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Measuring the Digital Transformation Maturity Level independently with the Design Science Research Methodology

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Measuring the Digital Transformation Maturity Level independently with the Design Science Research Methodology

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 needed to build effective research.

Keywords: Digital Transformation, Digital Maturity, Design Science Research Methodology, Digital Maturity Index

1. Introduction

Design Science Research Methodology 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 (Peffers et al., 2007). 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(J. Walls et al., 2004). 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. (Peffers et al., 2007, 2018)(March & Smith, 1995)(Nunamaker et al., 1990)(J. G. Walls et al., 1992)(Berndt et al., 2003)(Rothenberger & Hershauer, 1999)(Tulu et al., 2003)(Peffers et al., 2003)(Wilson, 1986)(Fulcher & Hills, 1996)(Eekels & Roozenburg, 1991)(Reich, 1995)(Takeda et al., 1990)(Adams & Courtney, 2004)(Cole et al., 2005)(Hevner et al., 2004)(March & Smith, 1995)(Nunamaker et al., 1990)(J. G. Walls et al., 1992)(J. Walls et al., 2004)(Vaishnavi et al., 2019; Vaishnavi & Kuechler, 2004)

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.
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, 2010(Offermann et al., 2010), in his work "Artifact Types in Information Systems Design Science - A Literature Review," Peffers, 2007 (Peffers et al., 2007), in his work titled "A Design Science Research Methodology for Information Systems Research," and Hevner, 2004(Hevner et al., 2004), in his work "Design Science in Information Systems Research".

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 (Teichert, 2019). 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 (Eltayeb et al., 2021) The presence of technology allows the opening of new opportunities in the industry(Fernández-Miranda et al., 2017).
DX in the measurement of digital skills is not always about technology (Haryanti et al., 2022). Economic problems, device investment costs, internet (Raj et al., 2020)(Chang et al., 2015)(Aghimien et al., 2020)(Breunig et al., 2016; Dalenogare et al., 2018) access that is not cheap, , low awareness of the use and (Bakon et al., 2020)(Wang et al., 2021)(Hong et al., 2017)(Igun, 2011)(James, 2005)(Acilar, 2020)(Ohemeng & Ofosu-Adarkwa, 2014)understanding of technology, and integration (Alenizi, 2020)(James, 2003)(Chang et al., 2015) of technology are problems(Raj et al., 2020)(Narwane et al., 2021)(Dalenogare et al., 2018; Majeed & Rupasinghe, 2017) 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(James, 2005)(James, 2004)(Arunachalam, 1999). (Ohemeng & Ofosu-Adarkwa, 2014)(Dimaggio et al.,

2004) Another digital divide is influenced by those who access and those who do not (access) the digital realm. (Ragnedda & Kreitem, 2018; Ragnedda & Muschert, 2017) 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 (Damle & Grover, 2020) . The multidimensional adoption of the digital maturity model is necessary to get a complete picture of the success of DX (Chanias & Hess, 2016)(Chesbrough, 2010). This study presents multidimensional digital maturity measurement (Haryanti et al., 2022) 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 (Haryanti et al., 2023). Previous research has been carried out to formulate dimensions related to the measurement of digital maturity (Haryanti et al., 2023).

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 the digital maturity index in this digital maturity measurement artifact includes: Organizational Structure, Technology, Strategy, Employees, Customers, Business Processes, 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" (Haryanti et al., 2022) and "The Extended Digital Maturity Model" (Haryanti et al., 2022)(Haryanti et al., 2023)

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 Research Methodology (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. 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(Hubka & Eder, 1996)(Johannesson & Perjons, 2014)(Gregor & Hevner, 2013; Hevner et al., 2004). 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, (Johannesson Paul, 2014) figure 1

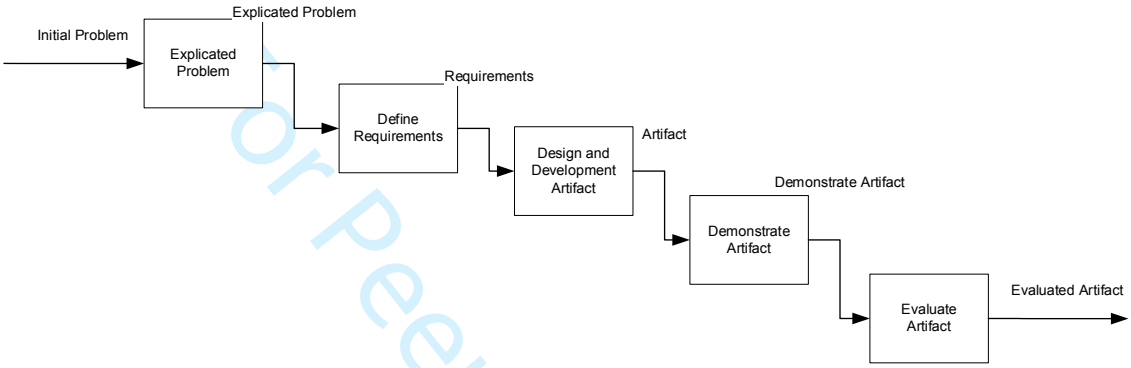


Figure 1 Methods Framework for Design Science Research (Johannesson Paul, 2014)

The explicated problem stage explains the problem and analyzes the practical problem. The challenge at this stage is to find the root of the problem so as to get various alternative solutions to the problem. The problem in question is a matter of public interest. What is meant by the problem that is in the public interest is the significant of local practices and global practices. The 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. (Gough et al., 1991; Johannesson Paul, 2014)(Bresky, 2007) 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 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)(Remane et al., 2017)(Bharadwaj et al., 2013)(Damle & Grover, 2020) of business models, strategic objectives, and roadmaps.

Business models are used by companies to deploy new technologies and ideas (Johnson, 2012),(Chesbrough, 2010) . 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 (Chanias & Hess, 2016; Teichert, 2019). 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 (Fischer et al., 2020). Factors driving of DX include: increasing technology penetration and adoption, competition intensity, and changes in consumer behavior (Damle & Grover, 2020; Verhoef et al., 2021). The various digital maturity models that have existed in previous studies are presented in the following table:

Table 1 Some Digital Maturity Models

Model Maturity Index	**PWC**(PWC, 2016; PwC, 2016)	**Deloitte/ TM**(Deloitte Switzerland et al., 2018)	**MIT/ Capgemini**(Fitzgerald et al., 2013)	**Forrestor's**(gills, Martin; VanBoskirk, 2016)

Dimension	1. Digital business model and customer access 2. Digitization of product 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, legal, and tax 7. Organization, 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 Beginner 2. Vertical integrator 3. Horizontal Collaborators 4. Digital Champion	1. Initiating 2. Appear 3. Perform 4. Forward 5. Lead	1. Beginner 2. Fashionista 3. Conservative 4. Digiratis	1. Skeptics 2.Adopters 3.Collaborators 4.Differentiators

As an effort to achieve Digital Transformation, various problems related to digital transformation must be addressed. Various digital transformation problems (Damle & Grover, 2020; Henriette et al., 2016)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(Jan Van Dijk, 2020).

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 process at the entire DSRM stage.

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 (Peffers et al., 2007) 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-Demonstrate Artifact-Evaluation. The DSRM stages are generally shown in figure 2 (Haryanti et al., 2022)(Johannesson & Perjons, 2014)

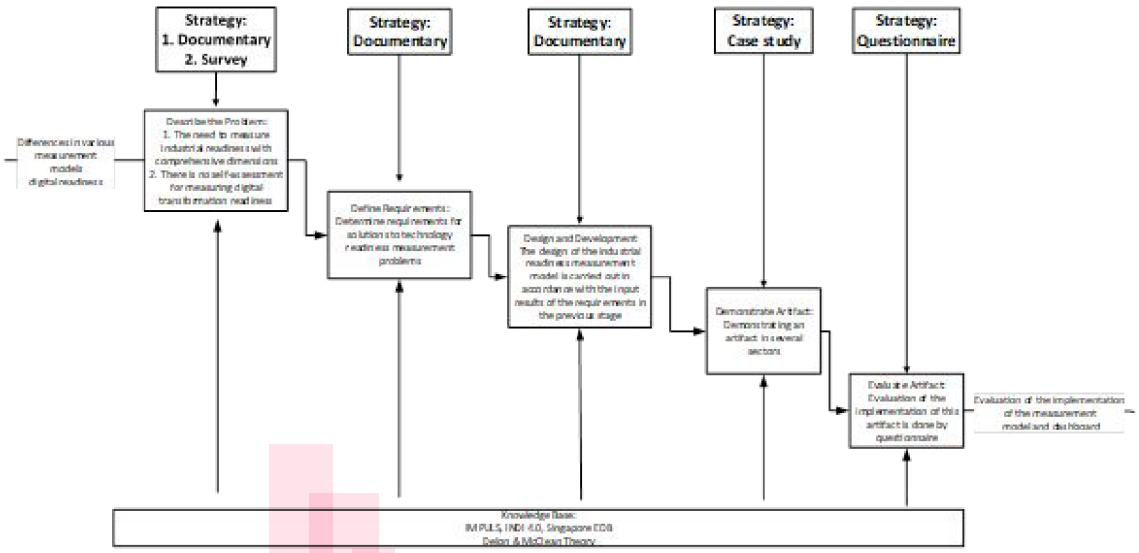


Figure 2 Digital Maturity Index Dashboard research method

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. Artifact in the form of a digital maturity measurement application is proposed as a solution to existing problems. Identification of problems is specifically discussed at the Explicated problem stage. The output of this first stage is also an input in the next stage, namely define requirements. Functional and environmental requirements are defined at this stage. The digital transformation 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 *(DeLone & McLean, 2003; Haryanti & Subriadi, 2020)* . 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 (Haryanti et al., 2023) 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 2 different industrial sectors to demonstrate artifacts as well as evaluate the results of artifact analysis. The Education and service sectors are used to represent demonstrations and evaluations of artifacts

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(Haryanti et al., 2023) 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 2) is a form of DSRM implementation in the digital maturity artifact

4.1 Described Problem

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 diverse and less comprehensive measurement results. At the same time, the use of repeated measurements of technological 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.

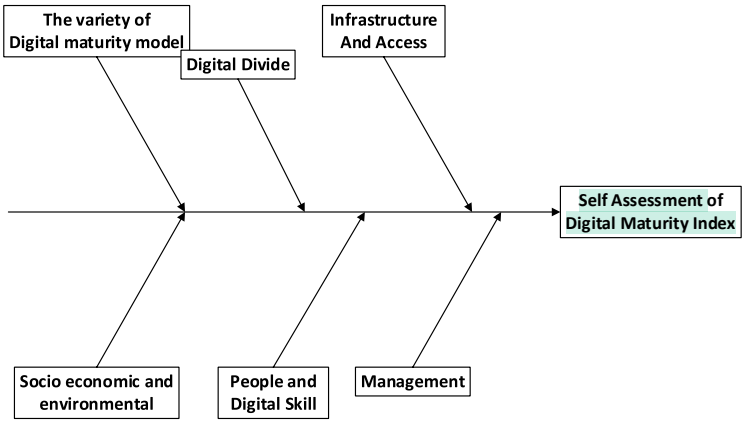


Figure 3 The Root Cause of the Problem Described

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.

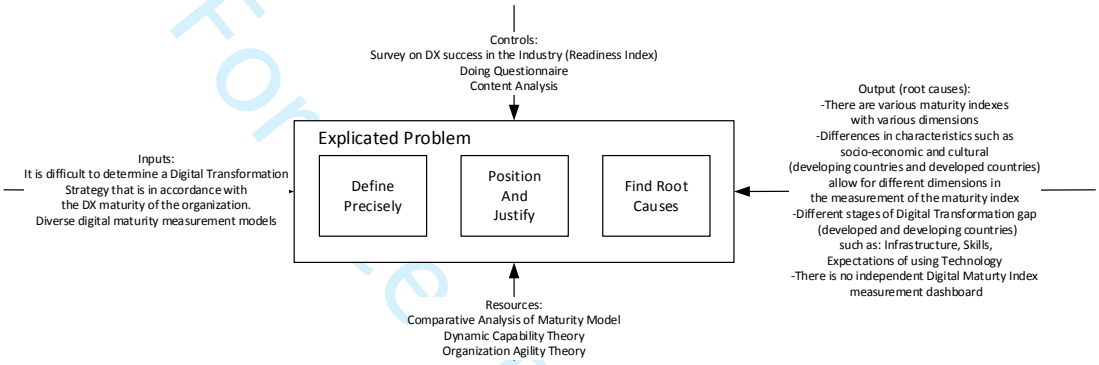


Figure 4 Activity of the Issue Described

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 figure 4

4.2 Define 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 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.

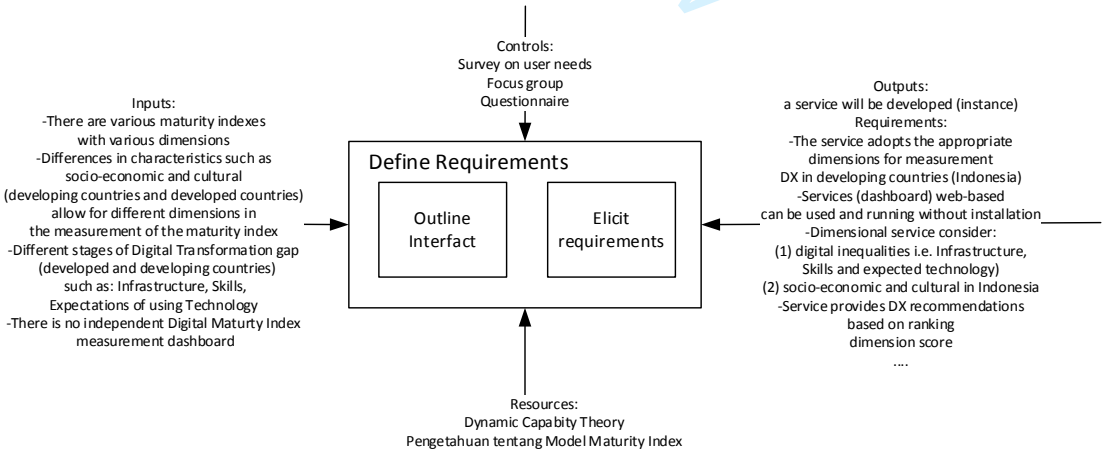


Figure 5 Define a requirement activity

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

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,
2) new ideas generated or elaborated with existing artifacts;
3) Assess and
4) 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 6.

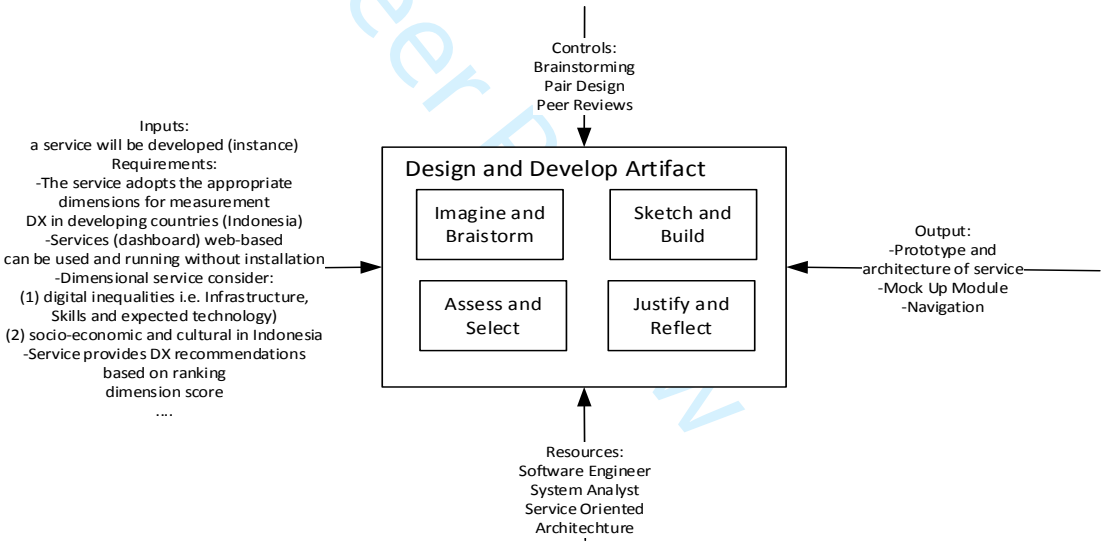


Figure 6 Designing and Developing artifact Activity

This digital maturity measurement artifact uses a website platform. The flow of application activities is presented in the form of a diagram block, figure 7. Dimensions and indicators for measuring the maturity of DX are translated into questionnaires. Furthermore, the data is processed by the system for the calculation of the maturity level of DX.

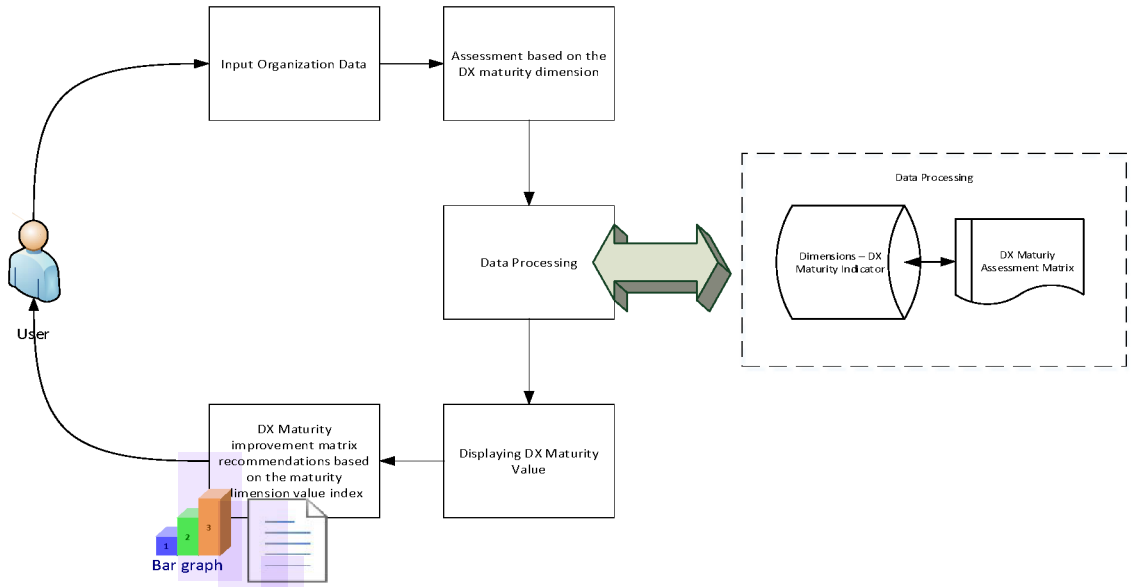


Figure 7 Block Digital Maturity Index self-assessment diagram

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 8.

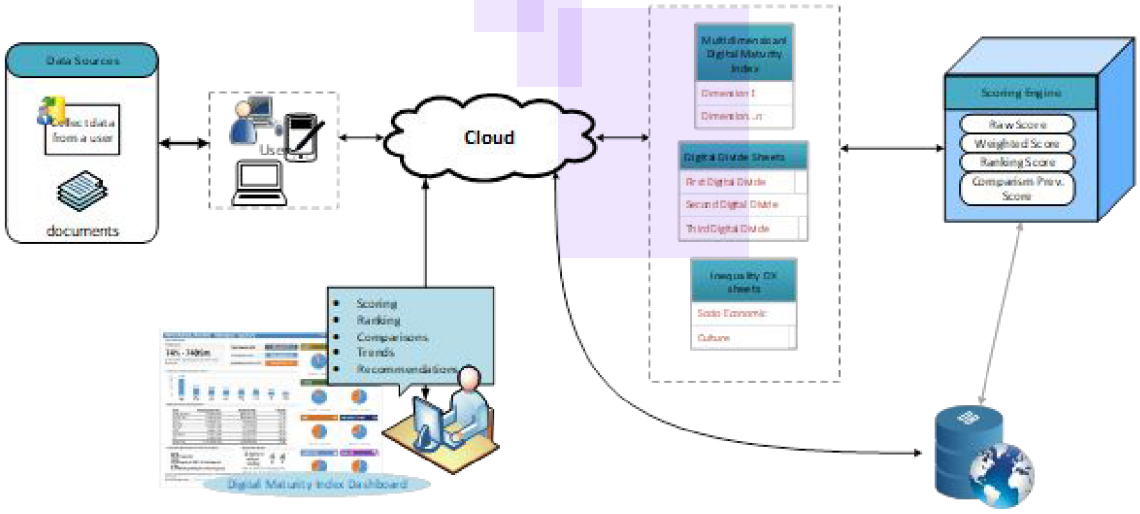
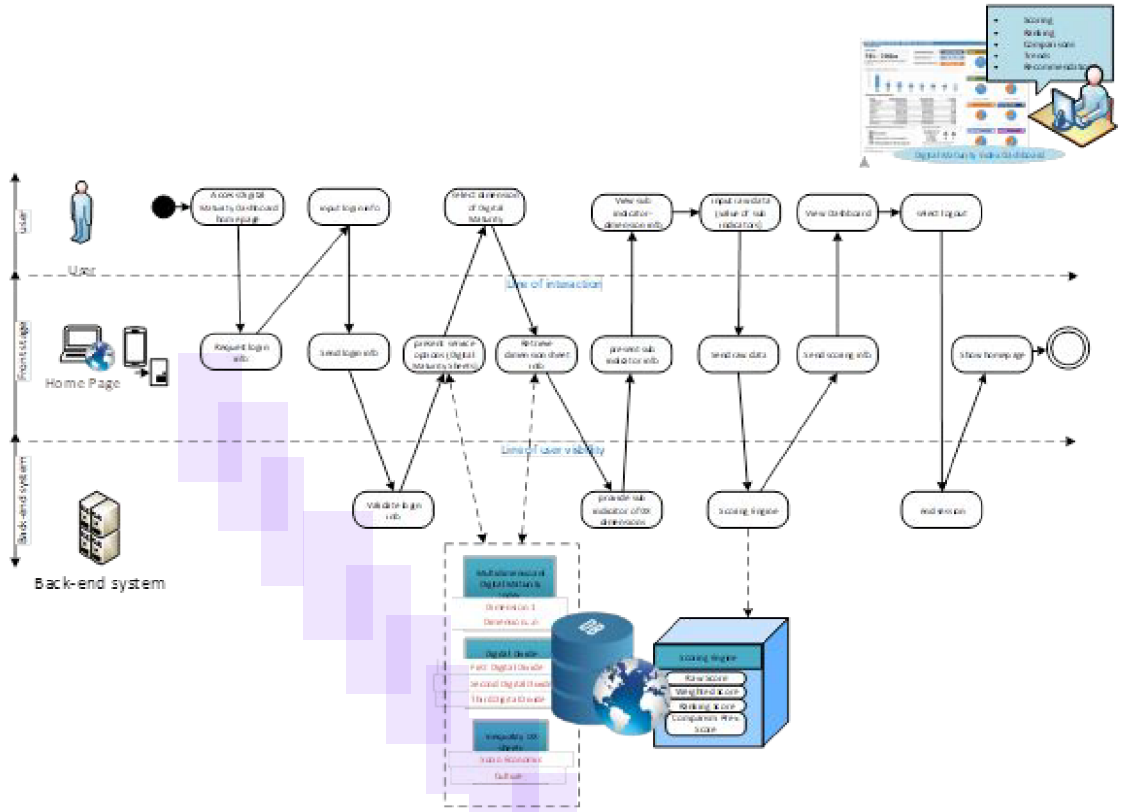


Figure 8

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 (Patrício et al., 2008). The SEB at each stage of the activity on the dashboard is presented in the figure 9



99 Service Experience Blueprint dashboard artifact

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. (Booch et al., 2005; Grady et al., 2005)(Booch et al., 2005). 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 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.

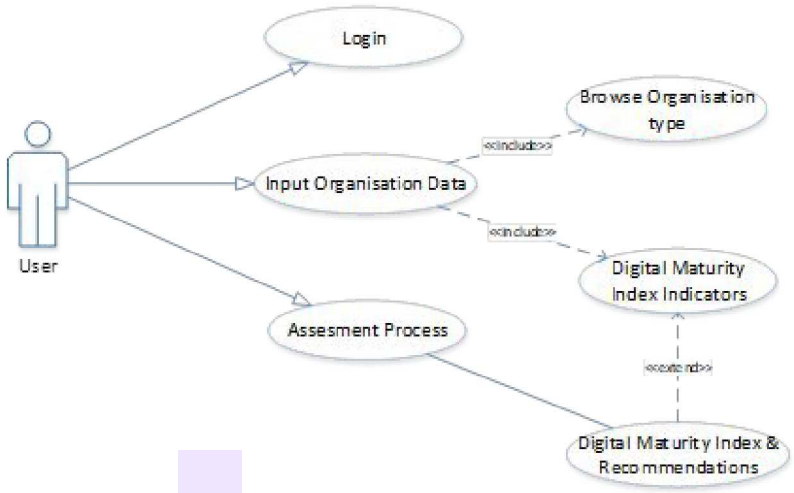


Figure 10 Digital Maturity Use Case Diagram

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

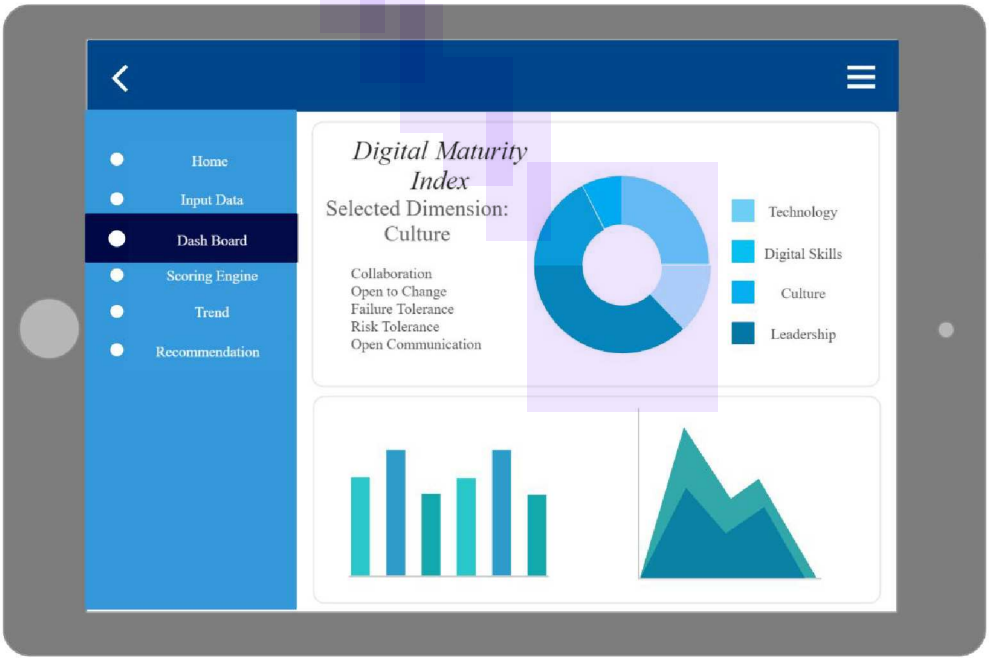


Figure 11 Dashboard Mockup

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 12.

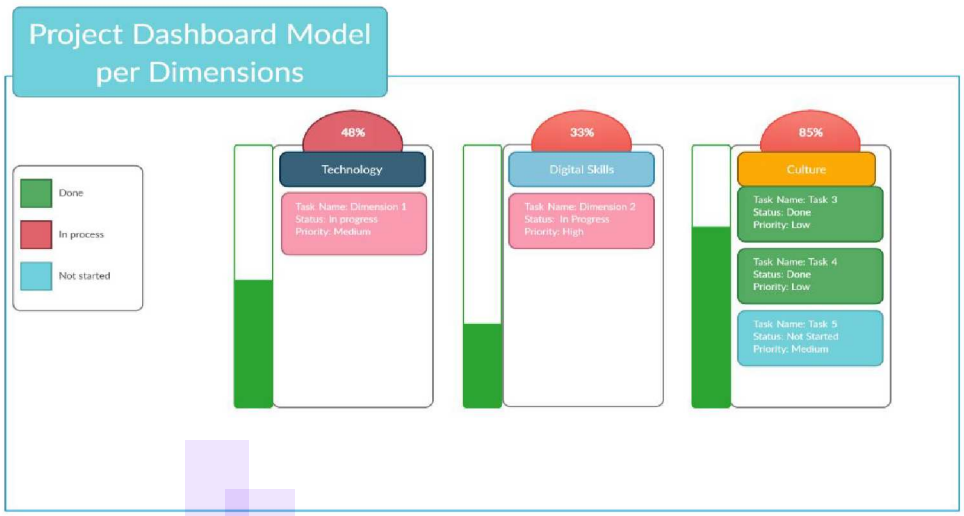


Figure 12 Measurement of each dimension of Digital Maturity

4.4 Demonstrate Artifact

The activity of demonstrating artifacts in this study was carried out by empirical testing on 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, 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 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.

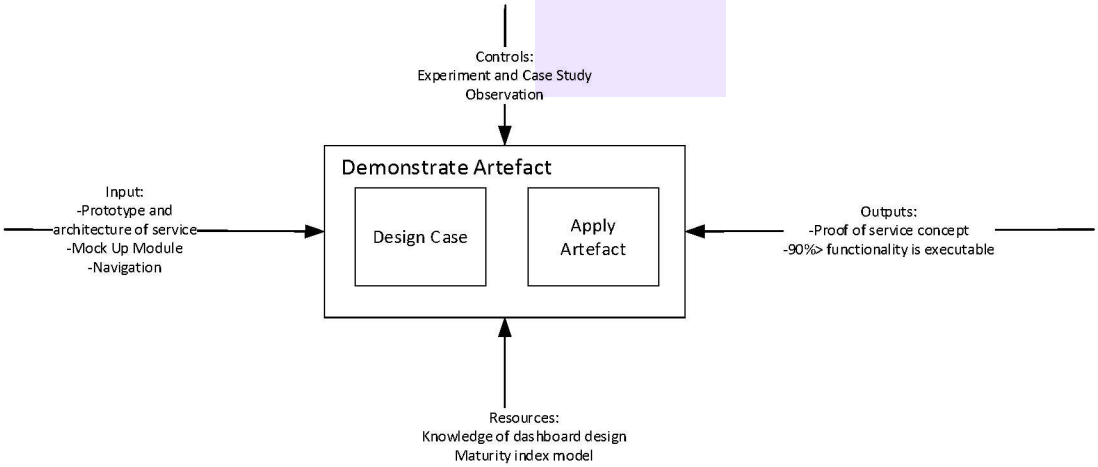


Figure 13 Demonstrating the artifact activity

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 (Akdil et al., 2018; Schumacher et al., 2016).

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

4.5 Evaluation Artifact

The artifact Evaluation activity (figure 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.

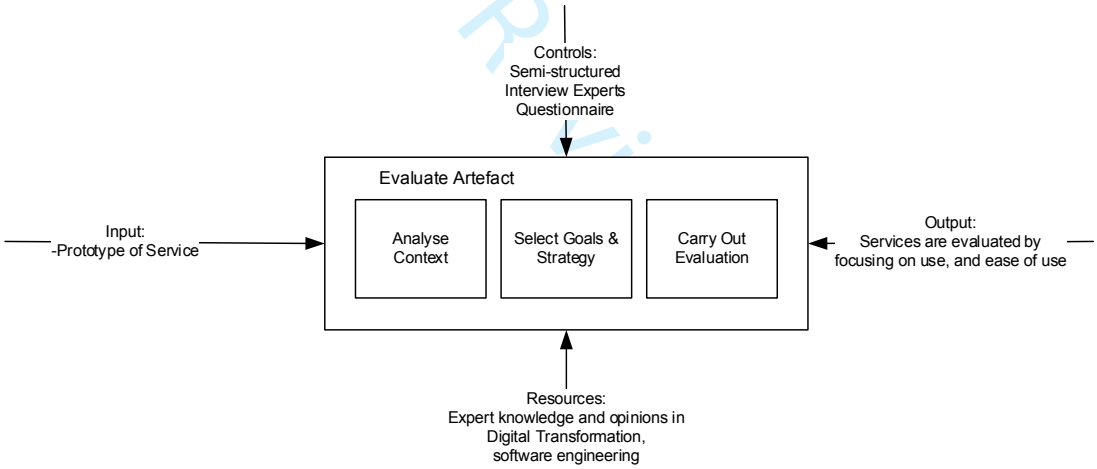


Figure 14 Evaluation of artifact Activity

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) 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 the scoring, and ranking of DX achievements from each dimension, investigation of existing DX problems, and recommendations for accelerating DX achievement through DX ranking scores. While the select goal & strategy (figure 14) describes the 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 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:(Haryanti et al., 2022, 2023)

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).

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 (Akdil et al., 2018; Haryanti et al., 2023; Schumacher et al., 2016) .

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

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.(Akdil et al., 2018)(Haryanti et al., 2022, 2023)

4.6 Visualizing the Framework

The stages of the framework are visualized using the IDEF0 Diagram (figure 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.

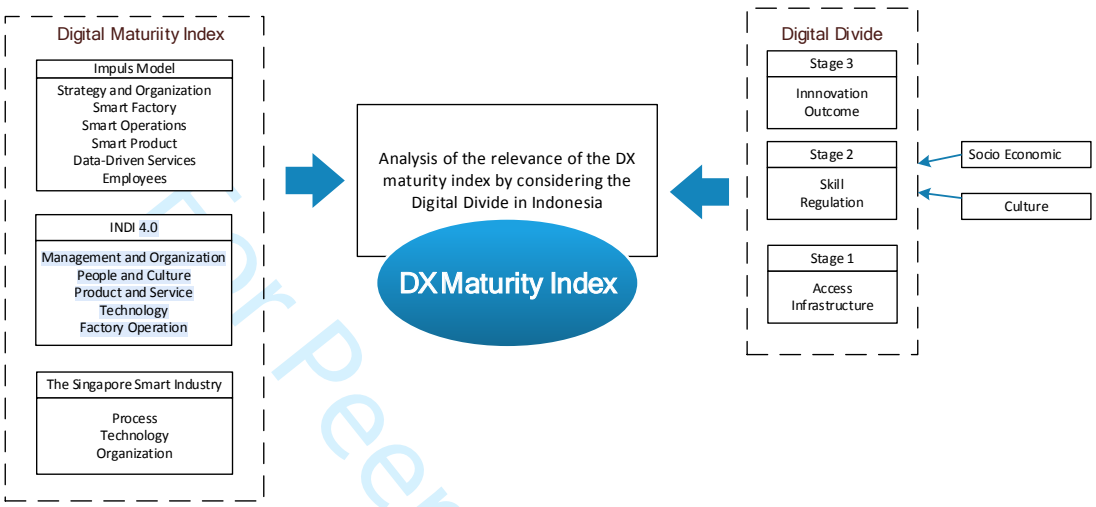


Figure 15 IDEF0 Diagram of the Digital Maturity Index

The output on the graph is the Digital Maturity Index Dashboard Application. The Digital Maturity model box on the right side of figure 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

The canvas displays all the stages of the DSRM. Graphically, the DSRM stage is presented in figure 16. There are four main divisions in the canvas, namely activities carried out by Practitioners, researchers, Engineers, and Management. Each of these activities has sub-activities. Activities carried out by practitioners regarding the identification of problems and technical matters, research activities on the basis of knowledge, construction, and stages of methodology (Explicate Problem, Define Requirements, Develop Artifact, Demonstrated artifact, Evaluate artifact. The activity of the engineer is related to the structure and function of an artifact, while the activity manager is related to the use and effects of artifact.

Problem Measurement of the digital maturity index is necessary so that organizations can determine the digital transformation strategy that is under DX maturity in organizations. There are various maturity index models, but these models have varying dimensions.	**Artifact** Building a self-assessment service for a 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 digital transformation capture approaches Delon and McClean's theory is used to assess tenant receipts from artifacts made
Exercise The dimensions of measuring the maturity index between developed and developing countries are different. This is due to different digital inequalities, whether from infrastructure readiness, skills, or technology expectations. Self-measurement of the digital maturity index is still limited, while organizations must be faithful when it comes to knowing the status of DX maturity in their organization.	**Requirement** The resource for determining the results of these specified requirements activities takes into account previous and existing research artifact s. 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.	**Construction** The Software Requirements used in the creation of artifact are described in the Service Experience Blueprint (SEB) and UML

Explicit Issues Finding the dimensions and indicators of the Digital Maturity Index for Digital Transformation in Indonesia based on a multidimensional comparative analysis of the digital maturity index. Consideration of the digital divide,	**Define Requirements** The Define Requirements activity generates functional and environmental requirements to support Artifact Design and Develop activities. In general, the results of the Define Requirements activity include (1) a multidimensional digital transformation readiness measurement model is needed, (2)	**Develop Artifact** The value generated in this study is the creation of the Digital Maturity Index Dashboard. The app is built on the web	**Demonstrating Artifact** The activity of demonstrating artifacts in this study is to conduct empirical tests on organizations. This demonstration or "proof of concept" is necessary to show that artifacts can solve an example of a problem. At this stage of Demonstration artifact, strategies are developed with a case study approach. Selection of case studies on the object of one of the	**Evaluation artifact** Artifact Evaluation activities determine how well artifact meets the requirements and to what extent it can solve, or alleviate, the practical problems that motivate research. The results of the empirical test become an input

including socio-economic and cultural differences, is necessary. The next survey strategy used is to survey the application of technological measurement models in one of the industries.	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. Secondary documentation and data processing strategies are used in the Define Requirements activity. Reference collection of technological readiness measurements was carried out and prepared for artifact construction using the theoretical approaches of Delon and Mc Clean		national industries located in Indonesia.	for the evaluation of Artifact. Strategies chosen in Evaluate Artifact with a questionnaire approach

Structure	**Function**	**Uses**	**Effect**
Structure to build artifact by conceptualizing classes in UML. Block Diagrams and parts of the use case diagrams are presented in this study.	Services should 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 in a web browser without installation.	The Digital Maturity Index self-assessment dashboard service generates recommendations for optimizing DX based on the ranking scores of each dimension.	The use of a digital maturity index self-assessment service helps organizations to achieve DX maturity status within the organization. Artifact can at the same time, identify on which dimension the organization gets the lowest achievement. Strategy recommendations are presented on the service.

Figure 16 Canvas 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*(Damle & Grover, 2020; Suppachok N,*

2021; Teichert, 2019) in organizations. Each stage is complemented by the implementation of case studies in the construction of artifacts. According to Peffer (Peffers et al., 2007), identifying the problem to reveal the root cause is an important part of artifacts. This is supported by Hevner (Hevner et al., 2004) , that the stages of artifact creation with the DSRM approach accommodate the decipherment of the problem at its core stage*(Chanias & Hess, 2016)*. 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 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 (Akdil et al., 2018; Haryanti et al., 2023). 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.(Hevner et al., 2004; Peffers et al., 2003)

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 (Schuh et al., 2020; Schumacher et al., 2016)(Hevner et al., 2004; Peffers et al., 2007). 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.

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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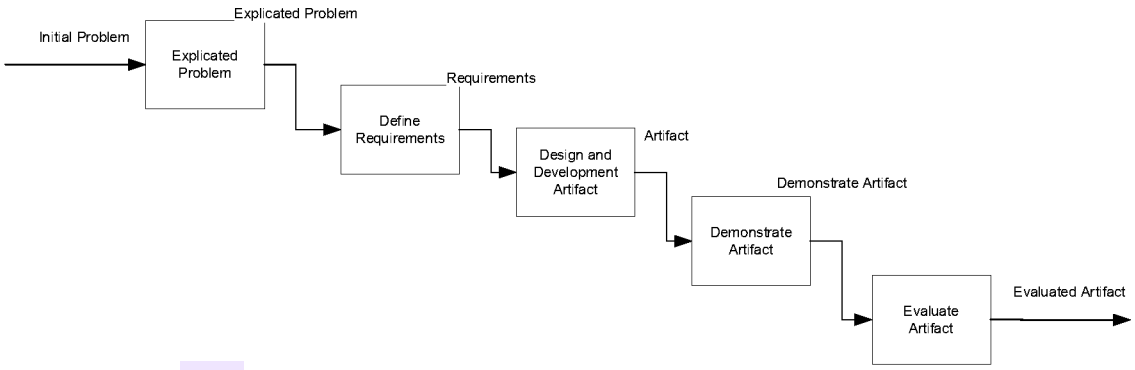


Figure 1 Methods Framework for Design Science Research (Johannesson Paul, 2014)

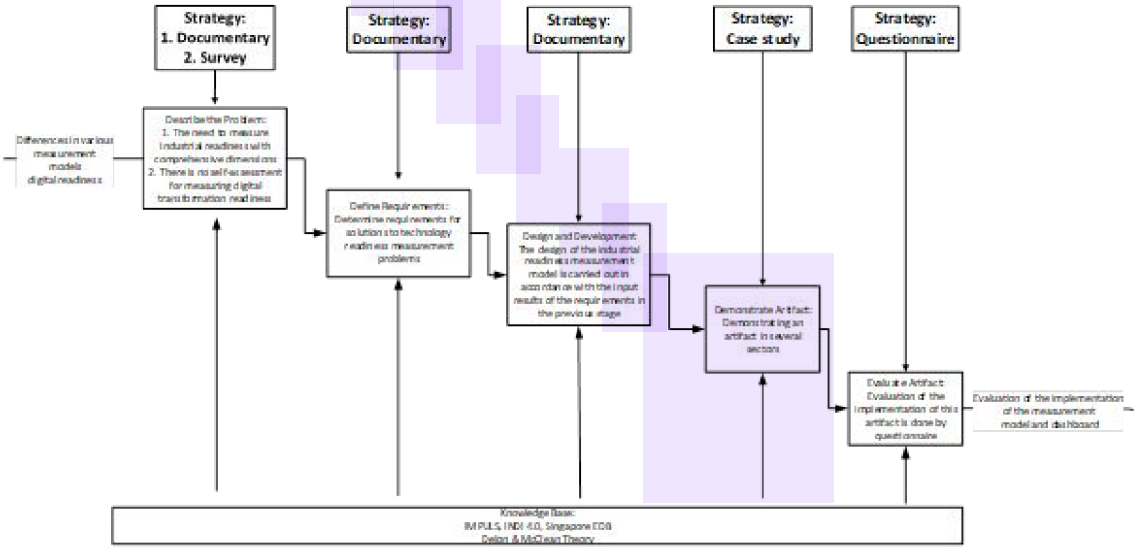


Figure 2 Digital Maturity Index Dashboard research method

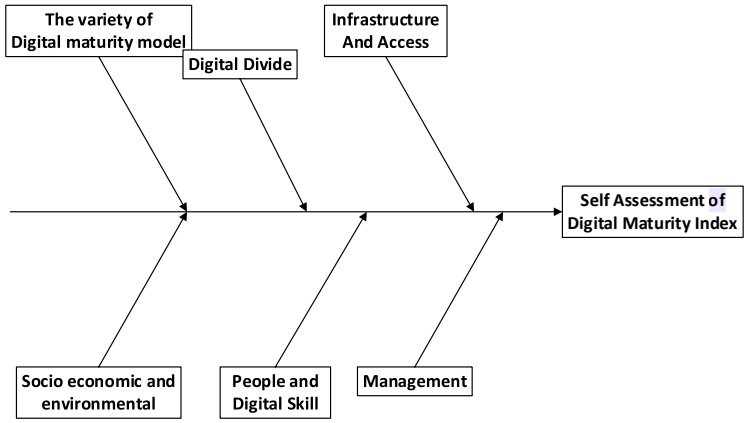


Figure 3 The Root Cause of the Problem Described

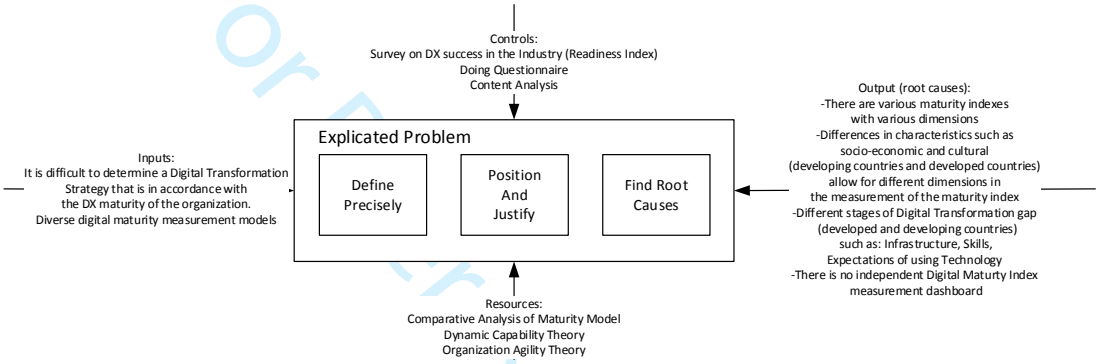


Figure 4 Activity of the Issue Described

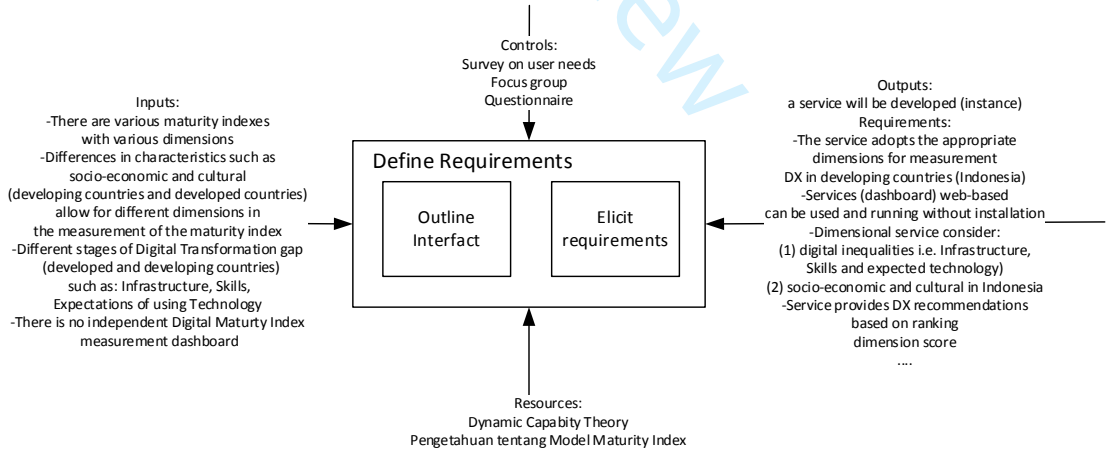


Figure 5 Define a requirement activity

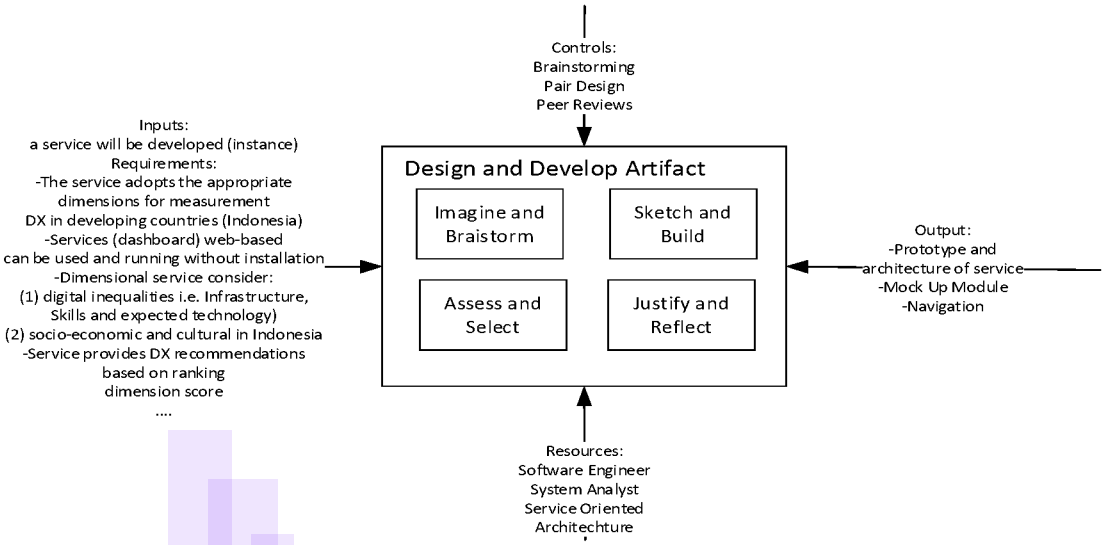


Figure 6 Designing and Developing artifact Activity

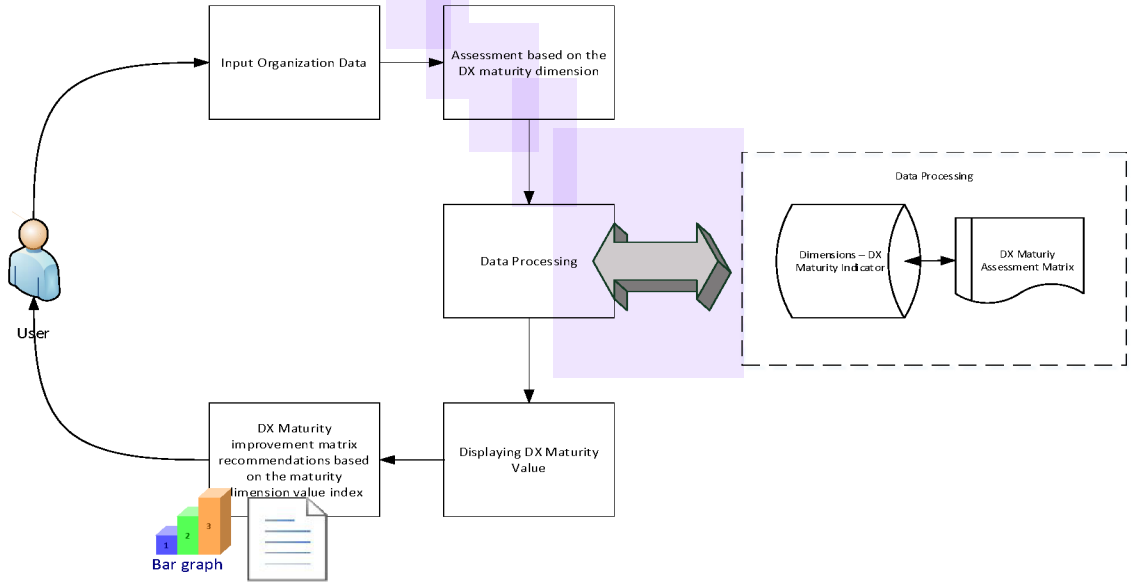


Figure 7 Block Digital Maturity Index self-assessment diagram

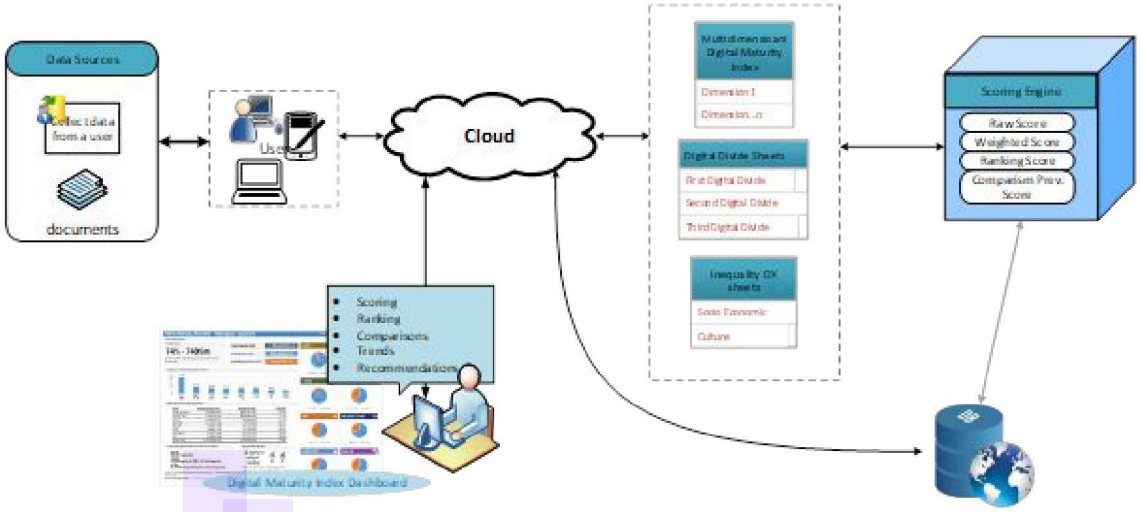
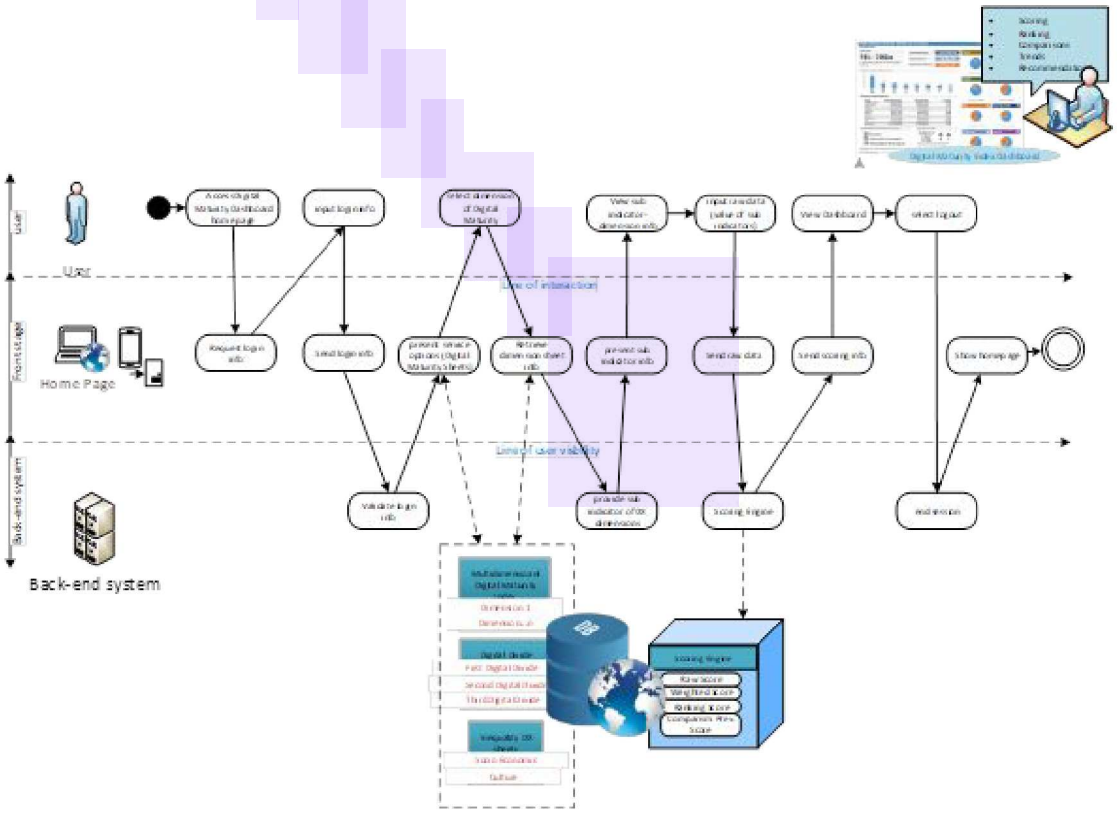


Figure 8



99 Service Experience Blueprint dashboard artifact

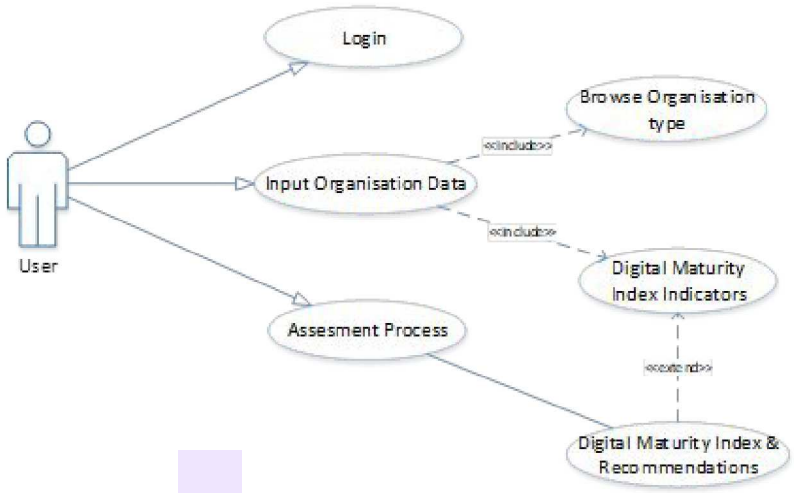


Figure 10 Digital Maturity Use Case Diagram

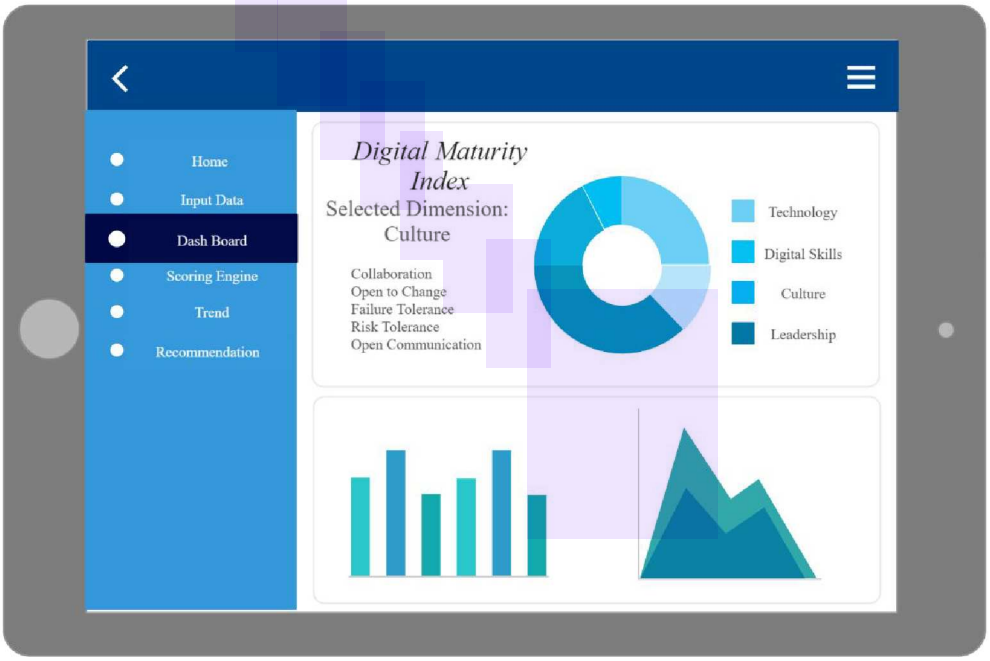


Figure 11 Dashboard Mockup

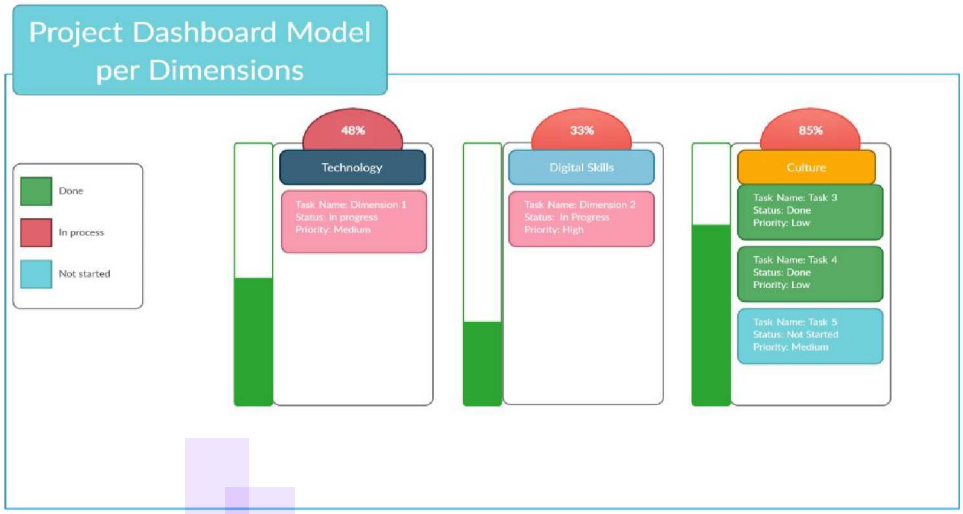


Figure 12 Measurement of each dimension of Digital Maturity

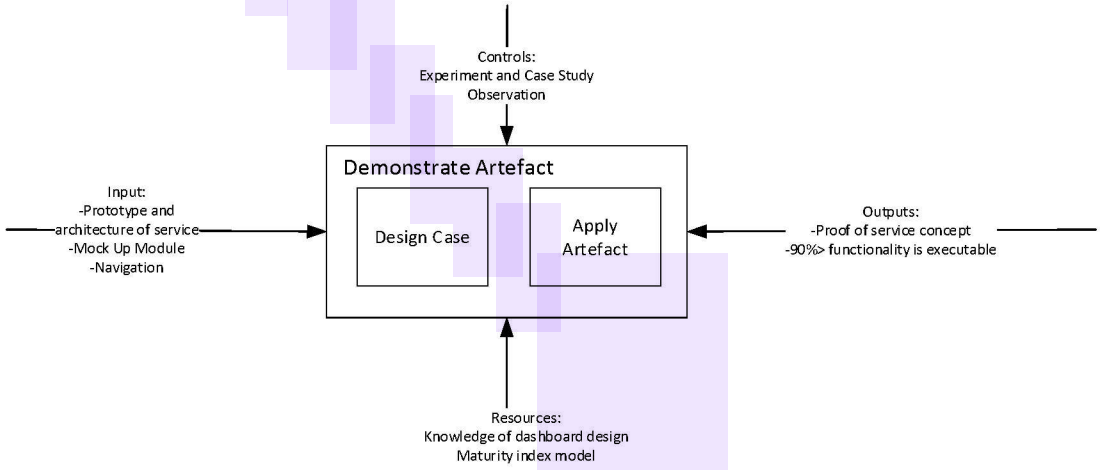


Figure 13 Demonstrating the artifact activity

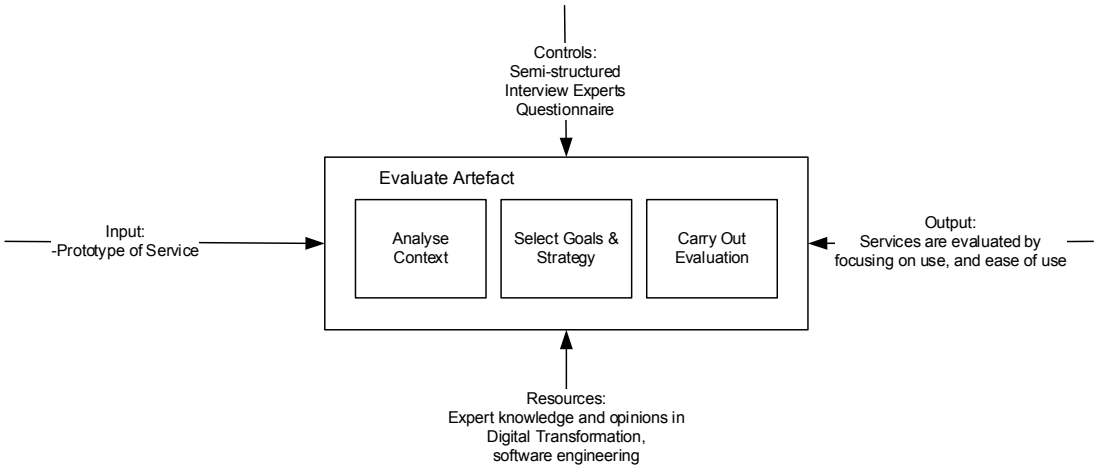


Figure 14 Evaluation of artifact Activity

Artifacts: Digital Maturity Index taking into account Digital Divide

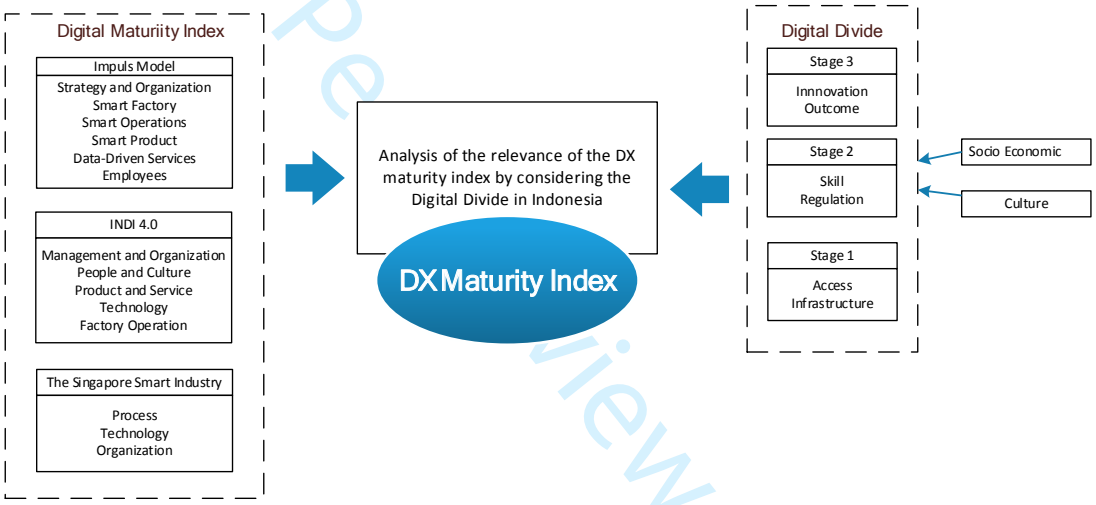


Figure 15 IDEF0 Diagram of the Digital Maturity Index

Problem	**Artifact**	**Knowledge Base**
Measurement of the digital maturity index is necessary so that organizations can determine the digital transformation strategy that is under DX maturity in organizations. There are various maturity index models, but these	Building a self-assessment service for a website-based Digital Maturity Index	- Analysis of the maturity ratio of pre-existing models. Dynamic Capacity Theory and Organization Ability Theory are used as digital transformation capture approaches Delon and McClean's theory is used to assess tenant receipts from artifacts made

models have varying dimensions.		
Exercise The dimensions of measuring the maturity index between developed and developing countries are different. This is due to different digital inequalities, whether from infrastructure readiness, skills, or technology expectations. Self-measurement of the digital maturity index is still limited, while organizations must be faithful when it comes to knowing the status of DX maturity in their organization.	**Requirement** The resource for determining the results of these specified requirements activities takes into account previous and existing research artifact s. 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.	**Construction** The Software Requirements used in the creation of artifact are described in the Service Experience Blueprint (SEB) and UML

Explicit Issues Finding the dimensions and indicators of the Digital Maturity Index for Digital Transformation in Indonesia based on a multidimensional comparative analysis of the digital maturity index. Consideration of the digital divide, including socio-economic and cultural differences, is necessary. The next survey strategy used is to survey the application of technological measurement	**Define Requirements** The Define Requirements activity generates functional and environmental requirements to support Artifact Design and Develop activities. In general, the results of the Define Requirements activity include (1) a multidimensional digital transformation readiness measurement model is needed, (2) 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.	**Develop Artifact** The value generated in this study is the creation of the Digital Maturity Index Dashboard. The app is built on the web	**Demonstrating Artifact** The activity of demonstrating artifacts in this study is to conduct empirical tests on organizations. This demonstration or "proof of concept" is necessary to show that artifacts can solve an example of a problem. At this stage of Demonstration 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.	**Evaluation artifact** Artifact Evaluation activities determine how well artifact meets the requirements and to what extent it can solve, or alleviate, the practical problems that motivate research. The results of the empirical test become an input for the evaluation of Artifact. Strategies chosen in Evaluate Artifact with a questionnaire approach

models in one of the industries.	Secondary documentation and data processing strategies are used in the Define Requirements activity. Reference collection of technological readiness measurements was carried out and prepared for artifact construction using the theoretical approaches of Delon and Mc Clean			

Structure	**Function**	**Uses**	**Effect**
Structure to build artifact by conceptualizing classes in UML. Block Diagrams and parts of the use case diagrams are presented in this study.	Services should 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 in a web browser without installation.	The Digital Maturity Index self-assessment dashboard service generates recommendations for optimizing DX based on the ranking scores of each dimension.	The use of a digital maturity index self-assessment service helps organizations to achieve DX maturity status within the organization. Artifact can at the same time, identify on which dimension the organization gets the lowest achievement. Strategy recommendations are presented on the service.

Figure 16 Canvas Artifact

Table 1 Some Digital Maturity Models

Model Maturity Index	**PWC**(PWC, 2016; PwC, 2016)	**Deloitte/ TM**(Deloitte Switzerland et al., 2018)	**MIT/ Capgemini**(Fitzgerald et al., 2013)	**Forrestor's**(gills, Martin; VanBoskirk, 2016)
Dimension	1. Digital business model and customer access 2. Digitization of product 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, legal, and tax 7. Organization, 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 Beginner 2. Vertical integrator 3. Horizontal Collaborators 4. Digital Champion	1. Initiating 2. Appear 3. Perform 4. Forward 5. Lead	1. Beginner 2. Fashionista 3. Conservative 4. Digiratis	1. Skeptics 2.Adopters 3.Collaborators 4.Differentiators