H.; Iwendi, C.; Member, S.; Liu, L.I.N.; Yong, W.; Bashir, A.L.I.K.; Member, S. Socio-Technological Factors Affecting User’s Adoption of eHealth Functionalities: A Case Study of China and Ukraine eHealth Systems. *IEEE Access* **2019**, *7*, 90777–90788. [CrossRef]
16. PesanLab.com, Pesan Tes Lab Online dari Laboratorium Klinik Pilihan Anda. 2017. Available online: <https://pesanlab.com/> (accessed on 10 August 2019).
17. WHO, Primary Health Care: Now More Than Ever. 2019. Available online: <https://www.who.int/whr/2008/en/> (accessed on 10 August 2019).
18. Mater, W.; Aldwairi, M.; Ibrahim, R. Enhanced Teamwork Communication Model for Electronic Clinical Pathways in Healthcare. *Open Bioinform. J.* **2018**, *11*, 140–163. [CrossRef]
19. Rodrigues, J.J.; Compte, S.S.; De la Torre Diez, I. *e-Health Systems: Theory and Technical Applications*; ISTE Press Ltd.: London, UK, 2016.
20. Heart, T.; Ben-assuli, O.; Shabtai, I. A review of PHR, EMR and EHR integration: A more personalized healthcare and public health policy. *Health Policy Technol.* **2017**, *6*, 20–25. [CrossRef]



21. Diana, A.L.Y.; Hollingworth, S.A.; Marks, G.C. Quality of physical resources of health facilities in Indonesia: A panel study 1993–2007. *Int. J. Qual. Health Care* **2013**, *25*, 488–496. [\[CrossRef\]](#)
22. Wahyuni, R. Explaining acceptance of e-health services: An extension of TAM and Health Belief Model Approach. In Proceedings of the 5th International Conference on Information Technology for Cyber and IT Service Management (CITSM 2017), Kota Denpasar, Indonesia, 8–10 August 2017.
23. Tan, P.J.B.; Hsu, M.-H.; Wahl, J.H. Teaching the Right Things and Teaching the Things Right: Professional Development for Mariners. *Educ. Innov. Appl.* **2019**, *1*, 535–538.
24. Juinn Bing Tan, P.; Hsu, M.-H. Interactive Instructional Device. *Children* **2019**, *3*, 95–98.
25. Tan, P.J.B.; Hsu, M.H. Designing a system for English evaluation and teaching devices: A PZB and TAM model analysis. *Eurasia J. Math. Sci. Technol. Educ.* **2018**, *14*, 2107–2119. [\[CrossRef\]](#)
26. Tan, P.J.B. An empirical study of how the learning attitudes of college students toward English E-Tutoring websites affect site sustainability. *Sustainability* **2019**, *11*, 1748. [\[CrossRef\]](#)
27. Tan, P.J.B. English e-learning in the virtual classroom and the factors that influence ESL (English as a Second Language): Taiwanese citizens' acceptance and use of the Modular Object-Oriented Dynamic Learning Environment. *Soc. Sci. Inf.* **2015**, *54*, 211–228. [\[CrossRef\]](#)
28. Ardian, M.; Chalidyanto, D. Implementation E-Health System on Use Behavior Customer based on Unified Theory of Acceptance and Use of Technology (Utaut). *Indian J. Public Health Res. Dev.* **2018**, *9*, 245–250.
29. Tan, P.J.B. Applying the UTAUT to understand factors affecting the use of english e-learning websites in Taiwan. *SAGE Open* **2013**, *3*. [\[CrossRef\]](#)
30. Pinem, A.A.; Sandhyaduhita, P.; Hidayanto, A.N. Barriers for Integration between Hospitals and the Ministry of Health in Indonesia. In Proceedings of the MakeLearn and TIIM Joint International Conference, Bari, Italy, 27–29 May 2015.
31. Wahyuni, T.; Parasetorini, A.; Rekam, P.; Kesehatan, I.; Administrasi, P.; Sakit, R. Metode Hot Fit untuk Mengukur Tingkat Kesiapan SIM RS dalam Mendukung Implementasi E-Health. *J. Manaj. Inf. Kesehat. Indones.* **2019**, *7*, 71–75.
32. Sandhyaduhita, P.; Science, C.; Indonesia, U. Hospital Service Quality from Patients Perspective: A Case of Indonesia. *Int. J. E-Health Med. Commun. (IJEHMC)* **2016**, *7*, 48–61. [\[CrossRef\]](#)
33. Restivo, M.T.; Cardoso, A. Exploring online experimentation. *Int. J. Online Eng.* **2013**, *9*, 4–6. [\[CrossRef\]](#)
34. Sell, R. Remote laboratory portal for robotic and embedded system experiments. *Int. J. Online Eng.* **2013**, *9*, 23–26. [\[CrossRef\]](#)
35. Titov, I.; Titov, E. Labicom.net—Putting your laboratory online in less than five minutes with WebPager tool: Automatic generation and real-time control of a LabVIEW based laboratory server from pluginless HTML page. In Proceedings of the 2nd Experiment International Conference, Coimbra, Portugal, 18–20 September 2013; pp. 180–183.
36. Restivo, M.T.; Da Silva, M.G. Portuguese Universities Sharing Remote Laboratories. *Int. J. Online Eng.* **2009**, *5*, 16–19. [\[CrossRef\]](#)
37. Lei, Z.; Hu, W.; Deng, Q.; Liu, Z.-W. HTML5-Based 3-D Online Control Laboratory With Virtual Interactive Wiring Practice. *IEEE Trans. Ind. Inform.* **2018**, *14*, 2473–2483. [\[CrossRef\]](#)
38. Veteran, L.P. Home: Layanan Laboratorium Patologi Veteran. 2019. Available online: <http://lab.dwiza.web.id/> (accessed on 10 August 2019).
39. Cayalab.co.id. Home: Caya Laboratorium Klinik. 2019. Available online: <http://cayalab.co.id/> (accessed on 10 August 2020).
40. WHO, Medical Records Manual: A Guide for Developing Countries. 2019. Available online: <https://apps.who.int/iris/handle/10665/208125> (accessed on 10 August 2019).
41. Goldfarb, N.I. Assessing Quality of Primary Care through Medical Record Review: Lessons and Opportunities. 2019. Available online: <http://jdc.jefferson.edu/cgi/viewcontent.cgi?article=1145&context=hpn> (accessed on 10 August 2019).
42. Afrizal, S.H.; Hidayanto, A.N.; Handayani, P.W.; Budiharsana, M.; Eryando, T. Narrative review for exploring barriers to readiness of electronic health record implementation in primary health care. *Healthc. Inform. Res.* **2019**, *25*, 141–152. [\[CrossRef\]](#) [\[PubMed\]](#)
43. Goodhue, D.L.; Thompson, R.L.; Goodhue, B.D.L.; Thompson, R.L. Task-Technology Fit and Individual Performance. *JSTOR* **2014**, *19*, 213–236. [\[CrossRef\]](#)
44. Lin, T.; Huang, C. Understanding knowledge management system usage antecedents: An integration of social cognitive theory and task technology fit. *Inf. Manag.* **2008**, *45*, 410–417. [\[CrossRef\]](#)
45. Lin, W. Perceived fit and satisfaction on web learning performance: IS continuance intention and task-technology fit perspectives. *J. Hum. Comput. Stud.* **2012**, *70*, 498–507. [\[CrossRef\]](#)
46. Yen, D.C.; Wu, C.; Cheng, F.; Huang, Y. Computers in Human Behavior Determinants of users' intention to adopt wireless technology: An empirical study by integrating TTF with TAM. *Comput. Hum. Behav.* **2010**, *26*, 906–915. [\[CrossRef\]](#)
47. Taylor, P.; Kuo, R.; Lee, G. Technology Knowledge management system adoption: Exploring the effects of empowering leadership, task-technology fit and compatibility. *Behav. Inf.* **2011**, 37–41.
48. D'Ambra, J.; Wilson, C.S.; Akter, S. Application of the task-technology fit model to structure and evaluate the adoption of E-books by academics. *J. Am. Soc. Inf. Sci. Technol.* **2013**, *64*, 48–64. [\[CrossRef\]](#)
49. Larsen, T.J.; Sørenbø, A.M.; Sørenbø, Ø. Computers in Human Behavior The role of task-technology fit as users' motivation to continue information system use. *Comput. Hum. Behav.* **2009**, *25*, 778–784. [\[CrossRef\]](#)
50. McGill, T.J.; Klobas, J.E. A task—Technology fit view of learning management system impact. *Comput. Educ.* **2009**, *52*, 496–508. [\[CrossRef\]](#)

51. Zhou, T.; Lu, Y.; Wang, B. Computers in Human Behavior Integrating TTF and UTAUT to explain mobile banking user adoption. *Comput. Hum. Behav.* **2010**, *26*, 760–767. [\[CrossRef\]](#)
52. Huang, T.C.; Wu, I.; Chou, C. Investigating use continuance of data mining tools. *Int. J. Inf. Manag.* **2013**, *33*, 791–801. [\[CrossRef\]](#)
53. Shannon, C.E.; Weaver, W. *A Mathematical Model of Communication*; University of Illinois Press: Chicago, IL, USA, 1949.
54. Masen, R.O. Measuring Information Output: A Communication System Approach. *Inf. Manag.* **1978**, *1*, 219–234. [\[CrossRef\]](#)
55. Pitt, L.F.; Watson, R.T.; Kavan, C.B. Service quality: A measure of information systems effectiveness. *MIS Q. Manag. Inf. Syst.* **1995**, *19*, 173–185. [\[CrossRef\]](#)
56. Petter, S.; Delone, W.; Mclean, E.R. Information Systems Success: The Quest for the Independent Variables. *J. Manag. Inf.* **2013**, *29*, 37–41. [\[CrossRef\]](#)
57. Dinev, T.; Albano, V.; Xu, H.; D’Atri, A.; Hart, P. Individuals’ Attitudes towards Electronic Health Records: A Privacy Calculus Perspective. In *Advances in Healthcare Informatics and Analytics*; Springer: Cham, Switzerland, 2016; ISBN 9783319232942.
58. Delone, W.H.; McLean, E.R. *Information Systems Success Measurement*; Foundations and Trends® in Information Systems 2.1: Auburn, AL, USA, 2016; ISBN 9781680831429.
59. Schaupp, L.C.; Fan, W.; Belanger, F. Determining Success for Different Website Goals. In Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS’06), Kauai, HI, USA, 4–7 January 2006.
60. Velasquez, N.F. Studying Knowledge Management System Success in System Administration. In Proceedings of the 42nd Hawaii International Conference on System Sciences, Big Island, HI, USA, 5–8 January 2009.
61. Cheok, M.L. Predictors of E-Learning Satisfaction in Teaching and Learning for School Teachers: A Literature Review. *Int. J. Instr.* **2015**, *8*, 75–90. [\[CrossRef\]](#)
62. Lin, H. Measuring Online Learning Systems Success: Applying the Updated DeLone and McLean Model. *CyberPsychol. Behav.* **2007**, *10*, 817–821. [\[CrossRef\]](#)
63. Urbach, N.; Smolnik, S.; Riempp, G. An empirical investigation of employee portal success. *J. Strateg. Inf. Syst.* **2010**, *19*, 184–206. [\[CrossRef\]](#)
64. Tsai, W.; Lee, P.; Shen, Y.; Lin, H. A comprehensive study of the relationship between enterprise resource planning selection criteria and enterprise resource planning system success. *Inf. Manag.* **2012**, *49*, 36–46. [\[CrossRef\]](#)
65. Maillet, É.; Mathieu, L.; Sicotte, C. Modeling factors explaining the acceptance, actual use and satisfaction of nurses using an Electronic Patient Record in acute care settings: An extension of the UTAUT. *Int. J. Med. Inform.* **2014**, 1–12. [\[CrossRef\]](#)
66. Hsu, M.; Chang, C.; Chu, K.; Lee, Y. Computers in Human Behavior Determinants of repurchase intention in online group-buying: The perspectives of DeLone & McLean IS success model and trust. *Comput. Hum. Behav.* **2014**, *36*, 234–245.
67. Zhou, T. An empirical examination of continuance intention of mobile payment service. *Decis. Support System.* **2013**, *54*, 1085–1091. [\[CrossRef\]](#)
68. Bossen, C.; Groth, L.; Witt, F. Evaluation of a comprehensive EHR based on the DeLone and McLean model for IS success: Approach, results and success factors. *Int. J. Med. Inform.* **2013**, *82*, 940–953. [\[CrossRef\]](#) [\[PubMed\]](#)
69. Ling, L.M.; Moi, C.M. Professional Students’ Technology Readiness, Prior Computing Experience and Acceptance of an E-Learning System. *Malays. Acc. Rev.* **2007**, *6*, 85–99.
70. Al-busaidi, K.A. Learners’ Perspective on Critical Factors to LMS Success in Blended Learning: An Empirical Investigation. *Commun. Assoc. Inf. Syst.* **2012**, *30*, 10–35. [\[CrossRef\]](#)
71. Wu, I.; Li, J.; Fu, C. The adoption of mobile healthcare by hospital’s professionals: An integrative perspective. *Decis. Support Syst.* **2011**, *51*, 587–596. [\[CrossRef\]](#)
72. Agarwal, R.; Prasad, J. The antecedents and consequents of user perceptions in information technology adoption. *Decis. Support Syst.* **1998**, *22*, 15–29. [\[CrossRef\]](#)
73. Karahanna, E.; Straub, D.W.; Chervany, N.L. Information technology adoption across time: A cross-sectional comparison of pre-adoption and post-adoption beliefs. *MIS Q. Manag. Inf. Syst.* **1999**, *23*, 183–213. [\[CrossRef\]](#)
74. Legris, P.; Ingham, J.; Collette, P. Why do people use information technology? A critical review of the technology acceptance model. *Inf. Manag.* **2003**, *40*, 191–204. [\[CrossRef\]](#)
75. Tam, C.; Oliveira, T. Understanding the impact of m-banking on individual performance: DeLone & McLean and TTF perspective. *Comput. Hum. Behav.* **2016**, *61*, 233–244.
76. Alqatan, S.; Noor, N.M.M.; Man, M.; Mohamad, R. A theoretical discussion of factors affecting the acceptance of m-commerce among SMTEs by integrating TTF with TAM. *Int. J. Bus. Inf. Syst.* **2017**, *26*, 66–111. [\[CrossRef\]](#)
77. Chang, S. The Literature Review of Technology Acceptance Model: A Study of the Bibliometric Distributions. In Proceedings of the Taipei Pacific Asia Conference on Information System, Taipei, Taiwan, 9–12 July 2010.
78. Lin, W.; Wang, C.; Lin, W.; Wang, C. Antecedences to continued intentions of adopting e-learning system in blended learning instruction: A contingency framework based on models of information system success and task-technology fit. *Comput. Educ.* **2018**, *58*, 88–99. [\[CrossRef\]](#)
79. Kim, T.T.; Lee, G. Modelling roles of task-technology fit and self-efficacy in hotel employees’ usage behaviours of hotel information systems. *Int. J. Tour. Res.* **2010**, *12*, 709–725. [\[CrossRef\]](#)
80. Yu, T.; Yu, T. Modelling the factors that affect individuals’ utilisation of online learning systems: An empirical study combining the task technology fit model with the theory of planned behaviour. *Br. J. Educ. Technol.* **2010**, *41*, 1003–1017. [\[CrossRef\]](#)

81. Lu, H.; Yang, Y. Computers in Human Behavior Toward an understanding of the behavioral intention to use a social networking site: An extension of task-technology fit to social-technology fit. *Comput. Hum. Behav.* **2014**, *34*, 323–332. [\[CrossRef\]](#)
82. Gorla, N.; Somers, T.M.; Wong, B. Organizational impact of system quality, information quality, and service quality. *J. Strateg. Inf. Syst.* **2010**, *19*, 207–228. [\[CrossRef\]](#)
83. Bailey, J.E.; Pearson, S.W. Development of A Tool For Measuring and Analyzing Computer User Satisfaction. *Manag. Sci.* **1963**, *29*, 530–545.
84. Seddon, P.B. A Respectification and Extension of the Delone and McLean Model of IS Success. *Inf. Syst. Res.* **1997**, *8*, 240–253. [\[CrossRef\]](#)
85. Carlos, J.; Chiu, C.; Jose, F. Understanding e-learning continuance intention: An extension of the Technology Acceptance Model. *Int. J. Hum.-Comput. Stud.* **2006**, *64*, 683–696.
86. Lwoga, E. Critical success factors for adoption of web-based learning management systems in Tanzania. *Int. J. Educ. Dev. Using Inf. Commun. Technol.* **2014**, *10*, 4–21.
87. Cheng, Y. Effects of quality antecedents on e-learning acceptance. *Internet Res.* **2012**, *22*, 361–390. [\[CrossRef\]](#)
88. Ahn, T.; Ryu, S.; Han, I. The impact of Web quality and playfulness on user acceptance of online retailing. *Inf. Manag.* **2007**, *44*, 263–275. [\[CrossRef\]](#)
89. Chen, H. Computers & Education Linking employees' e-learning system use to their overall job outcomes: An empirical study based on the IS success model. *Comput. Educ.* **2010**, *55*, 1628–1639.
90. Ghazal, S.; Al-samarraie, H.; Aldowah, H. "I am Still Learning": Modeling LMS Critical Success Factors for Promoting Students' Experience and Satisfaction in a Blended Learning Environment. *IEEE Access* **2018**, *6*, 77179–77201. [\[CrossRef\]](#)
91. Tantipongnant, P.; Laksitamas, P. An Analysis of the Technology Acceptance Model in Understanding Students' Behavioral Intention to Use University's Social Media. In Proceedings of the 2014 IIAI 3rd International Conference on Advanced Applied Informatics, Kitakyushu, Japan, 31 August–4 September 2014; ISBN 9781479941735.
92. Masrom, M.; Zainon, O.; Rahiman, R. Critical Success in E-learning: An Examination of Technological and Institutional Support Factors. *Int. J. Cyber Soc. Educ.* **2008**, *1*, 131–142.
93. Poon, W.; Low, K.L.; Yong, D.G. A study of Web-based learning (WBL) environment in Malaysia. *Int. J. Educ. Manag.* **2004**, *18*, 374–385. [\[CrossRef\]](#)
94. Park, S.Y.; Nam, M.; Cha, S. University students' behavioral intention to use mobile learning: Evaluating the technology acceptance model. *Br. J. Educ. Technol.* **2011**, *43*, 592–605. [\[CrossRef\]](#)
95. Lee, Y.; Hsiao, C.; Purnomo, S.H. An empirical examination of individual and system characteristics on enhancing e-learning acceptance. *Australas. J. Educ. Technol.* **2014**, *30*, 562–579. [\[CrossRef\]](#)
96. Taylor, P.; Wu, B.; Zhang, C. Empirical study on continuance intentions towards E- Learning 2.0 systems. *Behav. Inf. Technol.* **2014**, *33*, 37–41.
97. DeLone, W.; McLean, E. The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. *J. Manag. Inf. Syst.* **2003**, *19*, 9–30.
98. Allen, M.; Currie, L.M.; Bakken, S.; Patel, V.L.; Cimino, J.J. Heuristic evaluation of paper-based Web pages: A simplified inspection usability methodology. *J. Biomed. Inform.* **2006**, *39*, 412–423. [\[CrossRef\]](#)
99. Rivero, L.; Kalinowski, M. Practical Findings from Applying Innovative Design Usability Evaluation Technologies for Mockups of Web Applications. In Proceedings of the 2014 47th Hawaii International Conference on System Science Practical, Waikoloa, HI, USA, 6–9 January 2014; pp. 3054–3063.
100. Liu, I.; Chang, M.; Sun, Y.S.; Wible, D.; Kuo, C. Extending the TAM model to explore the factors that affect Intention to Use an Online Learning Community. *Comput. Educ.* **2010**, *54*, 600–610. [\[CrossRef\]](#)
101. Hsiao, K.; Chen, C. What drives smartwatch purchase intention? Perspectives from hardware, software, design and value. *Telemat. Inform.* **2018**, *35*, 103–113. [\[CrossRef\]](#)
102. Wu, W.; Shang, D. Employee Usage Intention of Ubiquitous Learning Technology: An Integrative View of User Perception Regarding Interactivity, Software and Hardware. *IEEE Access* **2019**, *7*, 34170–34178. [\[CrossRef\]](#)
103. Klaus, P.; Maklan, S. Towards a Better Measure of Customer Experience. *Int. J. Mark. Res.* **2013**, *55*, 227–246. [\[CrossRef\]](#)
104. Visinescu, L.L.; Sidorova, A.; Jones, M.C.; Prybutok, V.R. The influence of website dimensionality on customer experiences, perceptions and behavioral intentions: An exploration of 2D vs. 3D web design. *Inf. Manag.* **2015**, *52*, 1–17. [\[CrossRef\]](#)
105. Li, H.; Wu, J.; Gao, Y.; Shi, Y. Examining individuals' adoption of healthcare wearable devices: An empirical study from privacy calculus perspective. *Int. J. Med. Inform.* **2020**, *88*, 8–17. [\[CrossRef\]](#)
106. Taylor, P.; Kwon, O.; Choi, K.; Kim, M. User acceptance of context-aware services: Self-efficacy, user innovativeness and perceived sensitivity on contextual pressure. *Behav. Inf. Technol.* **2008**, *26*, 37–41.
107. Davis, F.D.; Davis, F. Perceived Usefulness, Perceived Ease of Use and User Acceptance of Information Technology. *MIS Q.* **1989**, *6*, 319–340. [\[CrossRef\]](#)
108. Chandra, S. Evaluating the Role of Trust in Consumer Adoption of Mobile Payment Systems: An Empirical Analysis. *Commun. Assoc. Inf. Syst.* **2010**, *27*, 561–588. [\[CrossRef\]](#)
109. Malhotra, N.K. *Marketing Research: An Applied Orientation*; Pearson Education: Delhi, India, 2006; pp. 2010–2014.
110. Likert, R. A technique for the measurement of attitudes. *Arch. Psychol.* **1932**, *22*, 1–54.
111. Hinkin, T.R. A Review of Scale Development Practices in the Study of Organizations. *J. Manag.* **1995**, *21*, 967–988. [\[CrossRef\]](#)

- 
112. Stone, E. *Research Methods in Organizational Behavior*; Scott Foresman: Northbrook, IL, USA, 1978.
  113. Hair, J.F.; Ringle, C.M.; Sarstedt, M. Partial Least Squares Structural Equation Modeling: Rigorous Applications, Better Results and Higher Acceptance. *Long Range Plann.* **2013**, *46*, 1–12. [[CrossRef](#)]
  114. Hair, J.F.; Risher, J.J.; Sarstedt, M.; Ringle, C.M. When to use and how to report the results of PLS-SEM. *Eur. Bus. Rev.* **2019**, *31*, 2–24. [[CrossRef](#)]
  115. Diamantopoulos, A.; Siguaw, J.A. Formative Versus Reflective Indicators in Organizational Measure Development: A Comparison and Empirical Illustration. *Br. J. Manag.* **2006**, *17*, 263–282. [[CrossRef](#)]
  116. Hair, J.F.; Black, W.C.; Babin, B.J.; Anderson, R.E.; Tatham, R.L. *Multivariate Data Analysis: A Global Perspective*, 7th ed.; Pearson Education Inc.: Hoboken, NJ, USA, 2010.
  117. Chin, W.W. Issues and opinion on structural equation modeling. *MIS Q. Manag. Inf. Syst.* **1998**, *22*, 7–16.
  118. Dishaw, M.T.; Strong, D.M. Extending the technology acceptance model with task technology fit constructs. *Inf. Manag.* **1999**, *36*, 9–21. [[CrossRef](#)]