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SYS-22-073 successfully submitted

1 message

Clifford Whitcomb <onbehalfof@manuscriptcentral.com> Wed, May 11, 2022 at 5:11 PM
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11-May-2022

Dear Mrs. haryanti,

Your manuscript entitled "The Design Science Research Methodology for Self Assessing Digital Transformation Maturity Index in Developing Countries" has been successfully submitted online and is presently being given full consideration for publication in Systems Engineering.

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2. First Feedback 16 Januari 2023

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SYS-22-073 - Decision on Manuscript

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16-Jan-2023

Dear Mrs. haryanti,

Manuscript ID SYS-22-073 entitled "The Design Science Research Methodology for Self Assessing Digital Transformation Maturity Index in Developing Countries" which you submitted to Systems Engineering has been reviewed.

The referees, of whom the comments are included at the bottom of this letter, bring up a significant number of issues that you will need to address in a revised version of your manuscript. A revised version of your manuscript that takes into account the comments of the referee(s) will be reconsidered for publication.

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Once again, thank you for submitting your manuscript to Systems Engineering and I look forward to receiving your revision.

Sincerely,

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Referee(s)' Comments to Author:

Reviewing: 1

Comments to the Author
To begin the cleanup process, let us proceed with the definition of a word that occurs frequently in the paper artifact. First, this word is spelled differently in the UK and the US. The authors need to decide which spelling they favor. Secondly, the esteemed Professor Hitchins, author of the book Systems Engineering A 21st Century Methodology defines this word to describe a cluster of objects that does not include humans. This paper cites system as an example of an artifact. Since systems often contain humans, the Hitchins definition would not apply, The authors need to decide whether system should be deleted from the list of examples or whether artifact should apply to any cluster of objects. Apart from the minor typographical errors cited above, this paper is well written and organized.

Reviewing: 2

Comments to the Author
This paper describes the application of a design science research methodology to development of a self-assessment tool for digital transformation. Though, I am unclear as to whether the intent of the paper is to describe a research methodology for general use of which the digital maturity index is an example or if the intent of the paper is to present a digital maturity index and the design science research method is the approach to develop the index. If it intent is the former, the authors never explain what the research gap is and how the methodology proposed addresses that gap. If the intent is the latter, then neither the digital maturity index nor the research results that validate the index are ever presented.

There is mention of a trial with ten users on page 17, but the results of this trial are never presented or discussed. Similarly, on page 18 there is mention of a questionnaire, but the results of the questionnaire are never described. If research was conducted on the efficacy of the digital transformation maturity index then 1. The authors need to describe the proposed index, 2. describe how it was developed, and 3. present the results of any assessments to determine the validity of the index. As it stands this paper is not really a research paper.

Reviewing: 3

Comments to the Author
On page 2 line 20 DX is used. I notice that DS was used prior to that. Should this be DS? I did not see another item discussing DS after line 20.

Tining Haryanti INA <tining.haryanti@gmail.com> Wed, Jan 18, 2023 at 11:31 AM
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[Quoted text hidden]

3. Review Round 1 19 Maret 2023

Measuring the digital transformation maturity level independently with the Design design Science science Research research ~~Methodology~~methodology

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Abstract

This study uses the Design Science Research Methodology (DSRM) approach in creating an artifact on the perspective of the Information System. Design Science as a valuable tool for creating a new artifact or developing an existing artifact through research. The DSRM Framework described in this study discusses the implementation of each stage, namely, Explicated Problem, Define Requirement, Design

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and Development, Demonstration, and Evaluation and is complemented by the implementation of case studies of artifact creation in DSRM stages. The Digital Maturity Measurement in question is a service to measure digital maturity in various dimensions. Each DSRM stage is mapped to a case study of that service.

Canvas visualization is presented to describe a complete picture of how the artifacts of Digital maturity services are built with the DSRM approach. This research also provides guidance on the principles, procedures, and characteristics needed to build effective research.

KEYWORDS

~~,~~design science research methodology, digital maturity, digital maturity index, digital transformation

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1 INTRODUCTION

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Design Science Research Methodology (DSRM) is a form of method that focuses on developing artifacts. According to Peffers, DSRM has stages that must be met to achieve effective research quality, namely Explicated Problems, Design and Requirement, Development, and Evaluation. The relationship between stages in this method is iterative.[60]. Researchers can use DSRM through any stage, such as development focus, or design, not always at first. The form of artifacts can be in the form of algorithms, applications, methods, or software. Previous researchers, March and Smith, and Walls used this method approach in focusing on building physical information systems.[79]. Various studies with DSRM have been present, but the literature that explicitly discusses each stage and its implementation is limited. Meanwhile, the comprehensive application of DSRM is needed as a form of guidance on the principles, objectives, and procedures needed to build effective research. This research presents each stage of DSRM in building artifacts from an information system perspective in the form of a digital maturity measurement service system.[60,59,50,54,80,8,68,74,58,82,28,22,66,72,2,16,37,50,54,80,79,76,75]

The artifact in the form of a digital maturity assessment service information system in this research is an application system built on web-based software. The creation process of the artifact uses the DRSM approach. According to McLeod,[51; ,52], an information system is a system that has the ability to collect information from all sources, process and use various media and methods to display information. Following McLeod's approach to information systems, the information system as an artifact in this research collects and processes information about an organization based on digital transformation achievement criteria and presents rankings or levels of digital maturity achievement within that organization. This information system receives organizational data input from users who directly interact with the system interface.[24].

In his book "Systems Engineering: A 21st Century Methodology," Prof. Hitchins, in the section "Human—part of the system, or user of the artifact?" explains that the user or human is outside the authority of the artifact, except for the necessary interface between humans and machines.[38]. The role of humans in this artifact is as users who interact with the interface of the digital transformation measurement system. Meanwhile, the measurement of digital transformation maturity is the responsibility of the artifact itself based on predetermined formulas and calculations within the system.

Several previous studies that support this research in understanding the creation of artifacts in the form of information systems using the Design Science Research approach include Offerman et al., 2010[55], in his work "Artifact Types in Information Systems Design Science—A Literature Review," Peffers et al., 2007[60], in his work titled "A Design Science Research Methodology for Information Systems Research," and

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Hevner et al., 2004[37], in his work “Design Science in Information Systems Research”.

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The case study used in this study is the construction of an artifact of measuring digital maturity independently. The limitations of the digital maturity measurement device independently form the basis for the selection of this case study. Existing Digital Maturity Measurements are limited and require a third party to access them. Meanwhile, organizations are faced with the demand to be able to make continuous improvements in adapting to technology over time.[73]. Monitoring and measuring the success of DX demonstrated through digital maturity levels at all times is necessary. The slow response and adaptation of existing technologies, allows the organization to be unable to compete and not survive.[23] The presence of technology allows the opening of new opportunities in the industry.[25].

DX in the measurement of digital skills is not always about technology.[33]. Economic problems, device investment costs, internet[65,13,3,12,17] access that is not cheap,, low awareness of the use and[7,81,39,41,44,1,56] understanding of technology, and integration[5,42,13] of technology are problems[65,53,17,49] that are not can be overlooked at the success of DX. Another problem is the limitation of Language literacy, since technology in general uses English, and cultural barriers such as social stratification play a role in gaining access to information.[44,43,6,56,21] Another digital divide is influenced by those who access and those who do not (access) the digital realm.[63,64] Technology readiness is one of the factors supporting the readiness of DX. Measurement of technological readiness in Indonesia is known as INDI 4.0 or Indonesia Industry 4.0 Readiness Index. This model measures industrial readiness in welcoming the industrial revolution 4.0. (Ministry of Industry of the Republic of Indonesia, 2018) Various measurements of digital maturity that exist have various dimensions, such as focus on evaluation, digital penetration in internal processes, customer focus, and strategy.[18]. The multidimensional adoption of the digital maturity model is necessary to get a complete picture of the success of DX.[14,15]. This study presents multidimensional digital maturity measurement[33] with the focus of the discussion being the construction of artifacts in the form of measurement services. Multidimensional is referred to as an extended form of digital maturity model.[34]. Previous research has been carried out to formulate dimensions related to the measurement of digital maturity.[34].

This paper is focus on the application of each stage of DSRM in building artifacts. Therefore, the development of artifacts in the form of digital maturity measurement application tools is presented sequentially according to stages based on the DSRM. While

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Employees, Customers, Business Processes, and Culture. In detail, the focus of discussion on the use of digital maturity measurement indices was discussed by the author in previous works, namely "The Design Science Research Methodology (DSRM) for Self-Assessing Digital Transformation Maturity Index in Indonesia"[33] and "The Extended Digital Maturity Model".[33,34]

The paper is arranged in several parts. The background of the problem and the focus of the research are explained in the first chapter. The next section describes a review of libraries related to DSRM and Digital Transformation. The third chapter connects the method and its implementation in a case study of the artifact development of digital measurement. The last chapter contains discussions and conclusions.

2 BIBLIOGRAPHY REVIEW

2.1 Design Science science Research research Methodologymethodology ~~(DSRM)~~

In general, design science is a scientific study that specifically discusses the creation of artifacts to solve practical problems that are in the public interest. DSRM~~Design Science Research Methodology~~ as one of the methods used as an approach to design science in designing new services, such as making artifacts. Meanwhile, artifacts are the result of human work as a form of solution to practical problems. The embodiment of artifacts according to Gregor & Hevner is divided into four types, namely construction, model, method and instantiation. An important characteristic inherent in artifacts is Purpose and novelty.[40,46,32,; 37]. This character means that artifacts must be able to solve significant problems (goals) by means of innovative money (novelty). Artifacts in the form of construction include the provision of vocabulary and symbols used to define and understand problems and solutions. Artifacts in the form of models include representations of possible problems and solutions, mathematical models, diagram models, and logic models). Artifacts as methods include: algorithms, practices, and protocols for performing task.

Meanwhile, artifacts in the form of instantiation include: physical systems that are working, such as medical devices or information systems that store, retrieve, and analyze electronic medical record data.

DSRM has five main activities including: Explicated Problem, Define Requirement, Design and Development, Demonstrate Artifact and evaluate artifact,[47] ~~figure 1~~Figure 1.

The explicated problem stage explains the problem and analyzes the practical problem. The challenge at this stage is to find the

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output of this stage is the identification of the root of the problem and the analysis of the problem.

The next stage is Define Requirement, this stage uses inputs from the output of the previous stage (Explicated Problem). The root of the problem has been identified and analyzed at the first stage. The define requirement activity outlines solutions in the form

of artifacts for solving the root of the problem that has been identified in the previous stage. Various requirements for making artifacts as a solution to the root of the problem are clearly described. Define requirement classifies artifact creation requirements in two categories, namely functionality requirements and required structure and environment requirements.[30,; 47,11]

The requirements for creating artifacts that have been identified at the Define Requirement stage, then become inputs for the Design and Development artifact stage. Artifacts are designed and developed by accommodating the functionality and structure requirements of artifacts. The artifacts that have been built will be demonstrated. This activity is called a 'proof of concept,' which explains the use of artifacts to users with the aim of proving the feasibility of artifacts in problem-solving for the public. All stages on the DSRM are interconnected as inputs and outputs. These five stages are iterative, not necessarily sequential.

2.2 Digital Maturity maturity Index index self-assessment

Digital Transformation provides both opportunities and challenges for organizations. The adoption of digital transformation good practices is accelerating the business process revolution, model, and practicality of business. Transforming the digital landscape is a requirement for partners, employees, and customers to jointly realize digital transformation. Digital Transformation represents an organization's strategy to survive in the technological era. Various studies formulate a digital transformation framework that covers four areas: digitization of customer experience, operations, products and services, and organizations. The DX framework is a continuous cycle of growth, refinement, and change supported by the essential pillars of cultural change, skills building, executive leadership, and redesign (Bottle, 2019)[67,9,18] of business models, strategic objectives, and roadmaps.

Business models are used by companies to deploy new technologies and ideas (Johnson, 2012).[15] Digital maturity is defined as the position of digital transformation of an organization. Digital maturity is meant how the organization builds a transformation strategy and what steps the organization takes for that transformation.

There are various ways of measuring digital maturity, for example it is measured through the revenue generated with respect to digital offerings in products and services.[14,; 73]. These measurements describe part of the DX aspect. Meanwhile, DX requires a multidimensional view. Comprehensive methods in determining digital strategy, IT development, digital capabilities, transparency, collaboration and agility, are needed in dealing with DX.[26]. Factors driving of DX include: increasing technology penetration and adoption, competition intensity, and changes in consumer behavior.[18,; 77]. The various digital maturity models

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that have existed in previous studies are presented in the following table:

As an effort to achieve Digital Transformation, various problems related to digital transformation must be addressed. Various digital transformation problems[18; ;36] include skills gaps, strategic changes, the integration of new technologies and the challenges of short-term outlook. The Digital Divide is divided in terms of access, skills, and outcomes. Digital problems between developed and developing countries are different due to several factors that affect digital harmony, namely income, education, welfare

(socio-economic) and culture.[45]

The focus of this research is on implementing DSRM in building artifacts in the form of digital maturity measurement services independently. Independent measurement of digital maturity is very limited. In general, digital measurements cannot be accessed for free and require third-party assistance. Comparative analysis of various digital maturity models is required as part of the

3 METHOD

3.1 Stages of research implementation

DSRM was used as a method in this study. Each stage of DSRM is equipped with details of its application to artifact creation. Although each stage on the DSRM can be iterative or non-sequential, this study presents the stages[60] by stages of the DSRM in sequence. It is intended to facilitate the understanding of the artifact creation flow. All stages of DSRM are presented in this study, namely Explicated Problem-Define Requirements-Design and ~~Develop~~Developments-Demonstrate Artifact-Evaluation. The DSRM stages are generally shown in Figure 2.[33,46]

3.2 Research activities based on the DSRM framework

Problem identification is the initial stage of DSRM in general. In this study, the need for tools to monitor the achievement of DX in organizations is the root of the problems discussed. Strategic are used to identify problems through the study of literature.

implementation sector is limited to several sectors that support the implementation of DX, namely, banking, health, education, manufacturing and government. At the define requirement stage, the study of application development literature is generally used such as the use of the theory of technological acceptance.[20,35] . In addition, interviews of industry players who are in direct

contact with digital transformation are needed to reveal what digital achievement monitoring needs are needed. Comparison of existing digital maturity measurements is used[34] to improve the use of dimensions and indicators in this digital maturity application later. The output of this define requirement stage becomes input at the design and Development stage. This artifact that has been built needs to be demonstrated to several related users. This study used two2 ~~d~~different industrial sectors to demonstrate artifacts as well as evaluate the results of artifact analysis. The Education and service sectors are used to represent

4 IMPLEMENTATION OF DSRM IN E-SELF ASSESSMENT CASE STUDY OF DIGITAL MATURITY INDEX

The application of DSRM to artifacts of digital maturity measurement applications independently is found in the entire stage of artifact creation. Identification of problems that begin with a literature study[34] related to DX was carried out to start this research. The services provided on artifacts not only show the maturity level of DX, but also the strategies suggested on each dimension used for DX assessment. The identification of this problem is the implementation of the DSRM explicated problem stage in the development of digital maturity measurement artifacts. Definition of various requirements needed in building artifacts for digital measurements is carried out to accurately map what is needed and what can be presented by artifact. The artifact testing in this study is specifically applied to various organizations that are directly involved with digital transformation, so that the artifacts built can be precisely realizing the needs of users in monitoring the success of DX in their organizations. The involvement of case studies in the construction of digital maturity artifacts at each existing stage (figure 2Figure 2) is a form of DSRM implementation in the digital maturity artifact.

4.1 Described p~~P~~roblem

Explicate problems in this study investigate and analyze the digital maturity index and possible Digital Transformation problems in organizations. The demands of technological adaptation become a necessity for organizations to be able to compete. Currently, there are various technological measurement indices, but the dimensional differences used in each measurement produce

readiness is impractical. Therefore, a device that can comprehensively measure the readiness of technology is needed. The problem in this study is how to find the dimensions and indicators of the Digital Maturity Index for Digital Transformation based on a multi-dimensional comparative analysis of the Digital Maturity Index.

The strategies used at this stage are documentative and survey. The documenting stage is carried out by studying the problem of measuring technological readiness through previous research documentation. The strategy surveyed the application of a technology measurement model in one of the industries. In the DSRM, the problem identification stage is the problem described. The initial problem as input at this stage is the need for independent services to measure the success of digital transformation in organizations.

In comparison, existing measurements vary with varying dimensions. Survey methods and document review literature are needed to clarify the issue. The result is obtained with several measurement models with several different measurement dimensions.

Moreover, existing measurements have not taken into account the significant visible digital inequalities between developed and developing countries.

A documentative method is required to study the literature on Digital inequality. There is a shift in the stages of digital inequality in developing countries. Critical factors that continue to influence digital inequality are issues that must be considered in producing measurement models. In addition, the measurement of DX adoption needs to be presented independently and easily. Thus, organizations can periodically know the state of readiness for digital transformation in their organizations. For organizations, this is an important issue because it threatens the sustainability of the organization in the future. The low adoption of DX is very likely to make the organization unable to compete. As for organizational elements, the identification of problems through the results of the DX readiness assessment is important as a management consideration in formulating future strategies. Whether infrastructure is available, whether workers have enough skills to use it, or whether there is value to expect in existing technology, the answer helps management identify the problems that hinder DX's success in the organization.

Figure 3 presents the stages of finding the root cause exactly. Conducting a survey of more than 100 workers in various sectors of organizational is necessary to find the root cause. A comparative analysis of various digital maturity index models provides perspectives on the different dimensions used. Furthermore, a documentative method is needed to identify digital stage trends to support the suitability of DX strategies within the organization. Mapping Explicated Problem activities are generally presented in

4.2 Define ~~R~~requirements

This activity aims to identify and describe artifact proposals to solve the problems previously described and collect the exact needs of the artifact proposals. The input at this stage is the Explicated Problem that has been discussed earlier.

The problem identified in the Explicated Problem is the need to independently measure the digital maturity index. The artifact outline based on this problem is model and instantiation, while the artifact outline is the stage of choosing the type of artifact designed to solve the problem. Agency is defined as a work system that can be used in practice. The problem of measuring technological readiness is obtained from the output of explanatory problems, including: (1) There are various maturity indices with various dimensions, (2) Differences in characteristics such as socioeconomic and cultural (developing and developed countries) allow for different dimensions in the measurement of maturity index, (3) Various stages of the Digital Transformation gap (developed and developing countries) such as Infrastructure, Skills, Expectations using technology, (4) There is no independent Digital Maturity Index measurement dashboard (figure 5Figure 5). Based on these problems, an artifact is needed in the form of a multi-dimensional industrial readiness measurement model that can be done independently by filling in predetermined criteria. The measurement is in the form of an easy and user-friendly dashboard to access. The scope of the organization is a lower-middle-class organization that has used new technologies and organizations that will operate with a specific technology. The resulting artifact s can provide a matrix with the weighting/level of each factor measuring the readiness of the technology to provide information for management in determining future progress.

Two other activities that support the identification of needs as inputs, namely Resources and Control. The resource for determining the results of these specified requirements activities takes into account previous and existing research artifacts. Therefore, a comparative analysis of artifact s previously, that is, a digital maturity measurement model, is carried out.

Dimensional differences and considerations of digital inequalities may increase the significance of measurements later on. In addition, resources at this stage also take into account the preferences of stakeholders. Control on the activity of defining requirements is the determination of research methods and strategies to help identify requirements. Surveys and study documents are the controls selected at this stage. A survey of several stakeholders across the organization was conducted to explore the adoption of Digital Transformation in their organizations. Meanwhile, the study document carried out is with a digital maturity index library study model and a comparative analysis of the model. Dynamic Capacity simultaneously measures organizational agility and is considered one of the supporting documents of this stage. The outline of artifacts in this study is the development of the Digital Maturity Index e-self-assessment service.

The input of the "Define Requirements" activity is the output of the Described Problem (see, Figure 5). The Define Requirements activity generates functional and environmental requirements to support Artifact Design and Develop activities. The functional requirements generated in the Define Requirements activity include: (1) Dashboard, as a result of this research, artifact can be run on a web browser without the need for installation, (2) To maintain data security, users and passwords are needed in the

application, (3) the service considers the stages of Digital Transformation and its inequality in developing countries, (4) the service provides an assessment on each measurement dimension, (5) the service provides recommendations for digital transformation achievement strategies based on measurement scores, (6) the service provides historical information on pre-conducted measurement of the digital maturity index in the form of trends, (7) the service provides detailed progress of sub-indicators on each dimension, (8) The service should allow users to move seamlessly between devices. While the environmental requirements generated in the Define Requirements activity include: (1) services must adopt appropriate dimensions to measure Digital Transformation, especially in developing countries, (2) services must be easy to maintain, and (3) services must be integrated with social media services such as Facebook, Twitter, and Google+, (4) services must be platform independent and can be adapted to mobile platforms such as Android and iOS, (5) the service should be easy to use. The stages of determining the requirements in this discussion are presented in Figure 5.

4.3 Design and ~~Develop~~develop

Based on the problems presented in the explicate problem section and the requirements specified in the *predetermined requirements,* the artifact produced in this study is the creation of a Digital Maturity Index Dashboard. In the Design and Develop stage, there are four sub-activities:

1) Imagine and ~~Brainstorming~~brainstorming,
2) new ideas generated or elaborated with existing artifacts;
3) ~~Assess~~ assess and
4) ~~Choose~~ choose one or more designs to use

In this study, various similar artifacts in the form of achievement measurement dashboards were used as one of the inputs for imagine and brainstorming in making artifacts. Several alternatives in the form of prototypes are created and compared to ensure that all the necessary requirements are met (the previous stage output: define requirements). The next stage is the construction of the artifacts themselves. The approach at the Design and Development stage is presented in figure 6Figure 6.

artifact platform. application activities

Furthermore, the data is processed by the system for the calculation of the maturity level of DX.

The input used in this application is organizational data according to the answer to the questions provided. Furthermore, the system processes data and provides an assessment based on each indicator. The implementation of the application based on its technical configuration is presented in figure 8Figure 8.

Details of activities at the design and development stages are presented with the Service Experience Blueprint (SEB) approach. In general, this method describes the activities carried out by the user along with the process activities carried out by the system. SEB is used to describe activities according to user interface design, so as to improve the overall customer experience.[57]. The SEB at each stage of the activity on the dashboard is presented in the figure 9Figure 9.

Figure 9 presents the flow of user activity as well as the processes in the system with the SEB approach. The user accesses the system by entering the organization's data according to the questions displayed on that system. The system is equipped with a score calculation engine mapped at the maturity level of digital transformation.[10,; 31;10]. Each score from the dimension is processed and compared to be able to provide suggestions for improvement and improvement to dimensions that have a low score. Each user use activity of the system is planned in the form of a use case diagram. The diagram in figure 10Figure 10 also explains the sequence of activities carried out by the system, starting from user activities to the system displaying the results of the digital maturity level.

The system processes the Transformation Digital maturity level assessment. An assessment of each dimension is performed and presented on the application dashboard (figure 11Figure 11).

The application is equipped with a dashboard that presents the results of the assessment thoroughly on each dimension. Dimensions that require improvement will be highlighted with different coloring figure 12Figure 12.

4.4 Demonstrate Artifactartifact

The activity of demonstrating artifacts in this study was carried out by empirical testing on the organization. This demonstration or "proof of concept" is necessary to show that artifacts can solve the example problem. At this stage of demonstration Artifact.

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Indonesia. There are two sub-activities at the Artifact Demonstration stage: Select or Case Design and Apply artifact. This study designed artifact self-assessment services as a new form of service in this study. This is considering the lack of maturity index measurement services in the form of applications.

Artifact is designed in case studies in the form of experiments. The case design includes [assignments] to users to fill in organizational conditions on some of the existing digital maturity index criteria and digital divide stages. As explained earlier,

there are three stages of the digital divide, namely infrastructure, skills, and outcomes. Ten app users conducted a multi-day trial to find out the trend of digital maturity index results. The test results are presented in the form of a rating or maturity level of digital transformation obtained through a digital maturity assessment. The DX maturity assessment is carried out by filling in a number of questions based on the index mapped in the standard process attribute in the form of a questionnaire. The scoring scores through the questionnaire answers are then processed using the given formula.[4,; 70]

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The user is granted access to the prototype service, which provides more than 90% of the necessary functions. The user performs the tasks described above, and the researcher then records all service interactions and analyzes them using quantitative methods. This experiment serves as a proof of concept, demonstrating that the service can be used as intended. Artifact Demonstration activities summarized in ~~figure 13~~Figure 13.

4.5 Evaluation ~~Artifact~~artifact

The artifact Evaluation activity (figure 14Figure 14) determines how well artifact meets the requirements and to what extent they can solve, or reduce, the practical problems that motivate research. The results of the empirical test become an input for the evaluation of Artifact. There are three sub-activities in Evaluation Artifact: Evaluation Context Analysis, Select Evaluation Objectives and Strategies, and Design and Conduct Evaluations.

Evaluation Context Analysis aims to analyze the evaluation context needed to determine the objectives, strategies, and limitations of the evaluation implementation. Context analysis (~~figure 14~~Figure 14) explains the participation answered at the evaluation stage in this study, namely how well the Digital Maturity Index Measurement is, which includes multidimensional digital transformation factors taking into account Digital Pleasure and resource inequality (Socioeconomic & Cultural). The objectives of the evaluation at this stage are the effectiveness of measuring the success of multidimensional Digital Transformation, knowing

evaluation carried out formatively (purpose for improvement). This formative evaluation is carried out by interviewing digital transformation experts to improve the services provided on the dashboard. In addition, the next strategy selection is a direct artifacts trial in the field with an artificial approach. The artificial approach referred to in this study is the existence of initially determined respondent requirements, namely in several sectors such as banking, education, and health. The last sub-activity,

Design and Carry Out Evaluation (figure 14Figure 14), carries out the evaluation process with the strategy that has been selected in the previous sub-activity. Strategies used to evaluate the Artifact dashboard service self-assessment digital maturity index include:

- The phase 1 strategy is carried out ex-ante (in the form of a prototype) with the strategy of interviewing several experts related to DX, DX supporting sectors (banking, education, health)
- The phase 2 strategy is carried out outpost (in the form of a final dashboard) and artificial (respondents determined from the education, health, and banking sectors) with the strategy method of the Delon & McClean theory approach to respondents according to industry.

A questionnaire is developed for each index used. For example, on the Organization and Structure dimension, the questionnaire answers readiness in aspects such as: (1) Organizational Structure Management, (2) Continuous Learning Management, and (3) Organizational Change Management. The questionnaire for the Organization and Structure section includes:[33, 34]:

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Organizational Structure Management

1. The organization has articulated the need for digital transformation.
2. The organization has a vision for digital transformation, driving change towards a workforce that understands digital technologies.
3. A digital unit/team is being created to explore digital opportunities (Valdez-de-Leon, 2016).

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Continuous Learning Management

1. The recruitment of selected "experts" to bring in the skills needed is currently underway, often in isolated teams.
2. The need for digital competence has been identified, and a general development plan is being defined.
3. Training and compensation schemes are being adjusted to align with digital strategies.

Organizational Change Management

1. Initial investments are being made to develop digital competencies, including training programs.
2. Digital strategies drive company-wide change, including organizational structure and key performance indicators.
3. Digital initiatives bring together people from different functions and departments, as well as external partners.

The evaluation of the assessment through the questionnaire answers is then processed using the formula that has been provided.[4,; 34,; 70] .

$$J_{(d,a)} = \frac{\sum_{q \in Q_{da}} \frac{\sum_{r \in R} H_{(r,q)}}{|R|}}{|Q_{da}|}$$

A: Attribute average value, Q: Question, D: Dimension, R: Respondent, A: Attribute

The results of the digital maturity assessment are then mapped based on the threshold value of the maturity level, namely Level 0: Incomplete, score below 0.2; Level 1: Performed, score below 0.80; Level 2: Managed, score below 1.60; Level 3: Established, score below 2.40; Level 4: Predictable, score below 3.20; Level 5: Optimize, score between 3.21 to 4.[4,33,34]

4.6 Visualizing the Framework framework

The stages of the framework are visualized using the IDEF0 Diagram (figure 15Figure 15). The input in this diagram is the dimension of the Digital maturity Index, and the Control used is the Digital Divide with the support of socioeconomic and cultural resources of the organization.

The output on the graph is the Digital Maturity Index Dashboard Application. The Digital Maturity model box on the right side of figure 15Figure 15 shows the first input of the artifact. Comparative analysis of several digital hand measurement models results in comprehensive digital maturity measurement dimensions. Meanwhile, the digital dividing box with control of socioeconomic and cultural factors is an additional input for artifact. Next, two inputs (maturity index box and digital division) are processed in the score calculation engine shown in the DX maturity index image (middle box). In the end, the resulting output is a score of achieving digital maturity in each dimension.

4.7 Canvas self -assessment digital maturity index

and function of an artifact, while the activity manager is related to the use and effects of artifact.

5 DISCUSSION

This study presents the implementation of the DSRM stages as a whole in making artifacts from an Information Systems perspective. The artifact in question is an application for measuring the maturity of digital transformation[18]; Suppachok N[71,73] in organizations. Each stage is complemented by the implementation of case studies in the construction of artifacts. According to Peffer,[60] identifying the problem to reveal the root cause is an important part of artifacts. This is supported by Hevner,[37] that the stages of artifact creation with the DSRM approach accommodate the decipherment of the problem at its core stage.[14] The root of this problem is the output of the explicated problem stage which then becomes input in the Define Requirements stage. This stage focuses on functional and environmental requirements to support the Design and Development stage. Functional requirements focus on how artifacts function, such as: artifact digital maturity measurement application can be run on the website platform without the need for installation, requiring username password to keep the data safe and provide historical previous measurements if any. While the environmental requirements in this study include: artifact digital maturity measurement application integrated with social media such as Facebook, twitter, and google, easy service used. Various requirements that have been determined at the Define Requirement stage become input at the next stage, namely Design and Develop. This stage focuses on the design and construction of artifacts. Designing a digital maturity measurement application presented in the form of a block diagram (discussed in the previous chapter).

Design with SEB~~Service Experience Blueprint~~ is implemented to facilitate identification. The steps of creating a system. The front end and back-end processes of the application are presented in sequence from the login process to the results of digital maturity. The application will present various criteria by weighting the assessment based on the industry classification determined by the user at the beginning of accessing the application. Each criterion has a series of questions as a form of assessment of the digital transformation that has occurred in the organization. The results of the answers to these questions will later be processed by a system with a certain formulation.[4,34] The final value obtained based on the assessment will be reprocessed by the system to map the level of digital maturity as well as present a proposed acceleration strategy. The output of the design and development stages is then tested on several users as well as testing their performance. The trial process is at the stage of Demonstrating artifacts. There are 2 organizations that test artifacts, namely education and transportation. This trial aims to determine the extent to which artifacts can measure digital maturity through the results of previous assessments. The evaluation results show

that there are differences in digital maturity levels. Organizations in the transportation sector get a higher level of maturity than education. Human resource criteria in the transportation industry get the highest score compared to other criteria. The high HR score makes it possible to support the success of other criteria in achieving maturity. The causes of differences in digital maturity levels need to be explored further and not discussed in this study. DSRM is one of the methods that provides convenience for

researchers and practitioners in building an artifact. The implementation of the stages as a whole allows the construction of artifacts that suit the needs.[37,; 58]

6 CONCLUSION

Research on DX continues to grow in line with the magnitude of the influence of successful DX on organizations. Organizations need to monitor the achievement of digital maturity to be able to map the right strategy going forward. However, existing digital maturity measures require paid, third parties to access them. Therefore, an artifact is needed in the form of a digital maturity measurement device. DSRM is an approach used to build artifacts.[69,; 70;37,; 60]. In the context of information systems, DSRM is often used as a method in building artifacts such as applications, software and information systems. There are various studies with the DSRM approach, but the inclusion of the completeness of the stages of the method with direct implementation in a real case of artifact development is still limited. Therefore, this research fills this gap by presenting the implementation of each stage of DRSM as a whole in producing artifacts. The stages in DSRM, namely Explicated Problems to Evaluations are presented and equipped with the implementation of problems in artifact development. The artifact in this study is the application of Digital Transformation Maturity Measurement independently. The selection of artifacts is based on the identification of problems described at the explicated problem stage. Various existing digital maturity measurements have a variety of different dimensions, besides that they are not equipped with applications that can be accessed independently for digital maturity assessment. Organizations need monitoring the level of achievement of digital transformation from time to time as a guide in formulating organizational strategies. Various functional and environmental requirements in support of artifact performance are spelled out at the Define Requirement stage. At the demonstrate artifact stage, a strategy case study is chosen by including several different organizations. In this study, educational organizations and transportation services demonstrated the artifacts that have been built. In the end, an evaluation of the use of artifacts was obtained, namely the level of digital maturity of the organization as well as the recommended strategy to be able to increase the level of maturity. As a preliminary study, the results of this study provide insights for academics and practitioners in designing artifacts with the DSRM approach. Future research is needed to uncover each stage of artifact development in more detail and expand cross-cutting case studies. In addition, the variety of sectors that implement digital transformation allows for different characteristics of achieving different digital skills. Therefore, more in-depth testing is needed in subsequent research, to reveal the characteristics of achieving digital maturity by being more specific in various sectors.

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DATA AVAILABILITY STATEMENT

The Data Availability Statement can be found at https://zenodo.org/record/8207253

~~ETHICAL COMPLIANCE~~

This is an observational study. The Local Ethics Committee has confirmed that no ethical approval is required. The author has no

~~conflict of interest to state~~

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ıti is a lecturer and researcher at department of Informatics, Universitas Muhammadiyah Surabaya, Indonesia. Her research interests are Digital Transformation, Digital Maturity Model, E-commerce, Sustainability, Information System Audit, Technology Acceptance Model; Mobile Payment; E-Learning; Enterprise Resource Planning Systems; ERP Implementation; Information Systems; Strategic Alignment; COBIT; Information System Framework

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FIGURE 1 Methods Framework framework for Design design Science science Research[47]research.[47]

FIGURE 2 Digital maturity index dashboard research method.

FIGURE 3 The root cause of the problem described.

FIGURE 4 Activity of the issue described.

FIGURE 5 Define a requirement activity.

FIGURE 6 Designing and ~~Developing~~developing artifact ~~Activity~~activity.

FIGURE 7 Block digital maturity index self-assessment diagram.

FIGURE 8 Technical ~~Diagram~~ diagram of ~~Self~~ self ~~Assessment~~ assessment ~~Digital~~ digital ~~Maturity~~ maturity ~~Index~~index.

FIGURE 9 Service experience blueprint dashboard artifact.

FIGURE 10 Digital ~~Maturity~~ maturity ~~Use~~ use ~~Case~~ case ~~Diagram~~diagram.

FIGURE 11 Dashboard ~~Mockup~~mockup.

FIGURE 12 Measurement of each dimension of ~~Digital~~ digital ~~Maturity~~maturity.

FIGURE 13 Demonstrating the artifact activity.

FIGURE 14 Evaluation of artifact ~~Activity~~activity.

FIGURE 15 IDEF0 Diagram diagram of the Digital digital Maturity maturity ~~Index~~index.

TABLE 1 Some Digital digital Maturity maturity ~~Models~~models.

FIGURE 16 Canvas ~~Artifact~~artifact.

Model ~~Maturity~~ maturity ~~Index~~index	PWC[61] ~~61~~62	Deloitte/ TM[19]	MIT/ Capgemini[27]	Forrestor's[29]
Dimension	1. Digital business model and customer access	1. Custom	1. Strategic ~~Assets~~assets	1. Culture.
	2. Digitization of product and service offerings	2. Technology	2. Internal operations	2. Technology

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	3. Digitization and integration of vertical and horizontal value chains	3. Strategy	3. Digital ~~Capabilities~~ capabilities (digital vision, Governance, engagement)	3. Organization
	4. Data and analytics as core capabilities	4. Operation		4. Insight
	5. Agile IT architecture	5. Organization & Culture		
	6. Compliance, security, legal, and tax			
	7. Organization, employees, and digital culture			
Digital Maturity maturity ~~Level~~[67]level[67]	1. Digital Beginner	1. Initiating	1. Beginner	1. Skeptics
	2. Vertical integrator	2. Appear	2. Fashionista	2.Adopters
	3. Horizontal Collaborators	3. Perform	3. Conservative	3.Collaborators
	4. Digital Champion	4. Forward	4. DigiratisDigitalis	4.Differentiators
		5. Lead		

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4. Decision: Round 1 21 Juni 2023

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Systems Engineering - Decision on Manuscript ID SYS-22-073.R1

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21-Jun-2023

Dear Mrs. haryanti,

Manuscript ID SYS-22-073.R1 entitled "Measuring the Digital Transformation Maturity Level independently with the Design Science Research Methodology" which you submitted to Systems Engineering, has been reviewed. The comments of the referee(s) are included at the bottom of this letter.

The referee(s) have recommended publication, but also suggest some minor revisions to your manuscript. Therefore, I invite you to respond to the referee(s)' comments and revise your manuscript.

The editors will review the changes as there is no need to send this paper back for more peer review. This will greatly reduce the amount of time for us the review the changes prior to publication.

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Once again, thank you for submitting your manuscript to Systems Engineering. I look forward to receiving your revision.

Sincerely,

Dr Stephen Adams
Associate Editor, Systems Engineering
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Dr Clifford Whitcomb
Editor-in-Chief, Systems Engineering
cliff.whitcomb@incose.net

Associate Editor: Adams, Stephen
Comments to the Author:
Thank you for responding to the reviewers' comments. Please see their new comments and respond by clarifying the appropriate text.

Referee(s)' Comments to Author:

Reviewing: 1

Comments to the Author
Although the authors reference the Hitchins book as recommended, the resulting text is still somewhat muddled. I recommend making it clear that in this paper artifacts are defined to include humans. At various points in this paper the authors use both US and UK spellings. I recommend that these be cleared up. I defer to other reviewers regarding the methodology.

5. Review Round 2 30 Juni 2023

Associate Editor: Adams, Stephen Comments to the Author:	Authors' Response
Thank you for responding to the reviewers' comments. Please see their new comments and respond by clarifying the appropriate text.	Thank you for the information
Referee(s)' Comments to Author: Reviewing: 1 Comments to the Author	Authors' Response
Although the authors reference the Hitchins book as recommended, the resulting text is still somewhat muddled. I recommend making it clear that in this paper artifacts are defined to include humans. At various points in this paper the authors use both US and UK spellings. I recommend that these be cleared up. I defer to other reviewers regarding the methodology.	Apologies for any confusion caused. We appreciate your feedback and would like to address your concerns. We will clarify the definition of the system as the form of artifact in this paper and address the explanation in the Introduction section (page 2). The artifact in the form of a digital maturity assessment service information system in this research is an application system built on web-based software. The creation process of the artifact uses the DRSM approach. According to McLeod (McLeod et al., 2008; McLeod & Schell, 2004), an information system is a system that has the ability to collect information from all sources, process and use various media and methods to display information. Following McLeod's approach to information systems, the information system as an artifact in this research collects and processes information about an organization based on digital transformation achievement criteria and presents rankings or levels of digital maturity achievement within that organization. This information system receives organizational data input from users who directly interact with the system interface (Everett & McLeod, 2007). In his book "Systems Engineering: A 21st Century Methodology," Prof. Hitchins, in the section "Human - part of the system, or user of the artifact?" explains that the user or human is outside the authority of the artifact, except for the necessary interface between humans and machines (Hitchins, 2007). The role of humans in this artifact is as users who interact with the interface of the digital transformation measurement system. Meanwhile, the measurement of digital transformation maturity is the responsibility of the artifact itself based on predetermined formulas and calculations within the system.

6. Decision: Round 2 27 Juli 2023

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Systems Engineering - Decision on Manuscript ID SYS-22-073.R2

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27-Jul-2023

Dear Mrs. haryanti,

It is a pleasure to accept your manuscript entitled "Measuring the Digital Transformation Maturity Level independently with the Design Science Research Methodology" in its current form for publication in Systems Engineering.

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Dear Mrs. haryanti:

Manuscript id: SYS-22-073.R2

The final files that you submitted for your manuscript have been checked and have been found to be suitable for publication and so will be forwarded to the publisher shortly.

Sincerely,
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8. Publikasi

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REGULAR ARTICLE

Measuring the digital transformation maturity level independently with the design science research methodology

Tining Haryanti, Nur Aini Rakhmawati, Apol Pribadi Subriadi

First published: 09 August 2023
https://doi.org/10.1002/sys.21714

Abstract

This study uses the Design Science Research Methodology (DSRM) approach in creating an artifact on the perspective of the Information System. Design Science as a valuable tool for creating a new artifact or developing an existing artifact through research. The DSRM Framework described in this study discusses the implementation of each stage, namely, Explicated Problem, Define Requirement, Design and Development, Demonstration, and Evaluation and is complemented by the implementation of case studies of artifact creation in DSRM stages. The Digital Maturity Measurement in question is a service to measure digital maturity in various dimensions. Each DSRM stage is mapped to a case study of that service.

Canvas visualization is presented to describe a complete picture of how the artifacts of Digital maturity services are built with the DSRM approach. This research also provides guidance on the principles, procedures, and characteristics

Systems Engineering

The Design Science Research Methodology for Self Assessing Digital Transformation Maturity Index in Developing Countries

Journal:	*Systems Engineering*
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Keywords. One of these must be chosen at the time of submission::	Digital Transformation, Digital Maturity Index, Design Science Research
Application Area:	AS03 Information & Communications

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Table 1 Several Digital Maturity Model

Model Maturity Index	**PWC**(PwC, 2016; PWC, 2016)	**Deloitte/ TM** (Deloitte Switzerland et al., 2018)	**MIT/ Capgemini** (Fitzgerald et al., 2013)	**Forrestor's** (Gill, Martin; VanBoskirk, 2016)
Dimension	1. Digital business model and customer access 2. Digitization of products and service offerings 3. Digitization and integration of vertical and horizontal value chains 4. Data and analytics as core capabilities 5. Agile IT architecture 6. Compliance, security, law, and taxes 7. Organizations, employees, and digital culture	1. Customer 2. Technology 3. Strategy 4. Operation 5. Organization & Culture	1. Strategic Assets 2. Internal operations 3. Digital Capabilities (Digital Vision, Governance, Engagement)	1. Culture. 2. Technology 3. Organization 4. Insight
Digital Maturity Level (Remane et al., 2017)	1. Digital Novice 2. Vertical integrator 3. Horizontal Collaborator 4. Digital Champion	1. Initiating 2. Emerging 3. Performing 4. Advancing 5. Lead	1. Beginner 2. Fashionistas 3. Conservative 4. Digiratis	1. Skeptic 2.Adopter 3.Collaborator 4.Differentiator

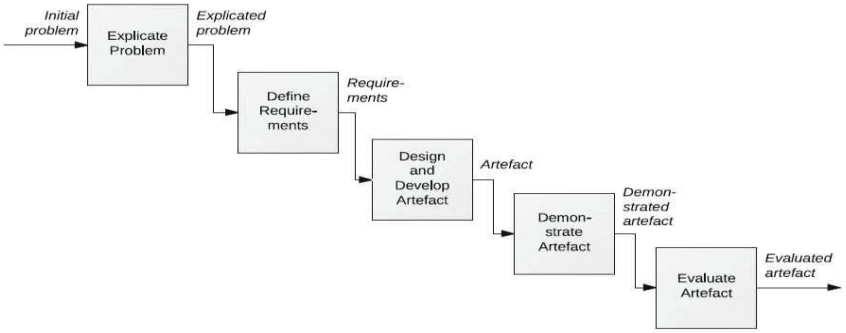

Figure 1 Method Framework for Design Science Research (Johannesson Paul, 2014)

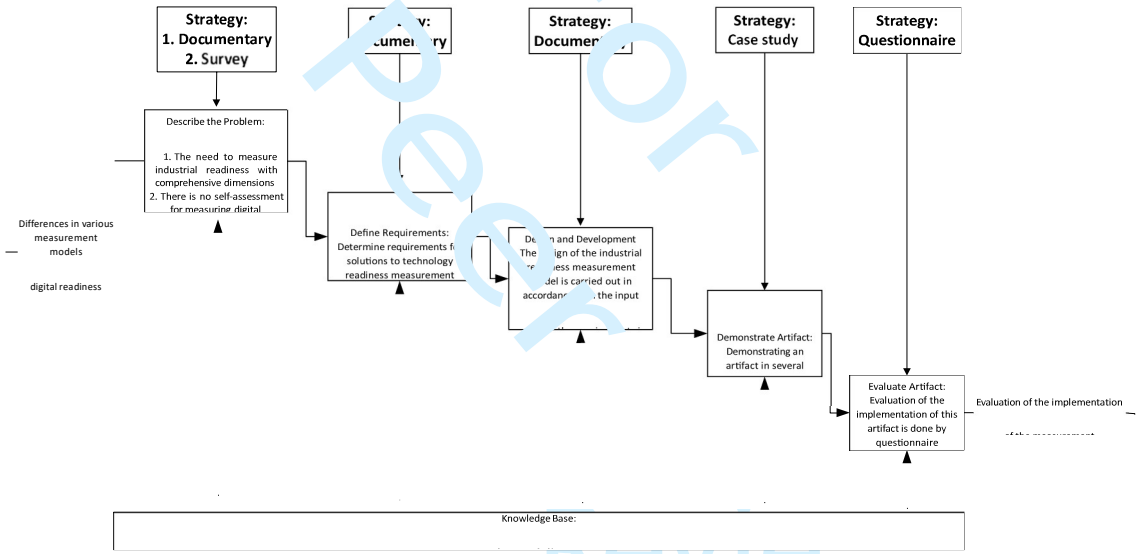

Figure 2 Research **methods step** *of Digital Maturity Index Dashboard*

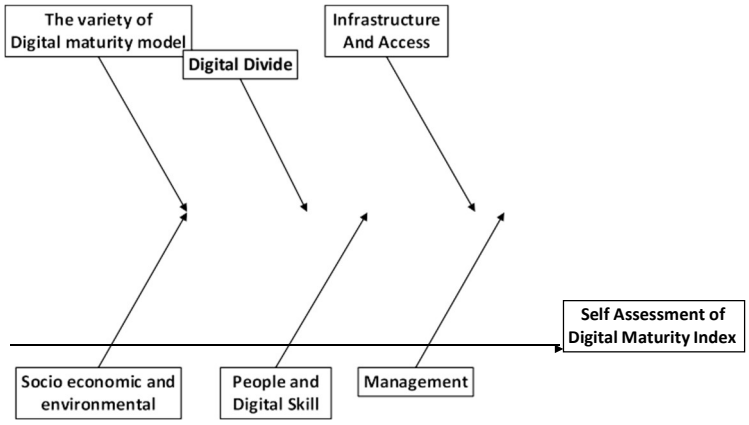

Figure 3 Root Cause Explicated Problem

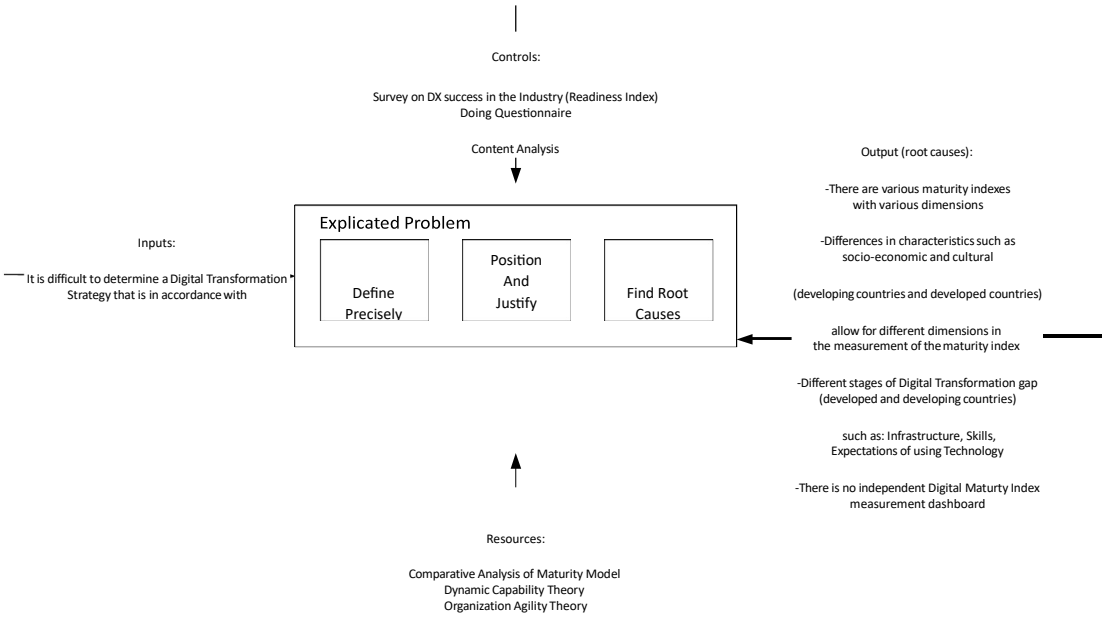

Figure 4 Explicated Problem Activity

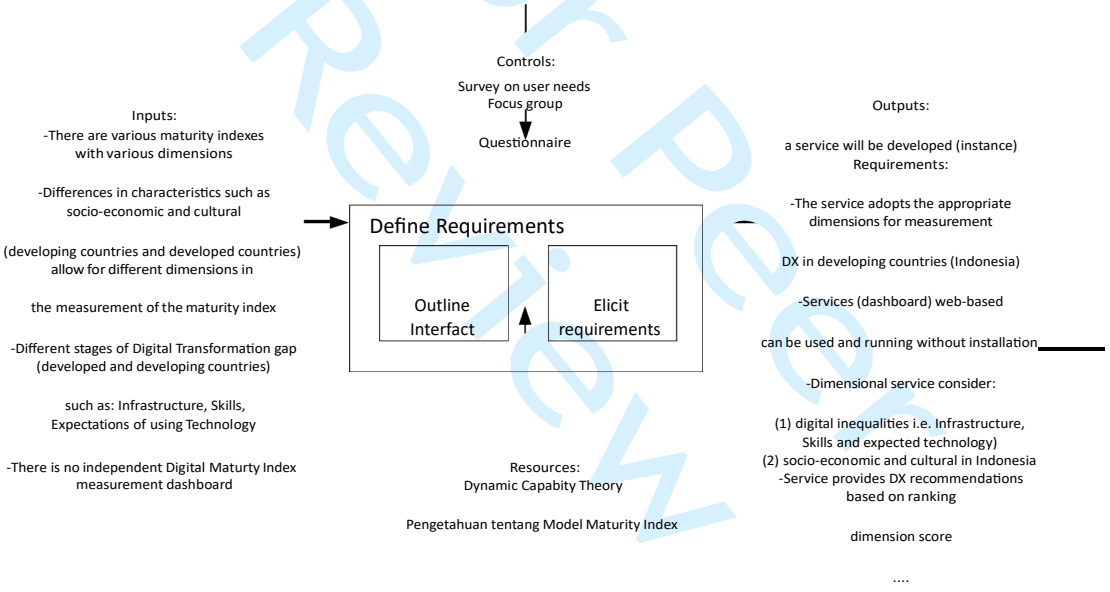

Figure 5 Define Requirements Activity

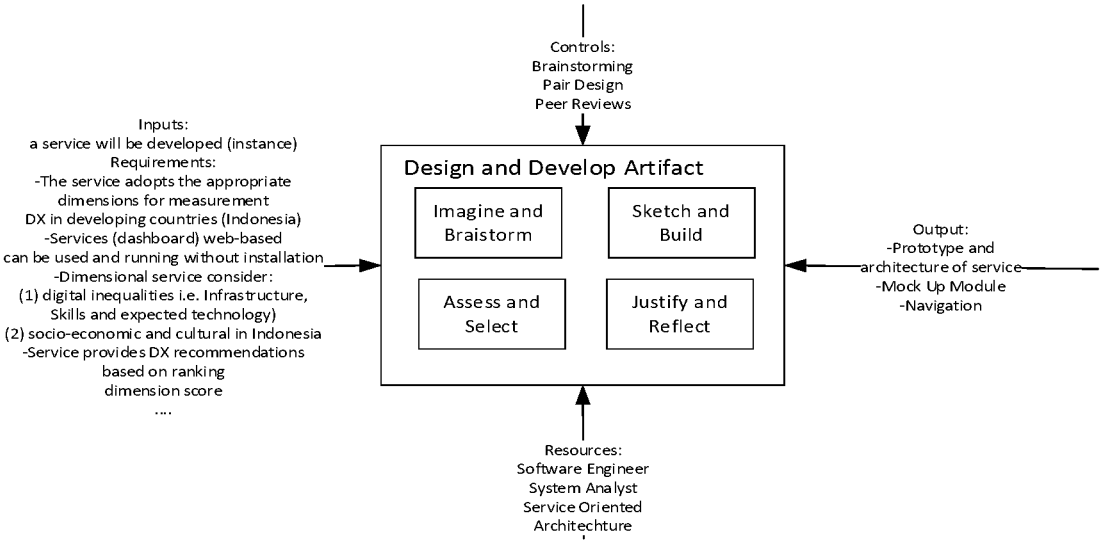

Figure 6 Design and Develop Artefact Activity

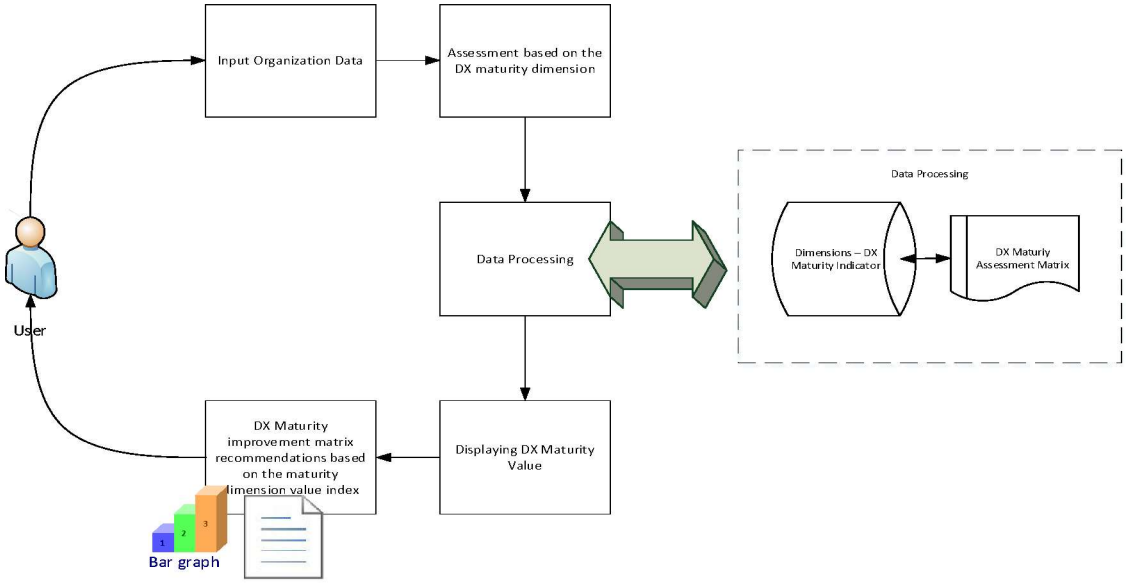

*Figure 7 Diagram block of **self-assessment Digital Maturity Index***

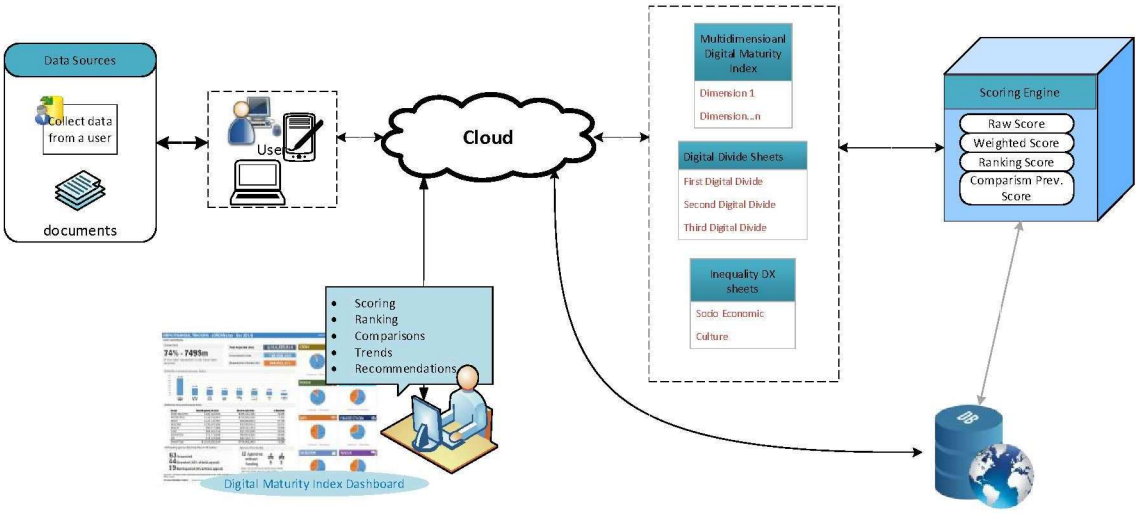

Figure 8 Technical Diagram Self Assessment Digital Maturity Index

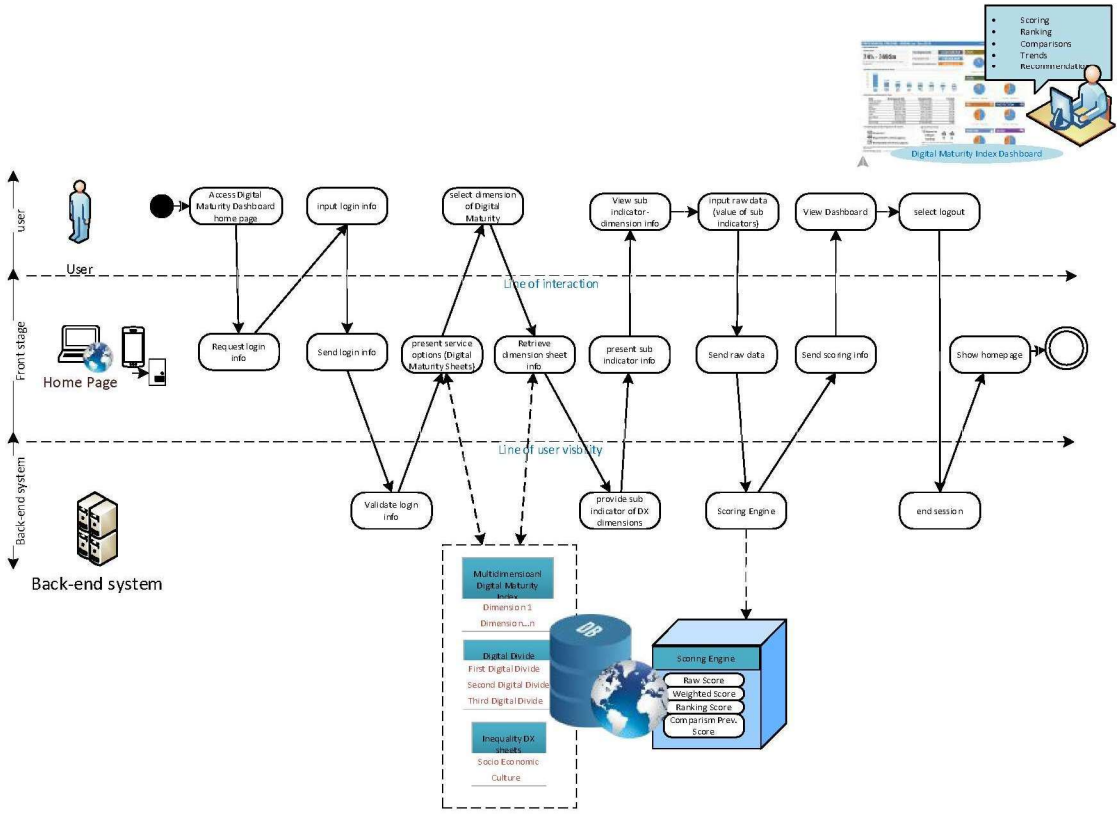

Figure 9 Service Experience Blueprint Artefact Dashboard

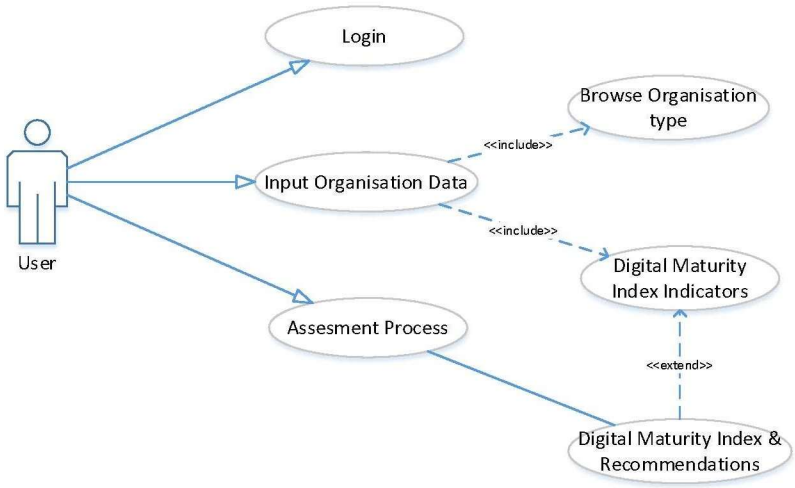

Figure 10 Use **Case Diagram Self Assessment Digital Maturity Index**

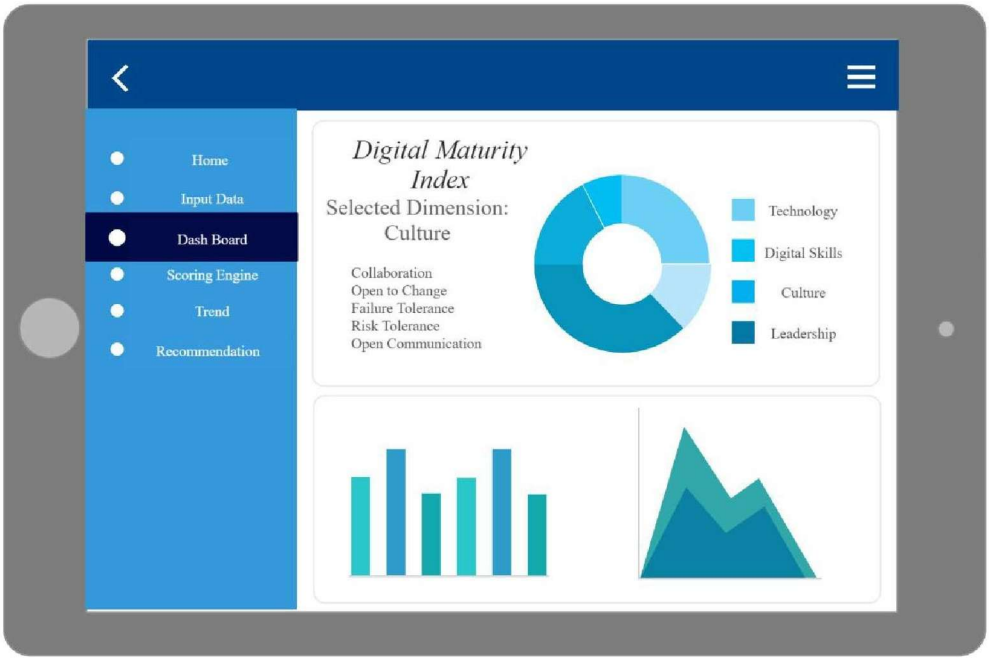

Figure 11 Mockup Dashboard

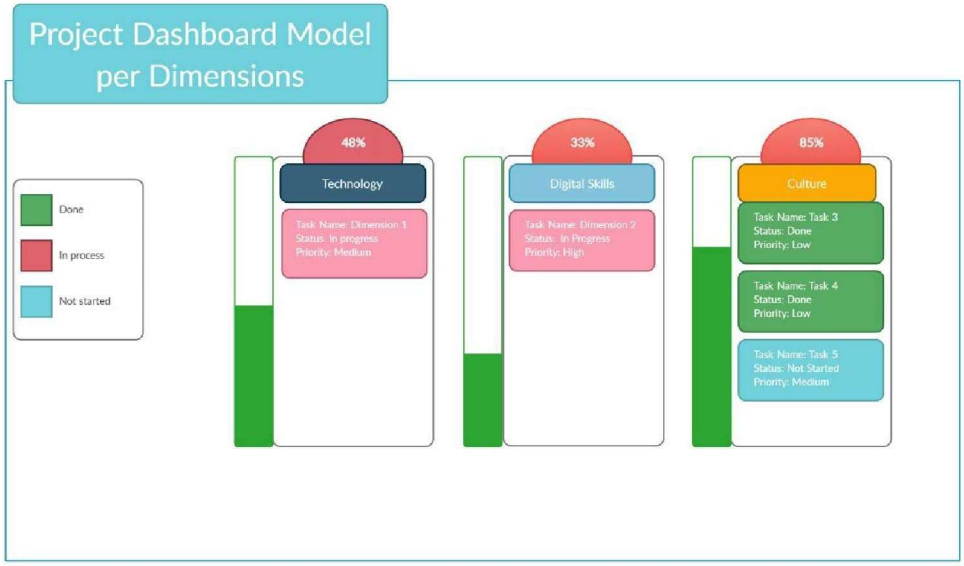

Figure 12 Measurement of each dimension of Digital Maturity

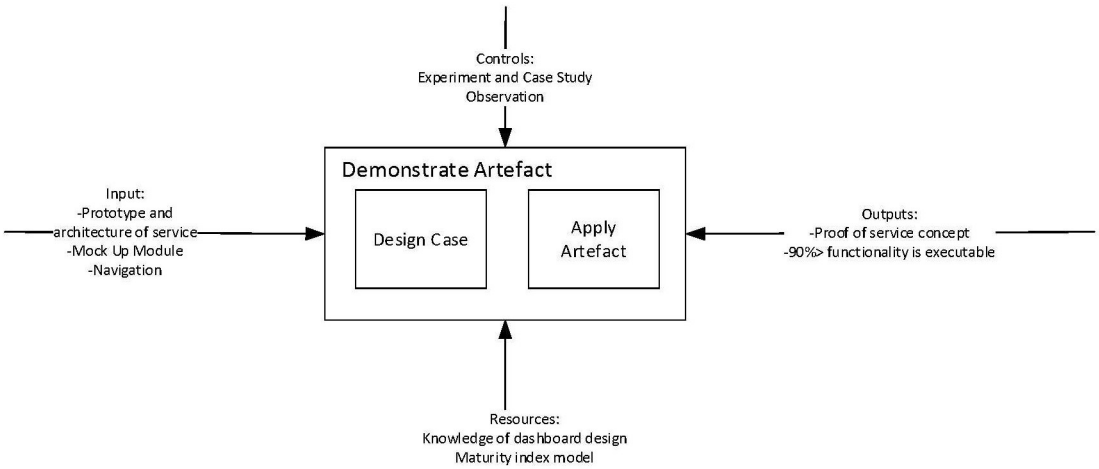

Figure 13 Demonstrate Artefact Activity

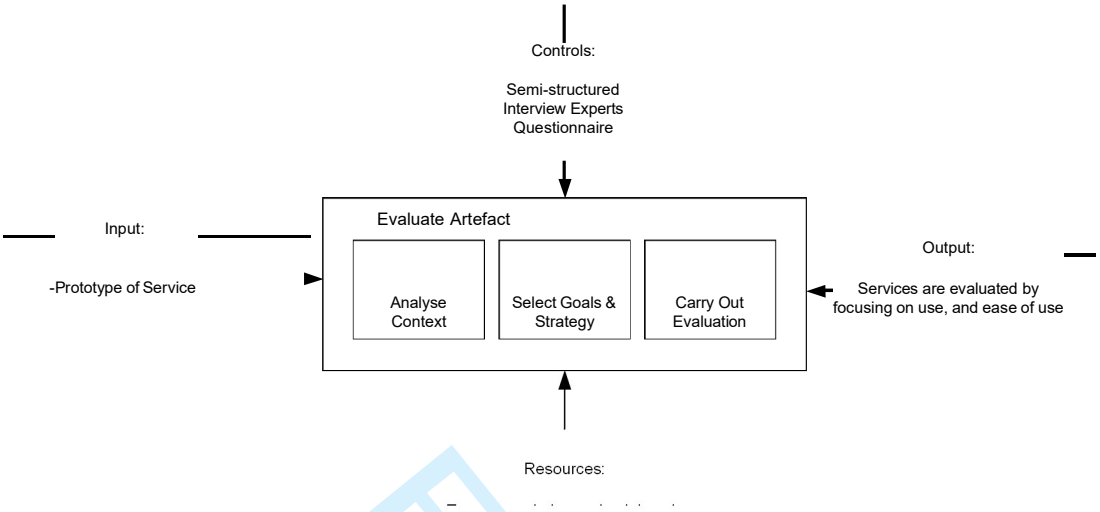

Figure 14 Evaluate Artefact Activity

Artifacts: Digital Maturity Index taking into account Digital Divide

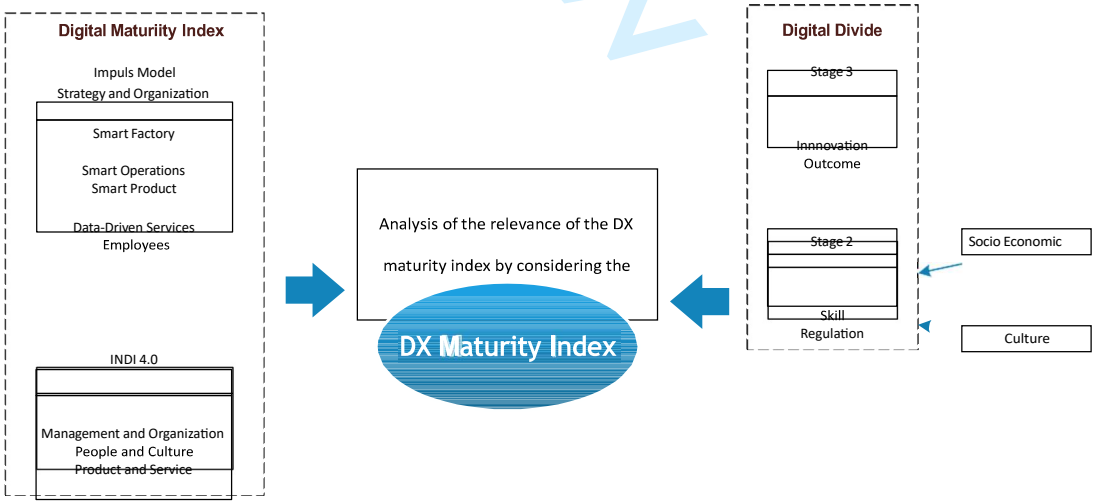

Figure 15 Diagram IDEF0 of Digital Maturity Index

Problem Digital maturity index measurement is needed so that organizations can determine digital transformation strategies that are under DX maturity in the organization. There are various maturity index models, but the model has varying dimensions.	**Artefact** Building self-assessment services for website-based Digital Maturity Index	**Knowledge Base** - Analysis of the maturity ratio of pre-existing models. Dynamic Capacity Theory and Organization Ability Theory are used as a digital transformation capture approach Delon and McClean's Theory is used to assess the acceptance of tenants of artefacts made
Practice The dimensions of maturity index measurement between developed and developing countries are different. This is due to different digital inequalities, both from infrastructure readiness, skills, and technology expectations. Digital maturity index measurement independently is still limited, while organizations need to be faithful when knowing the status of DX maturity in their organization.	**Requirements** The resource for determining the results of this defined requirement activity considers previous research and existing artefacts. Therefore, the comparison analysis of previous artefacts, namely digital maturity measurement models, was carried out. Differences in dimensions and considerations of digital inequalities can increase the significance of measurements later. In addition, resources at this stage also consider the preferences of stakeholders.	**Constructs** Software Requirements used in Artefact creation are described in the Service Experience Blueprint (SEB) and UML

Explicit Problem How to find the dimensions and indicators of the Digital Maturity Index for Digital Transformation in Indonesia based on the digital maturity index multi-dimensional comparison analysis. Consideration of the digital divide including socio-economic and cultural differences is needed. The next survey strategy used is to survey the application of technology	**Define Requirements** The Define Requirements activity generates the functional and environmental requirements to support the Artefact Design and Develop activity. In general, the results of the Define Requirements activity include (1) a multidimensional digital transformation readiness measurement model is needed, (2) a digital transformation readiness measurement can be carried out independently by filling in the specified criteria, (3) an easy and user-friendly dashboard to measure digital transformation readiness. The strategy of documentation and secondary data processing is used in the Define Requirements activity.	**Develop Artefact** The artefact produced in this study is the creation of the Dashboard Digital Maturity Index. This application is built on a web basis	**Demonstrate Artefact** The activity of demonstrating artefacts in this study by conducting empirical tests on the organization. This demonstration or "proof of concept" is needed to show that artefacts can solve an example a problem. At this stage of Demonstrate Artefact, strategies are developed with a case study approach. Selection of case studies on the object of one of the national industries located in Indonesia.	**Evaluate Artefact** Artefact Evaluation activities determine how well the artefact meets the requirements and the extent to which it can solve, or alleviate, the practical problems that motivate the research. Empirical test results become the input of Artefact evaluation. Strategies selected on Evaluate Artefact with a questionnaire approach

measurement models in one of the industries.	Reference collection of technology readiness measurements was carried out and prepared for artefact construction using the Delon and Mc Clean theoretical approach			
Structure Structure to build artefact by creating class concepts in UML. The Diagram Block and part of the use case diagram are presented in this study.	**Function** The service must adopt appropriate dimensions for Digital Transformation measurement, especially in developing countries (environmental requirements). The service can be used multiplatform (functional requirements), and the dashboard can be run on a web browser without installation.	**Usability** The Digital Maturity Index self-assessment dashboard service generates recommendations to optimize Digital Transformation based on each dimension's ranking score.	**Effects** The use of digital maturity index self-assessment services helps organizations to achieve DX maturity status in organizations. The artefact can at the same time, identify at which dimension the organization gets the lowest achievement. Strategy recommendations are presented on the service.	

Figure 16 The Canvas Artefact

The Design Science Research Methodology for Self Assessing Digital Transformation Maturity Index in Developing Countries

Abstract:

This study presents each stage of the design science research methodology (DSRM) framework for information systems. Design science provides essential support for research oriented towards the creation of artifacts. Studies discussing the role of design science (DS) are limited. The DSRM presented here incorporates the principles, practices, and procedures necessary to conduct research. Visualization of the framework and canvas is presented to provide a complete picture of the DSRM approach for research. A case study of the self-digital maturity measurement was used to describe the implementation of DSRM. It can independently design, develop, and implement artifacts in the form of digital maturity measurement services. The implementation of the activity approach and the sub-activity of the DSRM framework in the case study are presented. The designed methodology effectively fulfills the objectives of each DS activity and adds a reference to the development of DS research in IS science disciplines.

Key Words: Design Science Research methodology, Digital Transformation, Digital Maturity Index

1. Introduction

Design science research methodology (DSRM) emphasizes the design and construction of artifacts, such as systems, applications, methods, etc., that contribute to the field of IS in organizations (Peffers et al. 2007; Peffers, Tuunanen, and Niehaves 2018).). Its distinctive characteristics provide credibility as the basis for a potential DSR genre (Peffers, Tuunanen, and Niehaves 2018). The focus of this method is on artifact development. The design of DSRM is strongly influenced by design research, such as March and Smith(March and Smith 1995),

(Nunamaker, Chen, and Purdin 1990) and Walls (J. G. Walls, Widmeyer, and El Sawy 1992), each of which focuses on building physical information systems. The resulting DSRM departs from the premise that the designed artifact is likely to be a system or object to support system development, i.e., methods, algorithms, data theory, etc. DSRM research may begin with a

research problem, a client request, or even a pre-designed version of an artifact. Among the

case examples, Peffers et al. (Peffers et al. 2007), (Berndt, Hevner, and Studnicki 2003) started to solve public policy problems (Rothenberger and Hershauer 1999) started with development goals, (Tulu et al. 2003) began with given objectives, and (Peffers, Gengler, and Tuunanen 2003) begins with prototype artifacts and client problems. The practical axiom that guides DSRM is that researchers come to DSRs at various stages in a design or development effort, not always at the outset. The simple premise that guides DSRM leads this paper to warn readers not to think of it as “the only way DS research can be done…but only a good way to do it (Peffers et al. 2007)". Several researchers have attempted to provide some guidelines for defining DS research (Hevner et al. 2004). Work in engineering (Wilson 1986)(Fulcher and Hills 1996) (Eekels and Roozenburg 1991)(Reich 1995), Computer Science (Reich 1995)

(Takeda et al. 1990), and IS (Adams and Courtney 2004), (Cole et al. 2005) (Hevner et al. 2004) (March and Smith 1995) (Nunamaker, Chen, and Purdin 1990) (J. G. Walls, Widmeyer, and El Sawy 1992)(J. Walls, …, and 2004 2004) have attempted to collect and disseminate appropriate reference literature (Vaishnavi and Kuechler 2004; Vaishnavi, Kuechler, and Petter 2019); characterize the purpose; distinguish it from theory building and test research, in particular, and from other research paradigms; explain its essential elements; and claim its legitimacy. However, so far this literature has not explicitly focused on developing a methodology for conducting DS research and presenting it (Peffers et al. 2007). This study presents each stage in the DSRM's framework in information systems. Several studies discussing the role of design science are still limited. The design science research methodology (DSRM) is presented in 5 steps: Explicated problems, Define Requirements, Design and Develop, Demonstrate Artifacts, Evaluate Artifacts, and their sub-activities are discussed. The case study of self digital maturity measurement was selected to illustrate the implementation of DSRM. The selection of case studies is based on the limitations of independent measurement of the maturity index. At the same time, organizations need to know the maturity status of DX in their organizations any time.

The rapid development of technology has had a tremendous impact on the industry. Proper adaptation to the use of technology makes the industry able to compete even superior. Conversely, the mismatch of technology disclosure makes the industry no longer able to compete and does not even survive the competition. (Eltayeb et al. 2021). Meanwhile, the industry is a sector that contributes greatly to a country's economy. Industry readiness in technology is one of the barometers of adapting to technological developments. Network Readiness Index is an index published annually by the World Economic Forum in collaboration with INSEAD as part of the annual Global Information Technology Report. The presence of Industry 4.0 has great potential in developing the industrial sector. Industry 4.0 fundamentally brings together the digital and physical worlds and offers new opportunities to collect and use information. (Fernández-Miranda et al. 2017). It has the potential to increase efficiency and drive innovation on a large scale. Digital transformation is not always technology. Economic-social complexity is an integral part of the problem of Digital Transformation. The difficulty of investing in devices reviewed from a cost point of view becomes a fairly reasonable reason as the cause of the digital divide. (Raj et al. 2020) (Chang et al. 2015) (Aghimien et al. 2020)(Dalenogare et al. 2018; Breunig et al. 2016). Likewise, efforts to gain access such as broadband that is not cheap. (Bakon, Elias, and Abusamhadana 2020) (Wang, Guo, and Wu 2021) (Hong et al. 2017) (Igun 2011) (Jeffrey James 2005) (Acilar 2020) (Ohemeng and Ofosu-Adarkwa 2014), low awareness of the importance of technology (Alenizi 2020)(J. James 2003) (Chang et al. 2015), and the challenges of integrating technology in the value chain (Raj et al. 2020) (Narwane et al. 2021)(Dalenogare et al. 2018; Majeed and Rupasinghe 2017) becoming the problem for developing countries. Other problems that add to the complexity of digital transformation include language limitations because the technology generally uses English. (Jeffrey James 2005)(Jeffrey James 2004)(Arunachalam 1999), and cultural barriers such as

social stratification play a role in the acquisition of access to information (Ohemeng and Ofosu-Adarkwa 2014) (Dimaggio et al. 2004). For example, in developing countries in Southeast Asia, Indonesia is the country with the highest internet penetration (Nikkei Asian

Review 2018; MCKinsey 2016; Tjiptono, Arli, and Viviea 2016), yet lower in the Digital Transformation readiness index (Dutta and Lanvin 2021). Internet penetration is just one part of the broader axis of digital inequality. Thus, it cannot reduce the multidimensionality of the digital divide to the dichotomous difference between those who access and those who do not (access) the digital realm. (Ragnedda and Muschert 2017; Ragnedda and Kreitem 2018). Technological maturity is one of the supporters of Digital Transformation readiness. However, it is not necessarily able to thoroughly assess the readiness for Digital Transformation. In Indonesia, there is a measurement of industrial readiness in the face of the industrial revolution 4.0. The Ministry of Industry of Indonesia (2018) introduced the *Industrial Level Readiness* 4.0 measurement called INDI 4.0 or *Indonesia Industry 4.0 Readiness Index* (Kementrian Perindustrian RI 2018). This model measures the readiness of industry to welcome the industrial revolution 4.0. The measurement dimensions consist of Management and Organization, People and Culture, Products and Services, Technology and Factory Operations (Kementrian Perindustrian RI 2018). Revolution in many countries in preparing their infrastructure ahead of the industrial revolution 4.0 is suspected to contribute to bridging access problems (van Dijk 2005). There are several digital maturity measures that are further discussed in the literature chapter. The digital maturity measurement model has diverse dimensions. Many maturity models focus on evaluating and judging based on different levels of evolutionary maturity. While some models use status-based levels that describe the level of digital penetration in their internal processes, others use specific archetypes of the company such as agility, customer focus, and strategy. (Damle and Grover 2020). The adoption of a multidimensional digital maturity model is required to get a complete picture of the success of Digital Transformation. Digital maturity measurement is needed to determine the position of an organization's digital transformation (Teichert, 2019) through various dimensions that affect Digital maturity. Therefore, the identification of digital problems and the status of digital maturity in real terms from time to time independently is needed to support the success of digital transformation optimally. (Chanias and Hess 2016) (Chesbrough 2010).

This paper uses the Design Science Approach methodology (DSRM) ((Johannesson Paul 2014) to produce an artifact in the form of Self-Assessment Digital Transformation Maturity Index services for developing countries, especially Indonesia. DSRM is a specialized methodology in Design Science and Information Science. Design Science emerged in the late 1960s, focusing on the study of the process of transforming needs and demands into structures that can meet those demands (Hubka and Eder 1996). DRSM's focus is the design of valuable artifacts that potentially contribute to the organization's capabilities by solving specific problems. This paper aims to present DSRM as a methodology for developing technical applications and the design, development, evaluation, and implementation of measurement of digital transformation in organizations. This paper is divided into several chapters. In the first part, the problem is briefly described. The following section is a literature review that describes the DSR method. In chapter 3, the method of working on the paper is presented and detailed in chapter 4. Furthermore, discussions and conclusions are presented at the end of writing.The designed methodology effectively fulfills the objectives of each Design Science activity and

adds references to the development of Design Science Research in IS science disciplines.

2. Literature Review

2.1 Design Science Research Methodology

Design science (Hubka and Eder 1996) is the scientific study and creation of artifacts developed and used by people to solve practical problems of the public interest. DSRM is generally used to design new services, such as artifact applications (Johannesson and Perjons 2014). Artifacts are objects made by humans with the intent to be used in solving a practical problem. Artifacts can be of four types, as described by Gregor and Hevner (Gregor and Hevner 2013; Hevner et al. 2004): Construction (provides vocabulary and symbols used to define and understand problems and solutions); Models (representations of possible problems and solutions, mathematical models, diagram models, and logic models); Methods (algorithms, practices, and protocols for performing tasks); or agency (a physical system that works in nature, such as a medical device or information system that stores, retrieves, and analyzes electronic medical record data). The artifact must present two essential characteristics: purposefulness and novelty. It must solve a significant problem (purposefulness) innovatively (novelty).

According to Paul Johannesson et al. (Johannesson Paul 2014), a method framework for DSRM includes five main activities (figure 1): problem investigation and definition of requirements and artifacts' design and development and demonstration and evaluation.

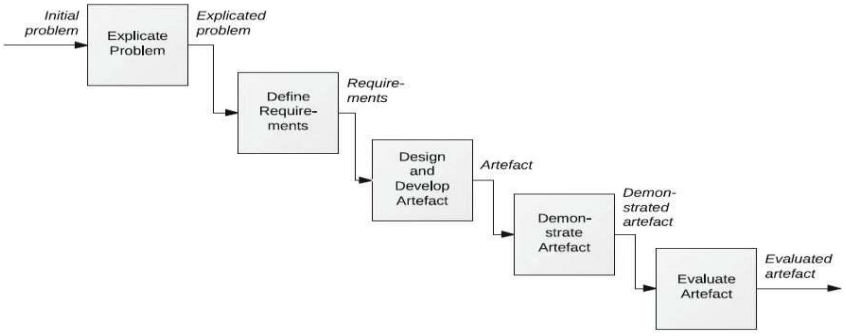

Figure 1 Method Framework for Design Science Research (Johannesson Paul 2014)

Explicate problem, investigates, and analyzes practical problems (Johannesson Paul 2014; Gough, Checkland, and Scholes 1991). The issue needs to be formulated precisely and justified by showing that it is essential for some practices. The problem must be of public interest, i.e., significant to one local practice and some global practices. Furthermore, the underlying cause of the problem can be identified and analyzed (Bresky 2007). The next

activity is the Define Requirement Activity. The Define Requirement activity outlines the solution to the described problem (explicated problem) in the form of artifacts. It brings up requirements, which can be seen as transforming the problem into demands on the proposed artifact. Requirements will be defined not only for functionality but also for structure and environment. Artifact Design and Development activities create artifacts that address the described issues and meet the specified requirements. Designing an artifact includes determining its function as well as its structure. The Demonstrate artifact activity is also called "proof of concept", explaining the use of artifacts developed to the user to prove the feasibility of the artifact being built. Demonstrations will show that artifacts can solve a problem. Artifact Evaluation activities determine how well artifacts meet requirements and solve problems.

DSRM activities can be done iteratively and move back and forth between all activities according to research needs. Therefore, these five activities in the design science framework do not have to be sequential. The relationship between one activity and another activity as an input-output relationship.

2.2 Self-assessment Digital Maturity Index

The presence of Digital Transformation is an important phenomenon for organizations. The revolution to accelerate business processes, models, and business practices by utilizing technology adoption opportunities is a digital transformation practice(Vial 2019). Changing the digital landscape is a requirement for partners, employees, and customers (Remane et al. 2017) to jointly realize digital transformation. Business models are undergoing changes in the future with the incorporation of digital technologies such as cloud computation, big data, social media, and mobile internet (Bharadwaj et al. 2013). Digital Transformation becomes an outline that represents the strategy of how an organization undergoes significant changes to be able to survive the technological era. Various studies formulate a digital transformation framework covering four areas: digitization of customer experience, operations, products and services, and organization. According to Dion Hinchcliffe(Damle and Grover 2020), the digital transformation framework is an ongoing cycle of growth, refinement, and change underpinned by critical pillars of cultural change, skills building, executive leadership, and business model redesign, strategic goals, and roadmaps. While the business model focuses on scientific research and management practices (Johnson, 2012), companies deploy new technologies and ideas with the help of business models (Chesbrough 2010).

From a managerial point of view, digital maturity is defined as the position of digital transformation of an organization. It explains what activities have been achieved and planned as transformation efforts (Chanias and Hess 2016). Model maturity explains how organizations build transformation strategies and what steps organizations take for those transformations (Teichert 2019). In the academic literature, there is a way of measuring digital maturity through revenue generated by digital offerings in products and services. However, the indicator describes only a few aspects of digital transformation. It is not enough to have a broader view of a digital maturity model. Therefore, companies need digital maturity models with multidimensionality.

When facing digital transformation, companies in the digital age need to implement comprehensive methodologies such as digital strategy, digital capabilities, IT development, collaboration, transparency, and agility (Fischer et al. 2020). Three main factors are driving the need for digital transformation, namely 1) the increasing internet penetration and the increasing adoption of accompanying technologies such as cloud computing and digital payment systems, 2) the intensity of competition from large global companies such as Apple, Amazon, Facebook, and Alibaba has dominated various industries., 3) changes in consumer behavior in response to the digital revolution as there

is a shift in customer preferences towards online purchases. (Verhoef et al. 2021; Damle and Grover 2020). There are various models of digital maturity with various dimensions in different countries. This dimension includes aspects of transformation management,

digitization of internal operations, digital products and service offerings, and digital customer interaction. Several models of digital maturity with their dimensions and maturity levels are presented in Table 1

Table 1 Several Digital Maturity Model

Model Maturity Index	**PWC**(PWC 2016; PwC 2016)	**Deloitte/ TM**(Deloitte Switzerland, ACSC, and ƒ 2018)	**MIT/ Capgemini**(Fitzgerald et al. 2013)	**Forrestor's** (Gill, Martin; VanBoskirk 2016)
Dimension	1. Digital business model and customer access 2. Digitization of products and service offerings 3. Digitization and integration of vertical and horizontal value chains 4. Data and analytics as core capabilities 5. Agile IT architecture 6. Compliance, security, law, and taxes 7. Organizations, employees, and digital culture	1. Customer 2. Technology 3. Strategy 4. Operation 5. Organization & Culture	1. Strategic Assets 2. Internal operations 3. Digital Capabilities (Digital Vision, Governance, Engagement)	1. Culture. 2. Technology 3. Organization 4. Insight
Digital Maturity Level (Remane et al. 2017)	1. Digital Novice 2. Vertical integrator 3. Horizontal Collaborator 4. Digital Champion	1. Initiating 2. Emerging 3. Performing 4. Advancing 5. Lead	1. Beginner 2. Fashionistas 3. Conservative 4. Digiratis	1. Skeptic 2.Adopter 3.Collaborator 4.Differentiator

Meanwhile, various issues must be addressed by organizations in implementing Digital Transformation. Some of these issues include (Damle and Grover 2020; Henriette, Feki, and Boughzala 2016): Inadequate internal skills, integration of new technologies, Strategic change,

and Short-term outlook challenges. In summary, these issues are mapped out on the digital divide. The Digital Divide defines it as digital inequality in aspects of access, skills, and outcomes. There is a difference in the digital divide between developed and developing countries. Various factors that affect differences in digital harmony include the level of well-being, income, education, and culture. These factors are part of socio-economic and cultural. Therefore, measuring the level of digital maturity needs to consider the digital gap factors, both socio-economic and cultural. (JAN VAN DIJK 2020). This research focuses on applying design science research methodology to produce an artifact in the form of digital maturity measurement services independently. The results of this study also answer the needs of management and society in general. It further finds out the position of readiness for digital transformation through activities that have been carried out or planned by the company to support digital transformation. The measurement of digital maturity independently that exists today is very limited, for example, strengthening independent digital life in taxation and particularly discussing taxes. In addition, multidimensional coverage is needed to accommodate a broader understanding of the concept of digital maturity models, as described earlier. Comparison analysis of various digital maturity models is needed as part of the Explicated Problem stage process that will be explained in the next chapter.

3 Method

3.1 Stages of Research Implementation

This research uses the *Design Science Research Methodology* (DRSM) approach by accommodating its framework (Johannesson Paul 2014). There are five activities in the framework: Explicated Problem, Define Requirements, Design and Develop, Demonstrate artifact, and Evaluation. The research steps for each activity are presented in figure 2.

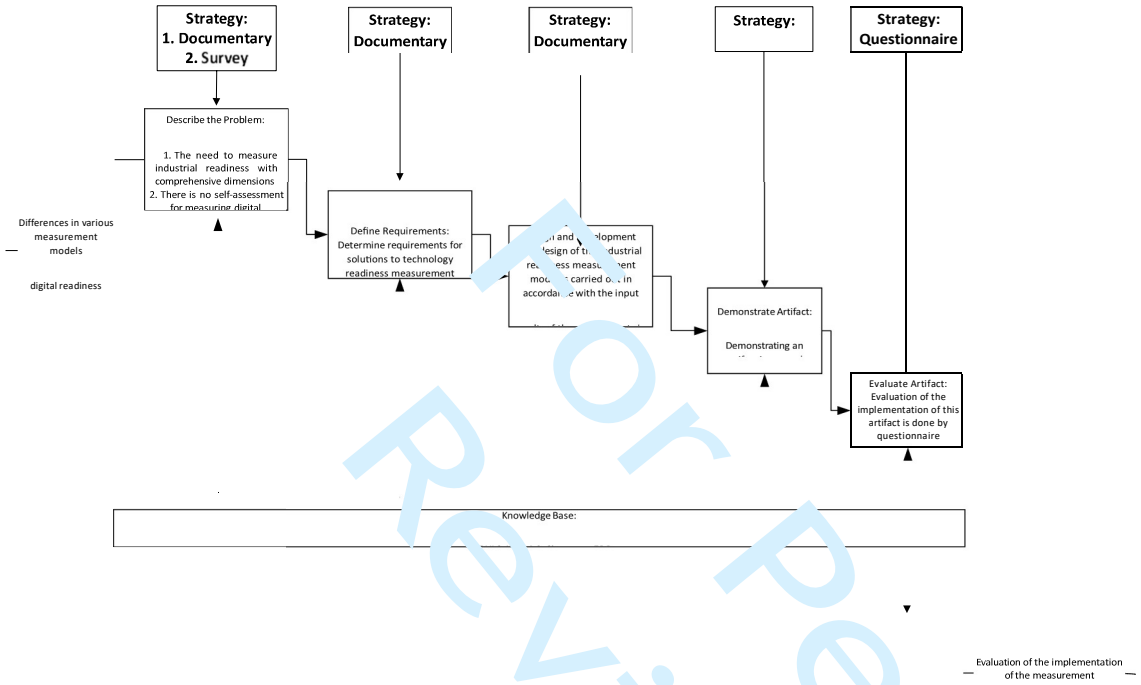

Figure 2 Research **methods step** *of Digital Maturity Index Dashboard*

3.2 Research activities based on the DSRM framework

The initial activity in this study was explicated problems. Input from this stage on problems related to digital maturity index measurement. Strategies for the Explicated

Problem with literature or documentary studies and surveys on the service user industry. In this study, service users covered various sectors that support digital transformation, such as banking, education, and health. The output of the Explicated Problem becomes the input

on the Define Requirements activity. At this stage, the planned strategy is enough literature study to support the procurement of systems or applications – self-assessment digital maturity index. User interviews are conducted to explore in-depth the needs of users. Furthermore, the Define Requirement activity results become inputs for Design and Develop activities. The literature review strategy is used at this stage, while the theory used to measure user acceptance of technology is Delon & McClean's theory (DeLone and McLean 2003). Comparison of various pre-existing models carried out to obtain digital transformation measurement services in organizations. The results of this stage of developing artifacts become input for demonstrating services in the industry. Strategy case studies are applied to the demonstration stage. It is through this demonstration activity that evaluation activities can be carried out. The approach used is a Questionnaire.

4 DSRM implementation in e-self assessment Digital Maturity Index case study

A series of case studies are presented on each DSRM activity to illustrate how the methodology is used when implementing the e-self assessment digital maturity Index

service, (Johannesson Paul 2014). In projects that support digital transformation in the industry, the development of e-self assessment digital maturity index services is needed. This service measures the organization's readiness for digital transformation, technology adaptation status, digital barrier identification, and recommendations for optimizing digital transformation through ranking scores on each dimension of Digital transformation. Digital Transformation, especially in developing countries, cannot be separated from the Digital divide. Therefore, this consideration of digital inequality needs to be considered in measuring the success of digital transformation and future organizational strategies. A different set of research methods is selected for each methodological activity to perform the necessary work tasks (Fig. 2).

4.1 Explicated Problem

Explicate problem in this study investigates and analyzes the digital maturity index and possible Digital Transformation problems in organizations. The demands of technological adaptation become a necessity for organizations to be able to compete. Currently, there are various technology measurement indexes, but the difference in dimensions used in each measurement results in diverse and less comprehensive measurement results. At the same time, the use of repeated technology readiness measurements is not practical. Therefore, a device is needed that can measure the readiness of technology comprehensively. The problem in this study is how to find the dimensions and indicators of the Digital Maturity Index for Digital Transformation in Indonesia based on the multi-dimensional comparison analysis of the Digital Maturity Index.

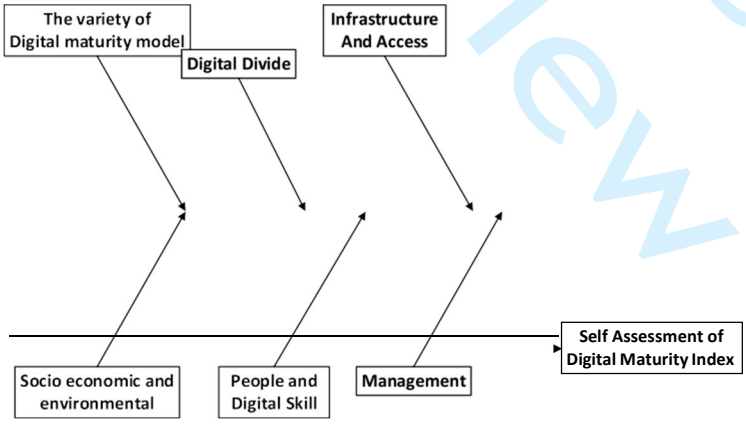

Figure 3 Root Cause Explicated Problem

The strategies used at this stage are documentative and survey. The documentative stage is carried out by studying the problem of measuring technological readiness through documentation of previous studies. The strategy surveys the application of technology measurement models in one of the industries. In DSRM, the problem identification stage is an explicated problem. The initial problem as input at this stage is the need for independent services to measure digital transformation success in organizations.

In comparison, the measurements that have existed vary with various dimensions. Survey methods and document review literature are needed to clarify the problem. The results were obtained by several measurement models with multiple dimensions of

different measurements. In addition, existing measurements have not considered the digital inequalities that are significantly visible between developed and developing countries.

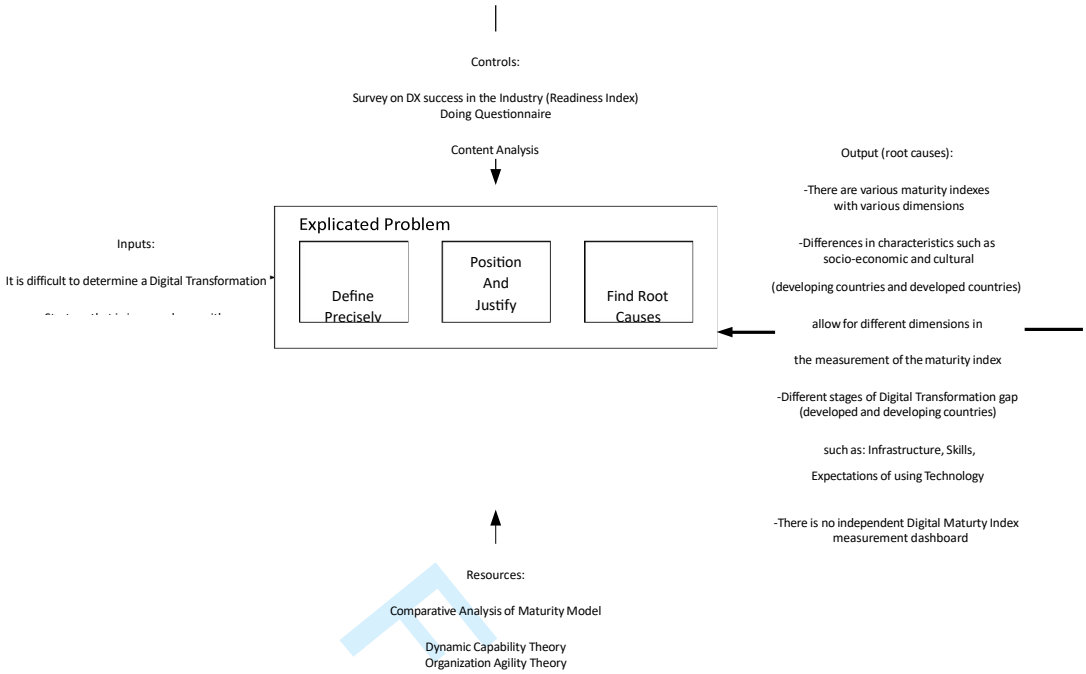

Figure 4 Explicated Problem Activity

A documentative method of studying literature on Digital inequalities is required. There is a shift in the stages of digital inequality in developing countries. Critical factors that continuously affect digital inequality are an issue that must be considered in generating measurement models. In addition, digital transformation adoption measurements need to be presented independently and easily. Thus, the organization can periodically find out the condition of digital transformation readiness in its organization. For organizations, this is an essential problem because it threatens the organization's sustainability in the future. The low adoption of DX is very likely to make organizations unable to compete. As for organizational elements, the identification of problems through the results of DX readiness assessment is important as a management consideration in formulating future strategy. Whether the infrastructure is available, whether workers have enough skills to use it, or whether there is expected value in existing technologies, the answers help management identify problems that hinder DX's success in organizations.

Figure 3 presents the stages in finding the root cause appropriately. Conducting surveys of more than 100 workers in different organizational sectors is needed to find the root cause. Comparative analysis of various digital maturity index models provides

perspective on the range of dimensions used. Furthermore, a documentative method for identifying digital stage trends is needed to support the conformity of DX strategies in organizations. Mapping Explicated Problem activities are generally presented in figure 4

4.2 Define Requirements

This activity aims to identify and create a picture of the proposed artifact to solve the problems described earlier and collect the exact needs of the proposed artifact. Input at this stage is the Explicated Problem discussed earlier.

The problem identified in the Explicated Problem is the need to independently measure the digital maturity index. Outline artifacts based on these problems are models and instantiation, while artifact outline is the stage of choosing the type of artifact designed

to solve the problem. Agency is defined as a working system that can be used in practice. The problem of measuring technology readiness is obtained from the output of the explicate problem, including: (1) There are various maturity indexes with various dimensions, (2) Differences in characteristics such as socio-economic and cultural (developing countries and developed countries) allow for different dimensions in the measurement of the maturity index, (3) Different stages of Digital Transformation gap (developed and developing countries) such as Infrastructure, Skills, Expectations of using technology, (4) There is no independent Digital Maturity Index measurement dashboard (figure 5). Based on these problems, an artifact is needed in the form of a multi-dimensional industrial readiness measurement model that can be carried out independently by filling in the specified criteria. The measurement is in the form of a dashboard that is easy and user-friendly to access. The organization's scope is a lower-middle organization that has used technology and a new organization that will operate with a particular technology. The resulting artifacts can provide a matrix with the weighting/level of each technology readiness measurement factor to provide information for management in determining future progress.

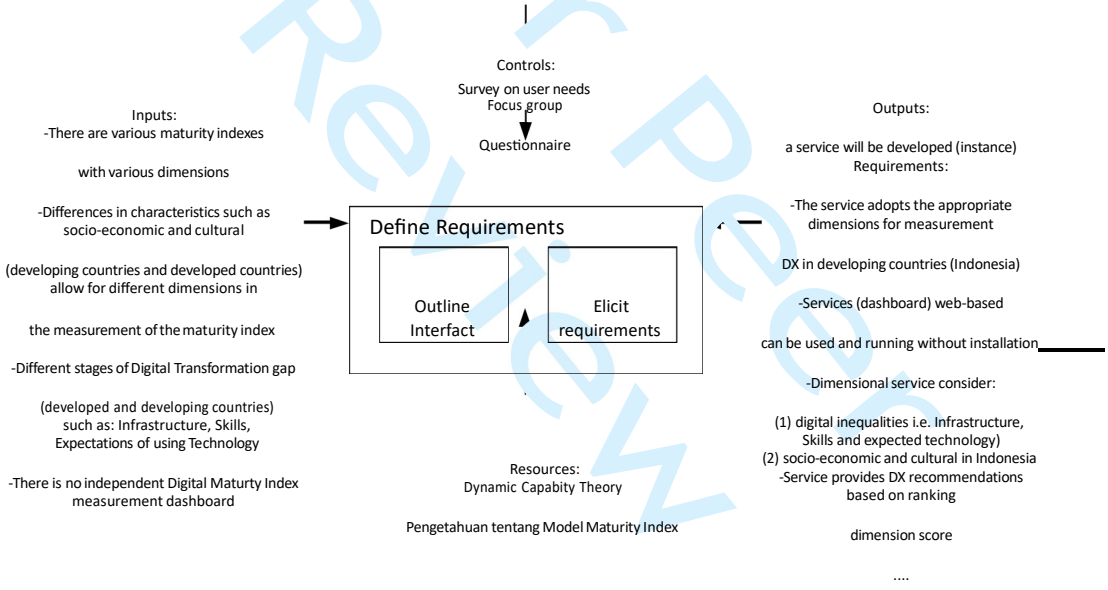

Figure 5 Define Requirements Activity

Two other activities support identifying needs as inputs, namely Resources and Control. The resource for determining the results of this defined requirement activity considers previous research and existing artifacts. Therefore, the comparison analysis of previous

artifacts, namely digital maturity measurement models, was carried out. Differences in dimensions and considerations of digital inequalities can increase the significance of measurements later. In addition, resources at this stage also consider the preferences of stakeholders. Control on defining requirement activities is the determination of research methods and strategies to help identify requirements. Surveys and study documents are the controls chosen at this stage. Surveys on several stakeholders across organizations were conducted to explore the adoption of Digital Transformation in their organizations. While the study document conducted is with the literature study model digital maturity index and the comparative analysis of the model. Dynamic Capacity simultaneously measures organizational agility and is considered one of the supporting

documents of this stage. Outline artifacts in this study are the development of e-self assessment Digital Maturity Index service.

The "Define Requirements" activity input is the output of the Explicated Problem (see Figure 5). The Define Requirements activity generates the functional and environmental requirements to support the Artifact Design and Develop activity. The functional requirements generated in the Define Requirements activity include: (1) Dashboard, as a result of this research, the artifact can be run on a web browser without the need for installation, (2) To maintain data security, user and password are required in the application, (3) the service considers the stages of Digital Transformation and its inequalities in developing countries, (4) the service provides scoring on each measurement dimension, (5) the service provides recommendations for strategies for achieving digital transformation based on the measurement score, (6) the service provides historical information on digital maturity index measurements that have been carried out previously in the form of trends, (7) the service provides detailed progress of the sub-indicators on each dimension, (8) the service must allow users to move seamlessly between devices. While the environmental requirements generated in the Define Requirements activity include: (1) services must adopt appropriate dimensions for measuring Digital Transformation, especially in developing countries, (2) services must be easy to maintain, and (3) services must be integrated with social media services such as Facebook, Twitter, and Google+, (4) services must be platform-independent and adaptable to mobile platforms such as Android and iOS, (5) services must be easy to use. The stages of defining requirements in this discussion are presented in Figure 5.

4.3 Design and Develop

Based on the problems presented in the explicate problem section and the requirements specified in *the defined requirement,* the artifact produced in this study is the creation of a Dashboard Digital Maturity Index.

In the Design and Develop stage, there are four sub-activities: 1) Imagine and Brainstorm, 2) new ideas generated or elaborated with existing artifacts; 3) Assess and 4) Select are the ideas produced assessed so that designers can choose one or more of

them to be the basis for further design. In the third sub-activity, Sketch and Build, the artifacts are built. In the last sub-activity, Justify and Reflect, designers review design decisions that have been made. In practice, these sub-activities are carried out in parallel and iteratively. Artifact's Design and Develop stage approach is described in more detail and discussed in the following research.

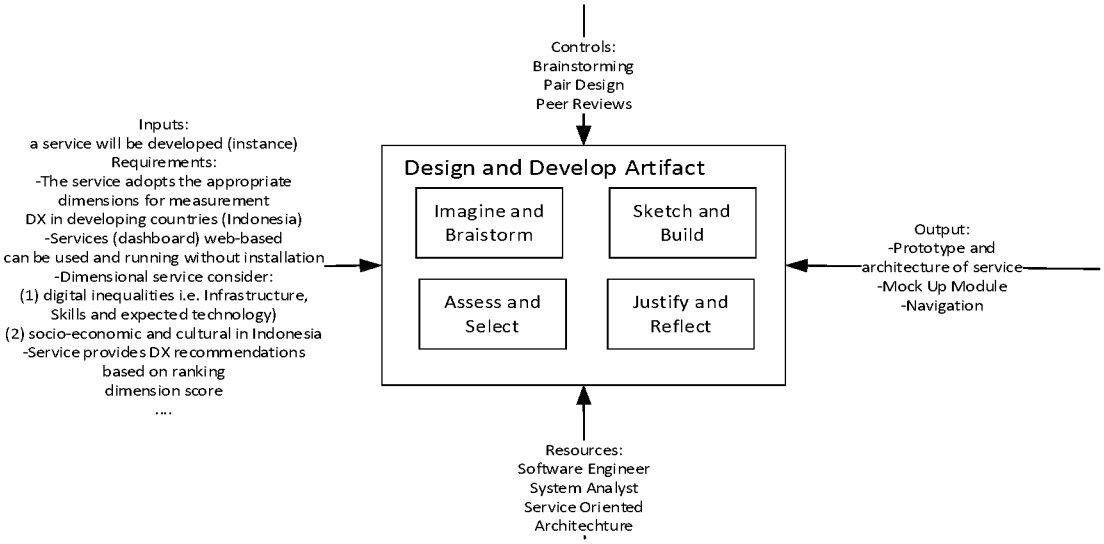

Figure 6 Design and Develop Artifact Activity

Artifact's digital maturity index service is planned to be Web-based. The block of diagrams is presented in chart 7. Users of this application can access the application as safely as possible with password protection. Furthermore, users can input data according to the criteria requested by the application. These criteria are translations of dimensions and indicators obtained from the Digital Maturity Index comparison analysis results. Finally, the system will display a ranking score and strategy recommendations to optimize digital implementation. The app is built on a web basis. The application diagram block is presented in figure 6.

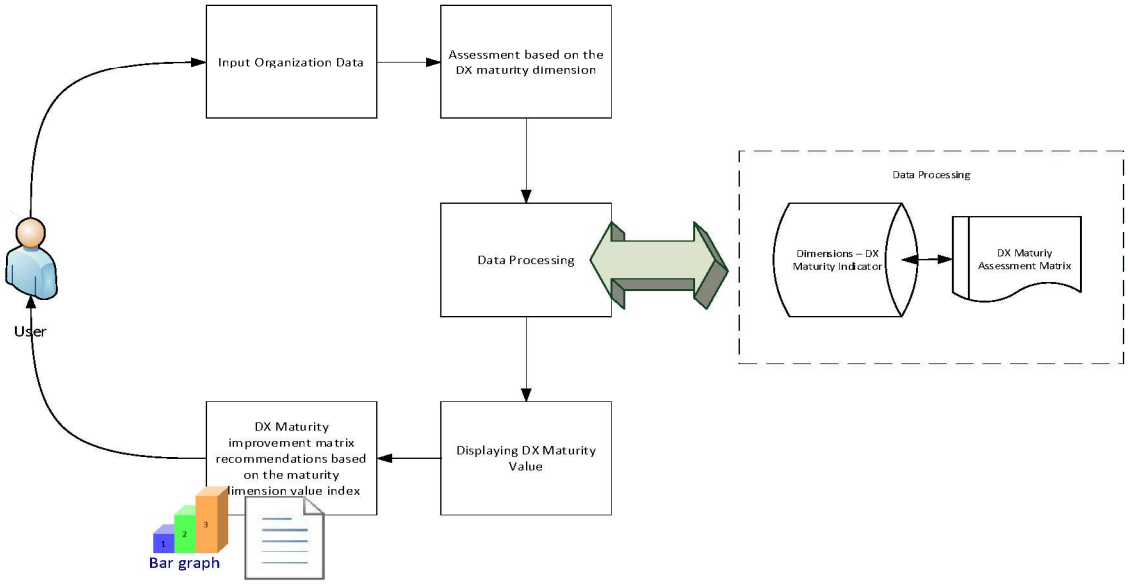

*Figure 7 Diagram block of **self-assessment Digital Maturity Index***

The user runs the application by inputting organizational data. The system will process and assess the digital maturity index based on each indicator. Technical configuration of The Digital Maturity Index Self-assessment service presented in figure 8

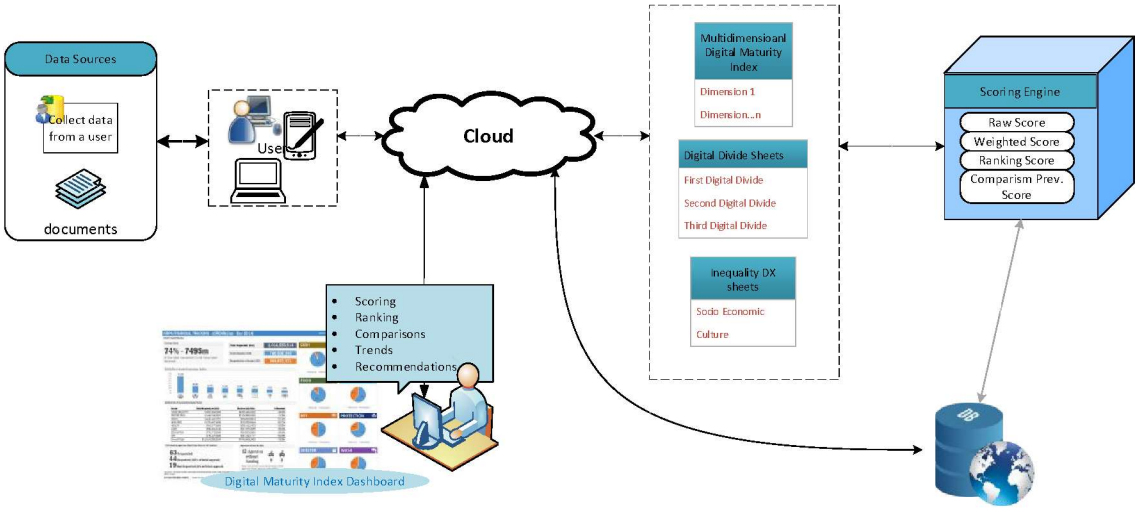

Figure 8 Technical Diagram Self Assessment Digital Maturity Index

The application will provide output in the form of digital Maturity Index values and information on improving aspects of Digital Transformation support based on their dimensions. Users can access various devices and input data according to the items requested on the system. The system carries out a scoring processor by accommodating the dimensions of Digital Transformation, Digital Inequality, and other inequality factors. Furthermore, the scoring system will assess the level of the digital maturity index presented on the dashboard. At this design and development artifact stage, mapping each activity on the dashboard is described with the Service Experience Blueprint (SEB) approach. The SEB method(Patrício, Fisk, and Falcão e Cunha 2008) was developed specifically for designing multi-interface service experiences. SEB builds on existing methods, combining contributions from service management and software engineering to create unifying approaches to address the infusion of technology into services. SEB enables the integrated design of multi-interface services, leveraging the advantages of each channel to enhance the overall customer experience. SEB at each activity stage on the dashboard is presented in figure 9.

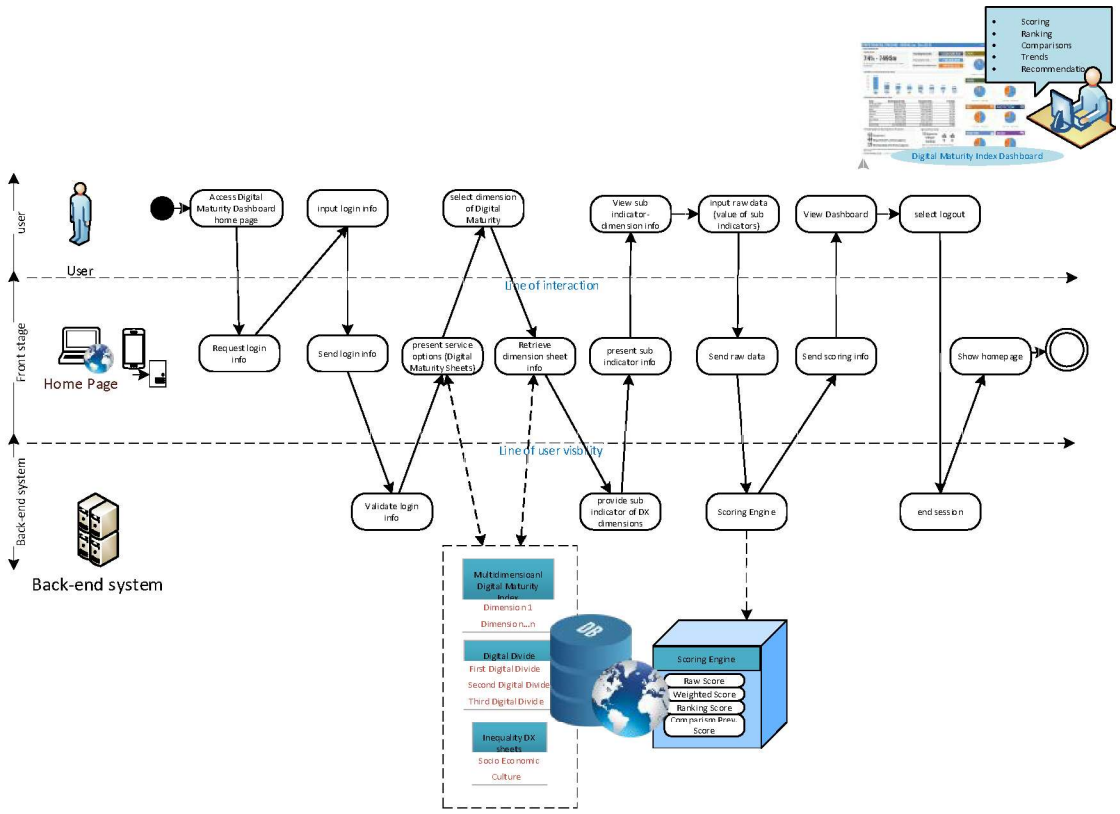

Figure 9 Service Experience Blueprint of Artifact Dashboard

SEB activity in the dashboard application begins with user identification through the login page. After the system carries out successful user verification, the system will display the input location for each indicator and sub-indicator. The score calculation engine will process user input and display the score results on the dashboard. Interaction design and software engineering methods involving case diagrams and activity diagrams of the integrated modeling language(Booch, Rumbaugh, and Jacobson 2005; Grady, Rumbaugh, and Jacobson 2005), also made useful contributions to designing interaction processes. A use case describes the sequence of actions that the system performs to produce useful results for the user (Booch, Rumbaugh, and Jacobson 2005) and can be analyzed at a fundamental or concrete level. In summary, the use case section of the system usage diagram is presented in figure 10

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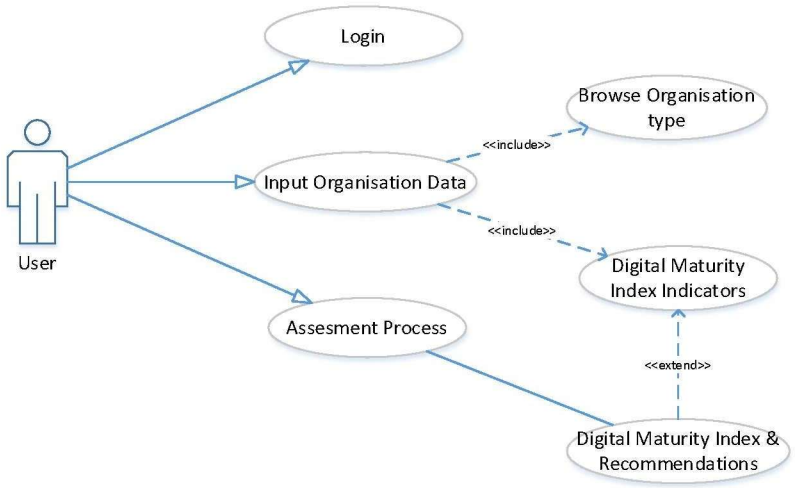

Figure 10 Use **Case Diagram Self Assessment Digital Maturity Index**

The design and development artifact stage presents details of activities and sub-activities. An in-depth review is needed for future research. The Digital Maturity Index Self-Assessment Service displays the measurement of each dimension's score on the Maturity Index, figure.

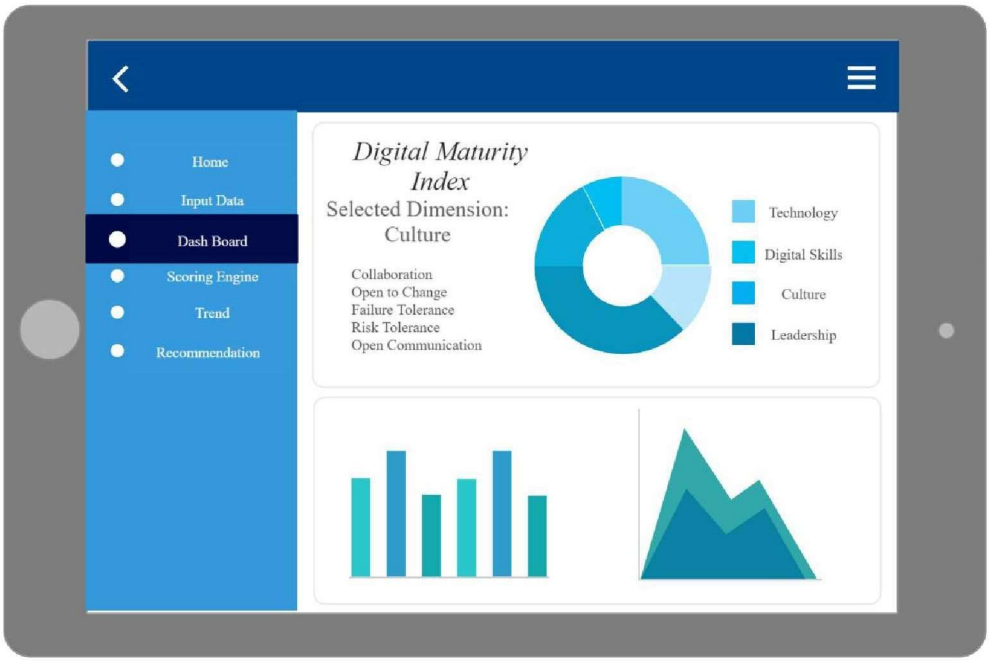

Figure 11 Mockup Dashboard

The dashboard service provides score measurement information on each dimension. Detailed presentation of data on each dimension makes it easy for users to have a specific dimension focused on improving digital transformation success, figure.12

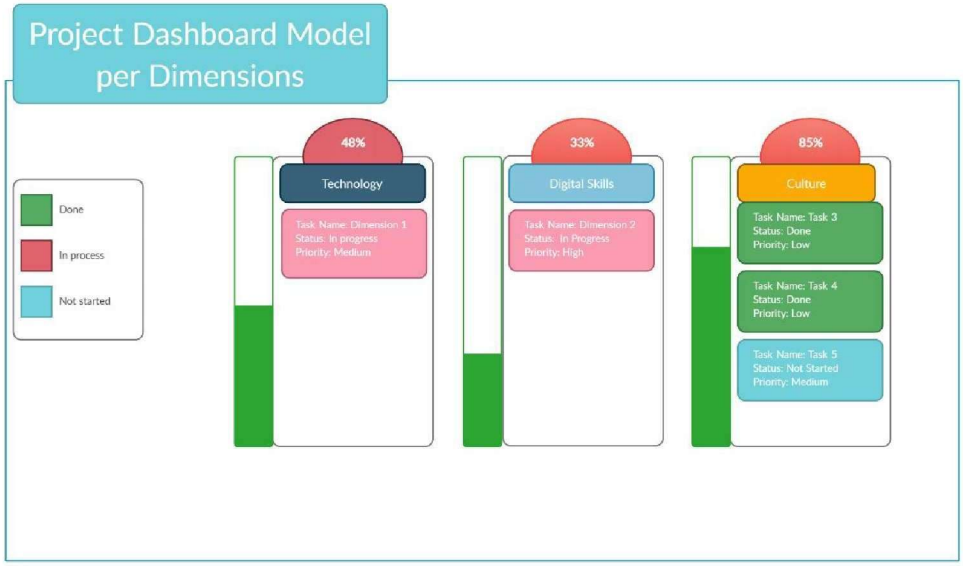

Figure 12 Measurement of each dimension of Digital Maturity

4.4 Demonstrate Artifact

The activity of demonstrating artifacts in this study was carried out by empirical testing on organizations. This demonstration or "proof of concept" is needed to show that artifacts can solve an example problem. At this stage of Demonstrate Artifact, strategies are used with a case study approach. Selection of case studies on the object of one of the national industries located in Indonesia. There are two sub-activities at the Demonstrate Artifact stage: Choose or Design Case and Apply artifact. This study designed artifact self-assessment services as a new service form in this study. This is considering the lack of maturity index measurement services in the form of applications.

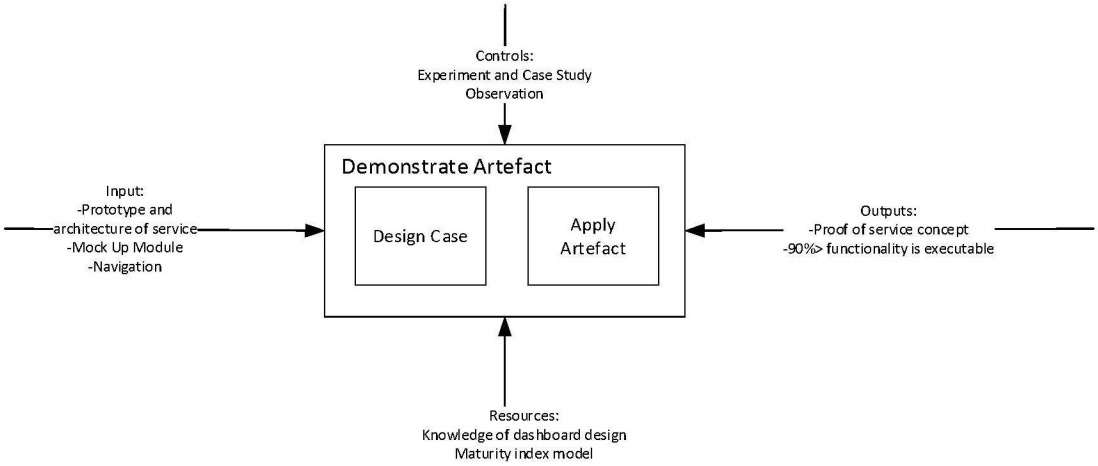

Figure 13 Demonstrate Artifact Activity

The artifact was designed in a case study in the form of experiments. Case design includes [assignment] to users to fill in organizational conditions on several digital

maturity index criteria and existing digital gap stages. As described earlier, there are three stages of the digital divide, namely infrastructure, skills, and outcomes. Ten users of the application conducted a trial for several days to find out the digital maturity index

results trend. Users are granted access to the prototype service, which provides more than 90% of the necessary functionality. The user performs the tasks described above, and the researcher then records all service interactions and analyzes them using quantitative methods. The experiment served as a proof of concept, showing that the service could be used as it should be. Artifact Demonstration Activity summarized in figure 13

4.5 Evaluate Artifact

Artifact Evaluation activities (figure 14) determine how well artifacts meet requirements and the extent to which they can solve, or alleviate, the practical problems that motivate research. Empirical test results become the input of Artifact evaluation. There are three sub-activities in Evaluate Artifact: Analyse Evaluation Context, Select Evaluation Goals and Strategy, and Design and Carry Out Evaluation.

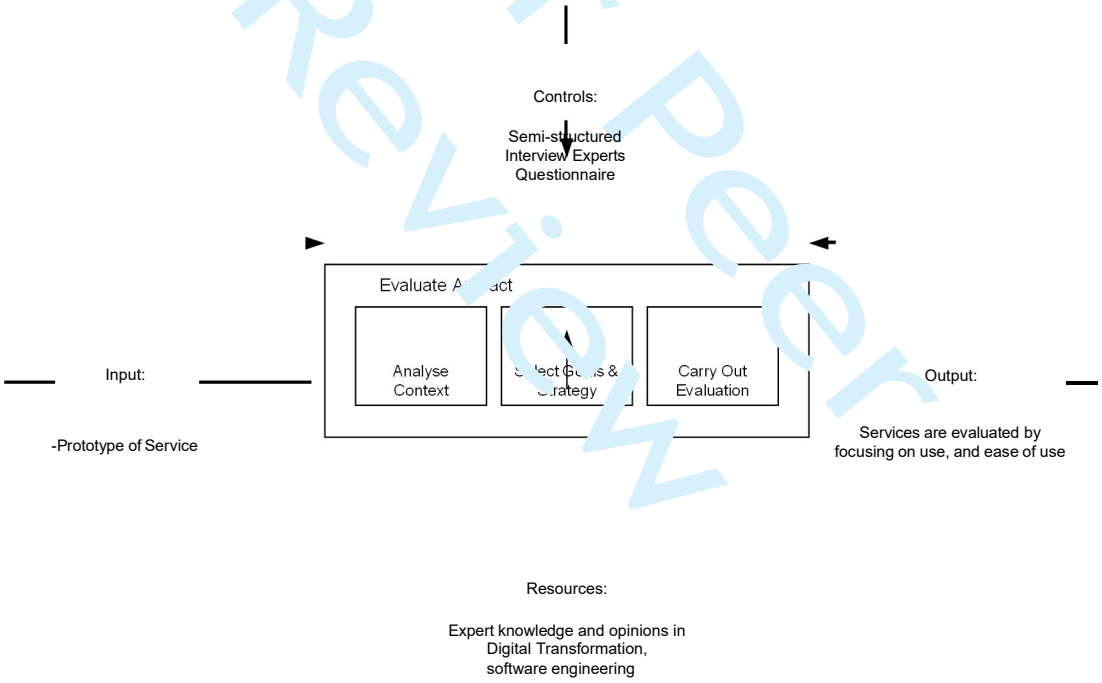

Figure 14 Evaluate Artifact Activity

Analyze Evaluation Context aims to analyze the evaluation context needed to determine the objectives, strategies, and limits for conducting the evaluation. Analyze context (figure 14) explains the participation answered at the evaluation stage in this study, namely how good the Measurement of Digital Maturity Index, which includes multidimensional digital transformation factors by considering Digital Pleasure and resource inequality (Socio-Economic & Culture). The purpose of the evaluation at this stage is the effectiveness of measuring the success of multidimensional Digital Transformation, knowing the scoring, and ranking of DX achievements of each dimension, investigating existing DX problems, and recommendations for accelerating DX achievements through DX ranking scores. While select goal & strategy (figure 14) describes the evaluation carried out in a formative (purpose for improvement). This formative evaluation is carried out by interviewing experts in Digital Transformation to improve services provided on the dashboard. In addition, the next strategy selection

is a test of artifacts directly in the field with an artificial approach. The artificial approach referred to in this study is the existence of respondent requirements determined initially, namely in several sectors such as banking, education, and health.

The last sub-activity, Design and Carry Out Evaluation (figure 14), runs the evaluation process with the strategy that has been selected in the previous sub-activity. The strategy used to evaluate artifact dashboard service self-assessment digital maturity index, among others:

- Phase 1 strategy is carried out in ex-ante (in the form of a prototype) with interview strategies of several experts related to DX, DX support sector (banking, education, health)
- Phase 2 strategy is carried outpost (in the form of the final dashboard) and artificial (respondents determined from the education, health, and banking sectors) with strategy method questionnaire Delon & McClean theory approach to respondents according to industries.

4.6 Visualize the Framework

The framework stages are visualized using IDEF0 Diagram (figure 15). The input in this diagram is the Digital maturity Index dimension, and the Control used is Digital Divide with the support of Socio-economic and cultural resources from the organization.

Artifacts: Digital Maturity Index taking into account Digital Divide

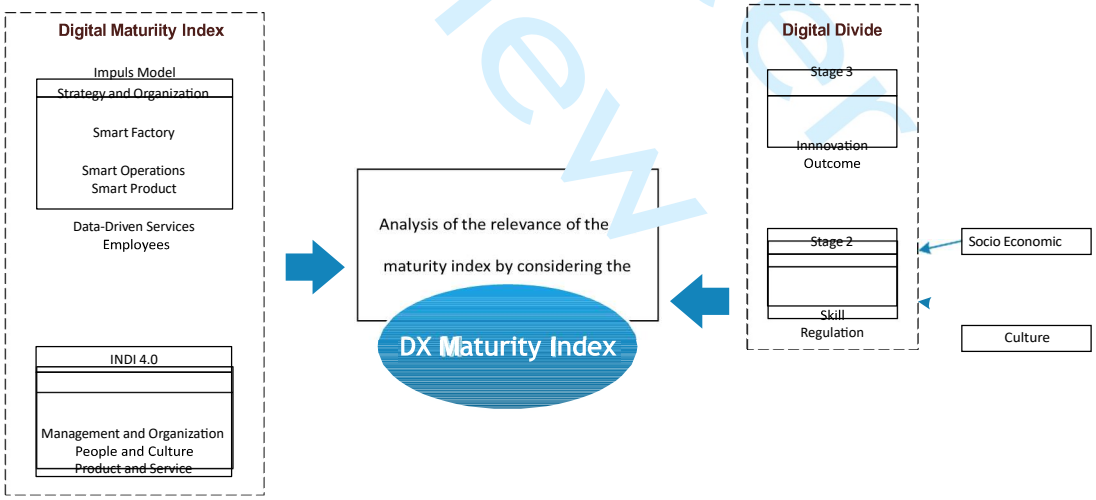

Figure 15 Diagram IDEF0 of Digital Maturity Index

The output on the chart is the Digital Maturity Index Dashboard Application. The Digital Maturity model box on the right side of figure 15 shows the first input of artifact. The comparison analysis of several digital hand measurement models produces a dimension of digital maturity measurement with a comprehensive. While the digital divide box with socio-economic and cultural factor control is an additional input to the artifact. Furthermore, the two inputs (maturity index box and digital divide) are processed in the score calculation machine shown in the DX maturity Index image

(centre box). In the end, the resulting output is the achievement score of digital maturity in each dimension.

4.7 Canvas of Self Assessment Digital Maturity Index

Canvas displays all stages of DSRM. Graphically, the DSRM stage is presented in figure 16. There are four main divisions in canvas, namely activity carried out by Practitioners, researchers, Engineers, and Management. Each of these activities has a sub-activity. Activities carried out by practitioners regarding identifying the problems and technical matters, research activities about the basis of knowledge, constructs, and stages of methodology (Explicate Problem, Define Requirements, Develop Artifact, Demonstrate Artifact, Evaluate artifact. Engineer activity is related to the structure and function of the artifact, while activity manager is concerned with the use and effect of an artifact.

Problem Digital maturity index measurement is needed so that organizations can determine digital transformation strategies that are under DX maturity in the organization. There are various maturity index models, but the model has varying dimensions.	**Artifact** Building self-assessment services for website-based Digital Maturity Index	**Knowledge Base** - Analysis of the maturity ratio of pre-existing models. Dynamic Capacity Theory and Organization Ability Theory are used as a digital transformation capture approach Delon and McClean's Theory is used to assess the acceptance of tenants of artifacts made
Practice The dimensions of maturity index measurement between developed and developing countries are different. This is due to different digital inequalities, both from infrastructure readiness, skills, and technology expectations. Digital maturity index measurement independently is still limited, while organizations need to be faithful when knowing the status of DX maturity in their organization.	**Requirements** The resource for determining the results of this defined requirement activity considers previous research and existing artifacts. Therefore, the comparison analysis of previous artifacts, namely digital maturity measurement models, was carried out. Differences in dimensions and considerations of digital inequalities can increase the significance of measurements later. In addition, resources at this stage also consider the preferences of stakeholders.	**Constructs** Software Requirements used in Artifact creation are described in the Service Experience Blueprint (SEB) and UML

Explicit Problem Finding the dimensions and indicators of the Digital Maturity Index for Digital Transformation in Indonesia based on the digital maturity index multi-dimensional comparison analysis. Consideration of the digital divide, including socio-economic and cultural differences, is needed. The next survey strategy used is to survey the application of technology	**Define Requirements** The Define Requirements activity generates the functional and environmental requirements to support the Artifact Design and Develop activity. In general, the results of the Define Requirements activity include (1) a multidimensional digital transformation readiness measurement model is needed, (2) a digital transformation readiness measurement can be carried out independently by filling in the specified criteria, (3) an easy and user-friendly dashboard to measure digital transformation readiness. The strategy of documentation and secondary data processing is used in the Define Requirements activity.	**Develop Artifact** The artifact produced in this study is the creation of the Dashboard Digital Maturity Index. This application is built on a web basis	**Demonstrate Artifact** The activity of demonstrating artifacts in this study is by conducting empirical tests on the organization. This demonstration or "proof of concept" is needed to show that artifacts can solve an example a problem. At this stage of Demonstrate Artifact, strategies are developed with a case study approach. Selection of case studies on the object of one of the national industries located in Indonesia.	**Evaluate Artifact** Artifact Evaluation activities determine how well the artifact meets the requirements and the extent to which it can solve, or alleviate, the practical problems that motivate the research. Empirical test results become the input of Artifact evaluation. Strategies selected on Evaluate Artifact with a questionnaire approach

measurement models in one of the industries.	Reference collection of technology readiness measurements was carried out and prepared for artifact construction using the Delon and Mc Clean theoretical approach			
Structure Structure to build artifact by creating class concepts in UML. The Diagram Block and part of the use case diagram are presented in this study.	**Function** The service must adopt appropriate dimensions for Digital Transformation measurement, especially in developing countries (environmental requirements). The service can be used multiplatform (functional requirements), and the dashboard can be run on a web browser without installation.	**Usability** The Digital Maturity Index self-assessment dashboard service generates recommendations to optimize Digital Transformation based on each dimension's ranking score.	**Effects** The use of digital maturity index self-assessment services helps organizations to achieve DX maturity status in organizations. The artifact can at the same time, identify at which dimension the organization gets the lowest achievement. Strategy recommendations are presented on the service.	

Figure 16 The Canvas Artifact

5 Discussion

Nowadays, technology is not only used as a tool but has become a necessity. Every organization requires proper disclosure of the use of technology. Knowledge of the level of digital maturity over time is required. Digital Transformation is a continuous cycle supported

by the main pillars of the organization (Damle and Grover 2020), as described in the previous chapter, is an effort to maintain the organization's sustainability in the technological era. The digital maturity measurement determines the position of the organization's digital transformation (Teichert 2019) on various dimensions that affect digital maturity. Models use numerical scores that can be expressed in percentages or absolute numbers. Therefore, identifying digital problems and the status of digital maturity in real terms from time to time independently is needed to support the success of optimal digital transformation (Chanias and Hess 2016). However, this solution has hardly been translated into digital maturity measurement services for end-users, such as enterprises. In general, the problems identified are 2, namely: the problem comes from the fact that various existing digital maturity measurement models have various dimensions. Measurement using various models of digital maturity alternately is certainly ineffective and time-consuming. In addition, the differences in the digital divide and factors that influence it, such as socio-economic and culture, need to be considered in the digital maturity model.

Furthermore, the level of digital maturity needs to be known in real terms over time easily. However, independent digital maturity measurement services are still limited (Suppachok N 2021). Therefore, a digital transformation self-assessment service is needed that can be used

independently by the company. Thus, the status of digital readiness and digital problems can be identified immediately. In building a digital readiness measurement service artifact, it is necessary to look at the entire service creation and development process from the point of view of all stakeholders and users. The DSRM developing self-assessment service artifacts digital transformation maturity model is used in this study. DSRM provides a solid scientific methodology where different people and professionals can come together and share their perspectives on how a new service, application, or product should be developed. This demonstration of independent digital maturity measurement services was conducted in several industrial sectors, such as banking, health, and education. The involvement of various industrial sectors in the implementation of the artifact demonstration stage is expected to provide a comprehensive evaluation for service improvement in the future. The artifact in this study is an instantiation. The researcher aims to make the artifact results a service, therefore, the participation of practitioners is carried out from the beginning of the research. Thus, the involvement of end-users in the demonstration stage, using their input from the service evaluation, became the strategy adopted in this study. The DSRM in this study has accommodated the entire service implementation cycle, from the design stage to the sustainability stage. All processes in the DSRM framework are presented at the artifact self-assessment stage of the Digital Transformation Maturity Index.

6 Conclusion

Currently, Digital Transformation research continues to grow. Various digital readiness measurement models have been studied. There are different dimensions in different models of measuring digital maturity. Many maturity models focus on evaluating and judging based on varying levels of evolutionary maturity. While some models use status-based groups that describe digital penetration in their internal processes, others use specific archetypes of the company such as agility, customer focus, and strategy. Gaining a broader view of the concept of the digital maturity model required the adoption of multidimensional measurements of factors affecting Digital Transformation. In addition, digital inequality needs to be considered at the level of digital transformation maturity, considering that developed countries and developing countries have differences in digital inequality.

Furthermore, the level of digital maturity needs to be known in real terms over time easily. The existence of services that can measure digital maturity independently, anytime, anywhere, helps organizations know the status of digital transformation success in the organization. Thus, digital problems can be immediately identified. The DSRM approach proposes the organization's DX readiness measurement service artifacts independently. To obtain data comprehensively, each DSRM steps are presented. Analysis of the comparison of various artifacts in the form of maturity index models is carried out. Consideration of the digital divide and other factors such as socio-economic complements the existence of this artifact. Artifact demonstrations are proposed to be carried out in several industrial sectors,

such as banking, health, and education. The involvement of several industrial sectors is expected to provide a comprehensive evaluation for future service improvements.

Ethical Compliance: This is an observational study. The Local Ethics Committee has confirmed that no ethical approval is required. Authors have no conflict of interest to declare

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