

CLOUD COMPUTING IMPLEMENTATION USING MODEL ROADMAP FOR CLOUD COMPUTING ADOPTION (ROCCA) IN PT MATRICA CONSULTING SERVICE

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Abstract - The purpose of this research was to build cloud computing referring to Roadmap for Cloud Computing Adoption (ROCCA) model so that the best strategy could be implemented in PT Matrica Consulting Service. The implementation of cloud computing had five stages modifications ROCCA adoption model. Those stages were analysis, design, adoption, migration, and management. Data were taken from distributing questionnaires and conducted interviews with R&D Manager and analyzed using SWOT analysis. The result is the implementation of cloud computing models, and implementation of private cloud and Software as a Service (SaaS) needs to be modified so it can be implemented properly. The implementation can increase the performance PT Matrica Consulting Service based on the characteristics of the cloud which is flexible and secure to be accessed as long as it is connected to the Internet and maintained properly.

Keywords: cloud computing, Roadmap for Cloud Computing Adoption (ROCCA)

I. INTRODUCTION

To implement efficiency and increase system performance, Information Technology (IT) consulting companies have begun to take advantage of information technology especially cloud computing. However, it still encounters some obstacles technically. According to Kaur and Singh (2015), the obstacles occurring in cloud computing can be divided into three categories. Three types in the first category are the use of barriers, five points in the second point are the development bottleneck, and the third category is a business obstacle. The obstacles are business continuity and service availability, data lock-in, data confidentiality/auditability, data transfer bottlenecks, performance unpredictability, bugs in the large-scale distributed environment, data security, scaling quickly, reputation fate sharing, and software license.

High availability is an essential service in IT consulting company. With many data, it is difficult to achieve the high availability if it does not improve the technology. Therefore, cloud computing is an effective and efficient way to present availability in the IT consulting company.

According to Schubert and Jeffery (2012), cloud concept based on the implementation guarantees an effective

cost of the computerized utility principle and makes it easy for users and providers to access to their resources (self-service), and pay-as-you-go. Thus, it minimizes administrative system costs and improves resource utilization and accounting. This is not excluded from the systematics cloud computing itself. Recent years, cloud has produced a tremendous impact on the global IT ecosystem by providing opportunities to new markets and new users.

Cloud computing adoption process will be better if it is done systematically. Therefore, it takes an adopted model to analyze and provide steps in the process of cloud computing implementation. Moreover, identifying the needs is an important task because the needs will determine how the form of the cloud is and how an institution can receive in its system.

Oracle states that a cloud roadmap guides institutions toward strategic adoption of the cloud (Mattoon, 2013). The roadmap is a framework where one project can contribute to the purpose of an institution, and guard it against deviant plans. The roadmap guides to achieve the benefits of cloud adoption, allows projects to work in parallel and remain coordinated to achieve a goal that has a value greater than the individual value of the project itself. Cloud roadmap consists of two basic coverage activities. First, it is program-level work to develop frameworks and guidelines to achieve goals. Second, the project that makes specific cloud capabilities is unified by program-level assets.

The cloud computing will change the paradigm of a company or IT organization to consider the investment in information communication technology. It has several advantages like the investment for capital transforms into operational costs with a more efficient quantity due to cloud computing. Thus the users do not need to provide infrastructure (data center, processing power, storage, up to the desktop application) to be able to have a system because all have been virtually done. Currently, the need for usage, maintenance, and security of information systems is increasing, and encouraging companies and organizations to improve and secure their systems. However, companies or organizations do not have large and good resources to buy systems for their needs, maintain their information systems and secure the system. It is likely that cloud computing will be the first choice and grow especially in Indonesia.

Even with cloud computing, the company simply hires the services of cloud computing providers. As previously described, cloud computing can reduce the initial investment of a company that requires usage, maintenance,

and security of the information systems better. In this case, large investments for a company or organization will turn into a manageable operational system. Even service providers such as Software as a Service (SaaS) in cloud can offer very low prices due to economic factors. With cloud computing, the company no longer needs to worry about the complexity of technology. Moreover, companies that use IT will not be afraid of things that can threaten the security of their information systems such as updating a technology or service provider in cloud computing. However, cloud computing should not serve as core business II in a company. Cloud computing should be support business II. That is the correct principle.

In Indonesia, there are not many researches on cloud adoption strategy model. According to Nimoko and Nugroho (2012), some of the newly available models are built for large companies or government organization. Khamidah, Sulistianingsih, and Papatungan (2010) analyzed the discourse of the application of cloud computing in the Islamic University of Indonesia (UII), but it had not used the adoption model. Meanwhile, Cenka, Hasibuan, and Suhartanto (2012) introduced the concept of cloud computing architecture in the form of a prototype for educational environment. It was combined with ICT-based education and cloud computing because the prototype needed to be developed again.

Furthermore, there are several researches on the implementation of cloud computing in Indonesia. The difference in each of these researches is described with various implementation, service, and adoption technic. Khamidah *et al.* (2010) implemented private infrastructure and cloud as an object in a university. There was no adoption method in this research. However, the Infrastructure as a Service (IaaS) and private cloud were enough to be implemented in the university depending on the requirement of the object. Then, Fardani and Surendro (2011) implemented public cloud and SaaS. They also used adoption method of ROCCA with Small and Medium Enterprises (SMEs) as the object of the research. Similarly, Hamzah and Nugroho (2012) described the method of hybrid cloud and SaaS, and the adoption method of ROCCA in SMEs.

Then, Nimoko and Nugroho (2012) used public cloud and IaaS in government organization. It was implemented by using two methods, Decision Framework for Cloud Migration (DFCM) and ROCCA. Moreover, the service and implementation method are not described in Cenka *et al.* (2012). However, the main value and unique topic of the research is the adoption method. It is Nan Cenka Architecture implemented in the university. Suprayogi and Ashari (2014) described the implementation of private cloud and IaaS with the adoption method of ROCCA in a university.

In addition, Irfan and Santosa (2015) described the public cloud and SaaS with ROCCA in SMEs. Setyawan (2016) did not describe the implementation method, the services, and adoption technic in this research. However, the object of this research was unique which was hospital. The researchers showed that the cloud computing technology was implemented not only in the government and university but also in the hospital.

The supporting technology contained in cloud computing is not new. The concept of cloud computing had been stated by a scientist named John McCarthy in 1960. It is said that the future of computing will be available and maintained as a public service (Hamdaqa & Tahvildari, 2012).

PT Matrica Consulting Service is a company engaging in the IT consulting company. The amount of data is a variable that increases in line with the company's continuous development. High availability also becomes the demand of the client for their system and business to run smoothly. This makes researchers interested in analyzing this issue into a case study of whether this method is feasible to be used in PT Matrica Consulting Service to meet the needs of their clients.

It is a great advantage for PT Matrica Consulting Service with a large amount of data. As the company grows, making maintenance is a very important factor to do. This can be done easily if it implements cloud computing and all data is stored in a centralized server. However, it does not reduce and add the factor of flexibility and high data scalability. It is because the application is currently separated in servers so that maintenance and data backup are still difficult to be done and collected (less organized).

From the background, the problem formulation can be drawn. First, it is to see how to model cloud computing with Roadmap for Cloud Computing Adoption (ROCCA) method that suits the business process used in PT Matrica Consulting Service. Second, it is to determine whether ROCCA can be used as a reference to PT Matrica Consulting Service. Thus, the purposes of this research are to building cloud computing referring to ROCCA so it can have a good strategy for the implementation in PT Matrica Consulting Service. Moreover, it designs cloud computing with ROCCA that can smooth the business flow in PT Matrica Consulting Service.

The benefits of this research are divided. For academic, the results can be used in developing cloud computing in IT consulting company. It also can be used as a reference for further research. Next, for the related institutions, it can get the server configuration as desired, simplify the process of maintaining and managing corporate servers, and save the budget for the procurement of servers and supporters. This cloud computing is scalability, and easy to increase the capacity as it needs change without having to purchase additional equipment. It can also be accessed everywhere with the Internet.

There are several limitations in this research. First, the research is only applied to PT Matrica Consulting Service. Second, the research refers to ROCCA. Last, this is a case study that will provide an overview of the feasibility of ROCCA applied in PT Matrica Consulting Services.

II. METHODS

ROCCA can be implemented in various conditions like in industry and government organizations. It is because ROCCA is a general model of cloud computing adoption. Besides that, ROCCA is intended for the public cloud model with SaaS where users simply select one of the cloud computing providers to apply to their organization. In this research, the researchers conduct a case study to analyze the infrastructure system running in PT Matrica Consulting Service. The research step is divided into five stages, namely the analysis, design, adoption, migration, and management (Shimba, 2010).

In the stage of analysis, the researchers analyze the users, systems, applications, and business processes in PT Matrica Consulting Service. Meanwhile, the design phase is associated with benchmarking, choosing which platform to use, cloud infrastructure, financial plans, security,

and preparation in adopting this project. The adoption stage integrates the applications with cloud platform and infrastructure. Then, the migration phase ensures that the application and data migration is performed as planned in the design stage. In the last stage or management stage, documentation is made to ensure continuation of support for future systems.

Table 1 Research Steps

Research Steps
Analysis phase
<ul style="list-style-type: none"> Collecting data Conducting interviews with those who deal with IT infrastructure Conducting observations in IT infrastructure that is already available and listing the devices and applications
Design phase
<ul style="list-style-type: none"> Choosing a cloud technology Planning budgets based on cloud technology selected Designing process of adoption and migration
Adoption phase
<ul style="list-style-type: none"> Selecting software and setting up a server with recommended hardware specifications Performing installation and proceeding with making cluster Conducting routing with intranet and installing a fire-wall
Migration phase
<ul style="list-style-type: none"> Creating a virtual server with default specifications and providing access to application owners Migrating applications and data using a variety of methods available migration
Management phase
<ul style="list-style-type: none"> Authorizing the management to related parties Documenting monitoring Supporting

In Table 1, modified adoption model ROCCA still use five original stages. There are analysis, design, adoption, migration, and management (Shimba, 2010). Moreover, there are some changes in each stage. First, in analysis phase, it begins with data collection. The next step is to interview the responsible party for the IT infrastructure, such as Communication center, IT department, programmer, and others. Then, the researchers observe the available IT infrastructure and record the related devices and applications. Based on the results of the data collection, the analysis can be continued by using the SWOT matrix to determine the company's key capabilities and needs and plan the analysis result strategy.

Second, in design phase, the selection of cloud technology will be done. The selection refers to the results of the previous analysis stage. Then, cost planning based on the cloud technology that has been selected and the design

of the process of adoption and migration, and the design process of adoption and migration will be done. This stage uses a pilot project model to determine the effectiveness of cloud computing implementation. This stage also determines which applications will experience the migration process to the new infrastructure.

Third, adoption phase is a preparatory phase where IT consulting company prepare for the cloud infrastructure. It starts from selecting the software and setting up the server with recommended hardware specifications. Then, the next process is to install, create a cluster, do the routing with the intranet, and install a firewall.

Fourth, migration phase can also be called as the core of the cloud computing adoption process. It moves the applications from a physical server to a virtual server. It starts from creating a virtual server with default specifications and granting access to the app owner. Then, the process of migrating applications and data using various available migration methods will be done. If the migrated application is not dependent on other applications, it is recommended to use the logical backup method.

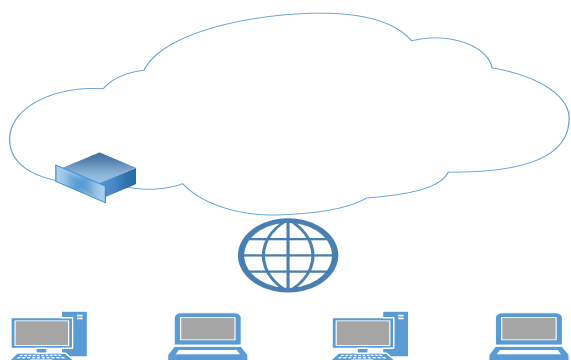
Fifth, it is management phase. After the process of adoption and migration has been done with the migration indicator and the application can run normally, this stage can be done. It is by providing management authority to related parties, such as IT division with mentoring for some time. It will be better if there are documentation and handbook to facilitate problems that will arise. Activities that are done at this stage are the monitoring and supporting the cloud users.

The initial stage before the start of the analysis is to gather the relevant data. Data is collected for the initial phase by interviewing the involved parties. Interviews are conducted based on Canonical (2013). It focuses on the budget, human resources, time to deployment project, needs and increase of IT technology, the latest data security, and privacy issues. All data are needed for the analysis process.

After the primary data collection process is done, the next step is to collect secondary data in the form of articles about the implementation of cloud computing. The researchers aim to learn the concept and know the various types of cloud computing implementation.

SWOT analysis is a relevant tool for developing strategies in decision-making processes. SWOT is an analytical tool to explore the four main components of an organization. First, it is strength. It measures the power within the organization. The power that is currently owned can be utilized to realize the opportunities and cover the threat. Second, it is a weakness in the organization. The weakness of the organization is expected to be anticipated so that it becomes a chance. Third, opportunity is the potential that can be achieved by a company. Last, other than the weakness, every organization must have a threat that comes from outside. Thus, it requires strategy to anticipate it.

Moreover, at the design implementation stage, the system will combine multiple physical servers into a single virtual server. The researchers can analyze the placement of the machines and the division of the workload in a single host server. Then, the implementation of the system is done by traditional development server. Traditional servers and virtual servers are connected to the network via cable media. The design of private cloud is in Figure 1.



III. RESULTS AND DISCUSSIONS

A company has an IT infrastructure (network, server, and data center). Indonesia has an area that is quite prone to natural disasters so it should store data and existing applications. The advantage of cloud computing is the location of data storage can be everywhere. Data located in the cloud will be secure. Moreover, in cloud computing, recovery can be done without having to wait for infrastructure repair (Nimoko & Nugroho, 2012).

From the interview, it can be concluded that PT Matrica Consulting Service commits to provide administrative and budget-related support, although the amount is limited and should be submitted early in the implementation of adoption. In addition, PT Matrica Consulting Service also assigns members from the IT division to provide data about the IT infrastructure in the company and open the necessary access including receiving the task of managing cloud computing infrastructure. The result of the interview and questionnaire can be seen in the Appendix.

The use of cloud computing has lock-in risk to service providers. The lock-in risk is small because it still allows the user to control most of the technology on IaaS. Meanwhile, in Platform as a Service (PaaS), the risk of lock-in becomes greater than IaaS. It is because users develop applications by utilizing the available platform. Moreover, to switch to another service provider, users only need to change the code associated with that platform if the application is developed with good documentation. Compared to IaaS or PaaS, SaaS has the biggest lock-in risk because users directly utilize applications provided by service providers. The data stored are in the proprietary format from the service provider.

On-premise private cloud is one of the solutions for sensitive applications. It allows users to have full control over their cloud infrastructure, applications, and data. From the convenience, users can take advantage of external cloud because there is no need to prepare and perform maintenance on infrastructure. Li *et al.* (2009) determined the characteristics of suitable applications for external cloud. It should not be a competitive advantage, mission-critical, and a core business applications. Then, it should contain little sensitive data and have no effect by the slow network or bandwidth.

SaaS will be better if there are applications for things commonly used by many parties who have the same

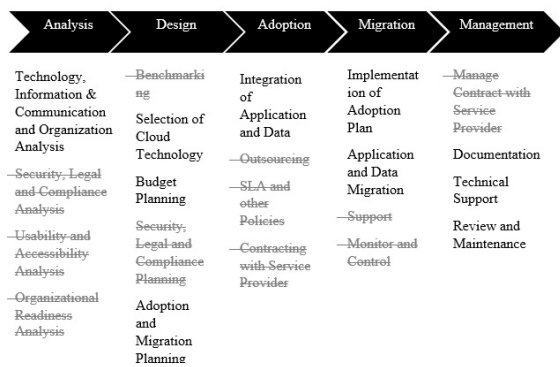


Figure 2 Adoption of ROCCA
(Source: Shimba, 2010)

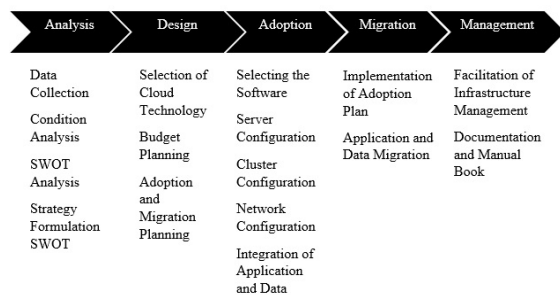


Figure 3 Modification Adoption with ROCCA

Based on the analysis of ROCCA and each phase of ROCCA, it is necessary to modify the ROCCA adoption model. The modified results can be seen in Figure 2 and Figure 3. The modification of adoption model ROCCA still uses five original stages, namely analysis, design, adoption, migration, and management. For the analysis stage, the requirements needed by the company is the creation of web-based applications or software as a medium for internal needs repository, and application or software built is based on Ubuntu. Moreover, security, legal, and regulatory issues for migration to the cloud have been analyzed along with the management in PT Matrica Consulting Service.

The risk from outside can be a database cracking, but the server is equipped with several securities such as firewall and login authentication with application-level security inside. This cloud can facilitate the performance of employees. For example, employees can update the project directly to their source code so that other team members will get updated too. Moreover, financial support will be provided by PT Matrica Consulting Service as long as the predetermined budget is still available, so the implementation of this cloud can run well.

The design is the second stage in ROCCA (Shimba, 2010). ROCCA does not explain the detail step as it is only the point of the mind (Nimoko & Nugroho, 2012). In this stage, it will discuss three principal thoughts in the selection of cloud infrastructure, budget planning, and planning the process of adoption and migration.

The scope of systems and applications is a project for making a cloud with SaaS services. System or application has been determined in accordance with the agreement. Applications based on Ubuntu system work on using python (OpenERP) programming languages. Meanwhile, platforms and infrastructure have been agreed regarding existing coverage. Then, vendors are not involved in establishing

security plans, laws and regulations as they are depended on the needs of the corporate system. PT Matrica Consulting Service chooses a vendor that can meet those needs.

After the cloud migration has been done, the trial service will be run for a few weeks before it is used live. The trial service should run well first.

The next stage is adoption. Nimoko and Nugroho (2012) said that the adoption of a preparatory phase is done by integrating and customizing applications and data to be migrated to the target platform and infrastructure. This stage can ensure that the application will run functionally in the new infrastructure, and interoperate with applications that are not in migration. Then, if all preparations have been made, the stage of migration can be performed by using all prepared plans. The trial service will be performed to ensure the application of the cloud is well before using the cloud.

After the cloud infrastructure is completed, the application and data migration phase can be conducted. There are several applications that need to be migrated. One of those is storage applications that have been made. Based on the initial condition of IT infrastructure in PT Matrica Consulting Service where all applications run on its server without the interdependence of applications and data between each other, the migration process is done by moving applications and data. It is with the backup method from the old server to the new server to perform the process of restoring the applications and data. After the IT division of PT Matrica Consulting Service and researchers ensure that the application has run normally, the application can be accessible to the users.

Technically, the time of application and data migration is done together with IT division in PT Matrica Consulting Service. It is because some applications that will be migrated is a product of PT Matrica Consulting Service, and IT division is the responsible party for network infrastructure in PT Matrica Consulting Service and server. In addition, the selected time to perform the migration process has previously been scheduled. It also notices maintenance announcement to the users with consideration of schedule adjustment. At that time, the level of all application usages involved in migration is in low conditions.

Meanwhile, data backup process on the physical server uses the logical backup method. It also moves the supporting data that is not stored in the database to the external hard disk. For the migration of applications, it uses master software stored in personal repository in IT division of PT Matrica Consulting Service so that this stage only does data migration.

After the application and data migration is completed, the new server can be operated, and the users can access it again. The development of cloud can improve the performance of employees in PT Matrica Consulting Service. With less critical data, it will be possible. Furthermore, user support, controlling, and monitoring will be done by the IT division in PT Matrica Consulting Service.

Next, in the management stage, private cloud implementation process with SaaS service model has been successfully executed. The application and data migration is done with an indication that the application can be re-accessed by the users and the data moved does not differ from the previous data. The next step is to give administrator access to R & D Manager and assist the cloud infrastructure management process in PT Matrica Consulting Service.

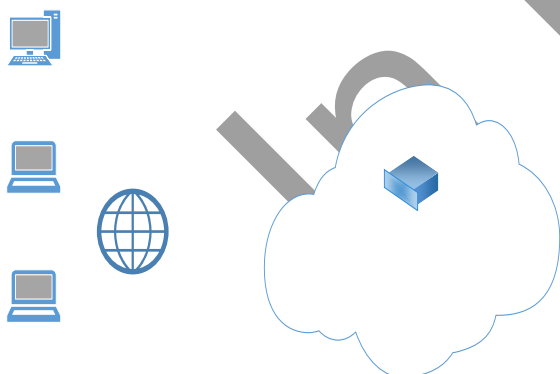
To improve the ability of IT division personnel in managing cloud infrastructure, the researchers give a handbook of the user manual and demonstrate this new

system or application. Moreover, testing is held two weeks after the application is uploaded. The maintenance is done by the IT division of PT Matrica Consulting Service. In general, the implementation of cloud computing in PT Matrica Consulting Service runs well. The cloud infrastructure built can run migratory applications, and the IT division can manage the cloud infrastructure that has just been created.

The adoption model of the ROCCA helps to define cloud technology and implement systematically. This implementation uses the SaaS service model and private cloud model. The adoption model of ROCCA is helpful in the implementation of cloud computing in PT Matrica Consulting Service. The stages described in the ROCCA model also make it easy to perform systematic implementation process. The model has been modified in IT consulting company. The analysis stage on ROCCA helps to focus on the primary needs and the ability of PT Matrica Consulting Service. Then, the results are used at the design stage to select cloud technology, designing the budget, and the adoption and migration strategy before implementing cloud computing.

In the implementation phase, ROCCA divides the process into two stages (adoption and migration). Adoption focuses on the preparation of installation and configuration of cloud infrastructure until it is ready. Meanwhile, the migration aims to move applications from the old server to the cloud infrastructure. The results of the design phase are done before becoming the standard for implementation. It also needs to be coordinated with several parties for infrastructure development. It must involve other parties, so the communication remains intertwined.

Management stage is the last stage of ROCCA. In this stage, the management is done by handovering the authority of cloud infrastructure management to IT division. This stage can be done if the migration stage operates well. It shows the implementation stage has been running smoothly and well.



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APPENDIX

Questionnaire

1. Analysis
 - a) Are the needs of the project already known and determined?
Yes, the creation of web-based applications or software is the medium for internal needs repository.
 - b) Are internal systems and applications analyzed?
Yes, internal system and application in PT Matrica Consulting Service use Ubuntu-based servers.
 - c) Are security, legal, and regulatory issues for migration to the cloud analyzed?
Yes, it has already been discussed with directors and management so that this migration can be done well.
 - d) Are the risks and benefits sourced from outside in the cloud analyzed?
Yes, the risks from the outside can break the database, but the server is equipped with several security levels such as firewall and login authentication with application-level security in it. The advantages of this cloud can facilitate the performance of employees. For example, employees can update the project directly to their source code so that other team members will get updated too.
 - e) Is the impact of cloud shifting with different stakeholders analyzed?
Yes, this will have an impact on the security and ease of access from outside.
 - f) Has the involvement in finance been analyzed?
Yes, it has been discussed earlier that financial support will be provided as long as a predetermined budget is available.
 - g) Has the application or system been identified?
Yes, the system or application has been identified based on Ubuntu.
2. Design
 - a) Is the scope of the system and application known?
Yes, the scope of the system and the application is limited to the creation of a cloud manufacturing project with the characteristics of SaaS.
 - b) Are the levels for application or system candidates already arranged?
Yes, the system or application has been determined in accordance with the mutual agreement. With the Ubuntu-based system, the application will be done using python programming language (OpenERP).
 - c) Is the cloud platform and infrastructure selected based on existing coverage?
Yes, the platforms and infrastructure have been chosen according to the agreed coverage.
 - d) Are the cost management and financial plan already in form?
Yes, the budget size and budget details have been made to keep the budget as planned.
 - e) Are plans for security management, laws and regulations feasible?
Yes, it is feasible so that the work of this project can be done.
 - f) Are vendors involved in building security plans, laws, and regulations?
No, it is because the development is made based on the needs of the system and we choose a vendor that can meet our needs.
 - g) Will prototyping or trial service be used before migration?
Yes, the trial service will run for few weeks before it is used.
3. Adoption
 - a) Are the prototyping or trial service used to ensure the integration of applications?
Yes, it will be done to ensure that the application with this cloud runs as well as before using the cloud.
 - b) Does the vendor agree with the Service Level Agreement (SLA), the security policy, and governance of IT procedures?
Yes, the vendor has agreed to it.
4. Migration
 - a) Is the development plan sufficiently detailed and complete?
Yes, this cloud development plan has been explained to the director and management of PT Matrica Consulting Service, so they agree and believe that this system will improve the performance of their employees.
 - b) Are the affected users of this migration already aware of the changes that will occur?
Most employees have been aware of the implementation of this system.
 - c) Is the application or data to be migrated critical enough or critical for the company?
It is quite important, but it is not too critical.
 - d) Is there a user support and control & monitoring mechanism?
Yes, the mechanism of user support and control & monitoring will be run by the IT division of PT Matrica Consulting Service.
5. Management
 - a) Is the vendor's contract and management done correctly?
Yes, our parties and vendors have agreed to a contract mutually.

- b) Has the project been signed?
Yes, the project has been signed by the management given direct trust from the director.
- c) Are the procedures of best practice documented?
Yes, the usage procedures have been documented and demonstrated.
- d) Is technical support established?
Yes, technical support will be done by IT division of PT Matrica Consulting Service.
- e) Has a testing and maintenance plan been done for a few weeks after the launching?
Yes, testing will be implemented in two weeks after uploading, and maintenance will be done by IT division of PT Matrica Consulting Service.
- f) Are application and data scopes already collected, analyzed and used to improve project success?
Yes, this has been done and discussed together to improve the success of this project.

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