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Cloud Computing as an Alternative IT Solution for SMEs: A System Dynamic Approach

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Abstract.*Small medium enterprises (SMEs) play a big role for GDP in Indonesia. In 2012, SMEs made contribution 59,08 % for GDP Indonesia. The amount of SMEs in Indonesia is 99,99 % from total company in Indonesia. From that data, we know that SMEs is very big market in Indonesia. However, despite many big contributions that SMEs gave, SMEs also have challenges for themselves. The limitation of capital is one of challenges that SMEs have to face. The limit of capital make SMEs spend their capital wisely. They have to think very carefully how to expand their business. Is it profitable or not. In this paper we want to understand about the phenomenon why SMEs are hard to implement information and system technology. We used observation and secondary data to construct the variables. After that, we use the variables to build the model using system dynamics. And then we simulate it to know the impact implementation of information technology to flow business of SMEs. To propose new alternative technology (cloud computing), we modified the variables in the model and simulated it. We compared the result between own information technology and cloud computing. The result shows that cloud computing is suitable to be implemented in SMEs.*

Keywords : *Cloud computing, SME, System Dynamic, Information Technology, Model*

1. Introduction

1.1. Background

Small medium enterprises (SMEs) play a big role for GDP in Indonesia. In 2012, SMEs made contribution 59,08 % for GDP Indonesia [Kementrian Koperasi dan UKM]. The amount of SMEs in Indonesia is 99,99 % from total company in Indonesia. From that data, we know that SMEs is very big market in Indonesia. And it will be raised in the following years. In general the role of SMEs we can define as the following :

1. SMEs create many job opportunities to reduce the level of unemployment and poverty in Indonesia
2. Have contribution for the increase of GDP and growth of economy in Indonesia
3. Have contribution for the increasing of export from Indonesia

However, despite many big contributions that SMEs gave, SMEs also have challenges for themselves. The limitation of capital is one of challenges that SMEs have to face. The limit of capital make SMEs spend their capital wisely. They have to think very carefully how to expand their business. Is it profitable or not.

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In the other hand, the implementation of information technology for enterprise is very useful to increase the performance of enterprise included SMEs. But to build own IT infrastructure, the company have to spend big amount of money. Maybe for big enterprise it is not necessary. But for SMEs it is a problem. With the limit of capital it is become dilemma for SMEs. In one hand, they have to implement information technology for efficient and effective management. But in other hand they have to spend big amount of money to build their own IT infrastructure.

In some organizations, the investments of IT may exceed 50 % of annual capital investment and it has been suggested that, by 2010, the average IT expenditure will be 5 % of revenue [Graeser, Willcocks, Pisanias, 2010]. That is why few SMEs implement IT infrastructure. So we want to propose alternative information technology that can implement by SMEs but can answer the limitation of capital that SMEs face.

Most of papers discussed about cloud computing side more than SMEs side. Several researchers that discussed about cloud computing and SMEs are from information technology background like Kourik, 2011; Briscoe and Marinos, 2009; Weindhardt, 2009. Kourik, 2011 discussed about implementation cloud computing in SMEs from risk assessment and security side. Briscoe and Marinos, 2009 discussed about cloud computing in community. How cloud computing used in community service. Although some of researchers have discussed about cloud computing and SMEs like Sharma, et al. 2010.

The originality of this paper is the author wants to propose cloud computing as an alternative IT solution for SMEs especially in Indonesia. Sharma, et al. 2010 already discussed about implementation cloud computing for SMEs in India. They used qualitative and quantitative as their research methodology. In Indonesia, there is no paper that discuss about propose implementation of cloud computing in SMEs. The author used different research methodology and scope to discuss about this topic. The author used modelling and simulation as research methodology.

First, we analyze the implementation of information technology affect capital of SMEs. And then we propose alternative information technology, in this case cloud computing, and see how it affect the capital of SMEs. After we simulate, we compare it and see how that kind of information technology affect the capital of SMEs. We can select the best kind of information technology that reduce the expenditure of SMEs's capital.

1.2. Research objectives

The research objectives of this paper are :

1. To understand why information technology is needed especially for SMEs
2. To propose alternative technology that suitable for SMEs condition
3. Compare between own information technology and alternative technology (cloud computing) based on affect for SMEs's capital

2. Literature Review

2.1. Cloud Computing

Many definitions related to cloud computing. Basically the concept of cloud computing is access the source of information through internet, anywhere and anytime. Vaquero ,Rodero-Merino, Caceres, and Lindner defined cloud computing could be defined as the integration of virtual resources according to user requirements, flexibly combining resources including hardware, development platforms and various application to create services [Vaquero, Rodero-Merino, Caceres, Lindner, 2009]. U.S. NIST (National Institute of Standards and Technology) defined cloud computing is a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

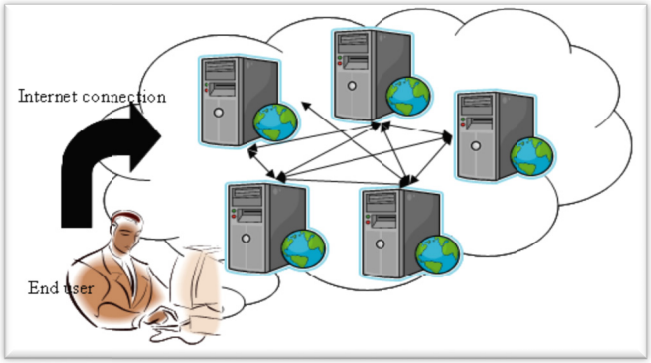

Figure 1. Cloud Computing Concept Map

In figure 1, we see that user just need internet connection to use cloud computing. The user or customer can access their sources from anywhere and anytime. They do not have to consider about the spesification of the server. Because cloud computing will adapt based on the needs of customer.

The benefits of the cloud computing [Saugatuck Technology, 2008], include :

- Short implementation cycles, cloud computing especially a SaaS (software as a service) can be employed in minimal time, often just with a click of a button
- Low entry costs, due to the usage-based pricing approach, costs are entirely linear to usage and can be planned
- Low risk of obsolescence, it is in the interest of the provider to keep their SaaS offerings up-to-date. Users benefit from new releases with extended functionality easily
- Customization, usually cloud services offer a wide range of configurations well adapted the requirements small and medium enterprises
- Integration, if the SaaS provider offers web service –APIs and Service-oriented Architectures (SoA), SaaS solutions can be integrated into existing software environments
- Reduced demand for own IT resources, cloud services drastically reduce the requirement on the IT organization of an enterprise in terms of required personnel and skill base
- Focus on the core business, especially small and medium enterprise benefit from the reduction of "tedious" IT related overhead
- Collaboration and mobility, cloud services offer instant access to the enterprise application environment anytime and from anywhere where internet access is available. This is especially beneficial for mobile and/or distributed workforces.

Cloud computing provides added value for organizations; saving costs in operation, resources and staff-as well as new business opportunities for service-oriented models [Vouk, 2008; Briscoe, Marinos, 2009; Haynie, 2009; Schubert, Jefferey, Neidecket-Lutz, 2010; Chang, Bacigalupo, Wills, Roure, 2010;Chang, Wills, De Roure, 2010]. The focus of cloud computing is in how to change from capital expenditure (CAPEX) to operational expenditure (OPEX). Nowadays, many SMEs perceive that IT resources as capital expenditure). Cloud computing is proposed to change that problem.

There are three kind of services that cloud computing propose [Chang, De Roure, Wills, Walters, 2011] :

- Infrastructure as a Service (IaaS) is divided into Compute Clouds and Resource Clouds. Compute Clouds provide users access to computational resources such as CPUs, hypervisors

and utilities. Resource Clouds contain managed and scalable resources as services to users-in other words, they provide enhanced virtualisation capabilities.

- Platform as a Service (PaaS): provides computational resources via a platform upon which applications and services can be developed and hosted. PaaS typically makes use of dedicated APIs to control the behaviour of a server hosting engine that executes and replicates the execution according to user requests (e.g. access rate).
- Software as a Service (SaaS), referred to as Service or Application Clouds, offer implementations of specific business functions and business process that are provided with cloud capabilities. Therefore, they provide applications and/or services using a cloud infrastructure or platform, rather than providing cloud feature themselves.

Cloud computing also have some characterization. Necessity, reliability, usability, and scalability are the characters of cloud computing. Necessty related to utility to satisfy everyday needs of the users. Reliability related to expectation about the utility when the user requiree it. Usability related to the convenient and easy to use, despite cloud computing is quite complex architecture. Scalability related to capacity that fit with the needs of users and can be expand according to the needs of the customer.

2.2. System Dynamic

The fundamental idea of System Dynamics is that socioeconomic and business systems can be regarded as continous feedback control systems that have self-regulating properties by virtue of the technological and accounting relationships between system variables and the policies that are used to manage system [Sharp, 1977]. System dynamic is used to change or modify the structure of a problem. It is different with statistical approach. Statistical approach just focus to adapt the problem. It is not change the structure of a problem. So for long term, system dynamic is very useful especially to propose new policies or maybe new product development also. The system dynamics approach therefore focuses on explanation and policy design rather than prediction. This methodology want to see the behaviour of system. And then we change it with causal loop diagram the variables of the system. After that, we see the behaviour of the systems with the new variables. The system dynamics approach involves :

- Defining problems dynamically, in terms of graphs overtime
- Striving for an endogenous, behavioral view of the significant dynamics of a system, a focus inward on the characteristics of a system that themselves generate or exacerbate the perceived problem
- Thinking of all concepts in the real system as continous quantities interconnected in loops of information feedback and circular causality
- Identifying independent stocks or accumulations (levels) in the system and their inflows and outflows (rates)
- Formulating a behavioral model capable of reproducing, by itself, the dynamic problem of concern. The model is usually a computer simulation model expressed in nonlinear equations, but is occasionally left unquantified as a diagram capturing the stock-and-flow/causal feedback structure of the system
- Deriving understanding and applicable policy insights from resulting model.
- Implementing changes resulting from model-based understandings and insights

3. Model Building

3.1. *Scope of the model*

In this section, we do some steps to build the model. Figure 2, explain the steps that we follow to build the model.

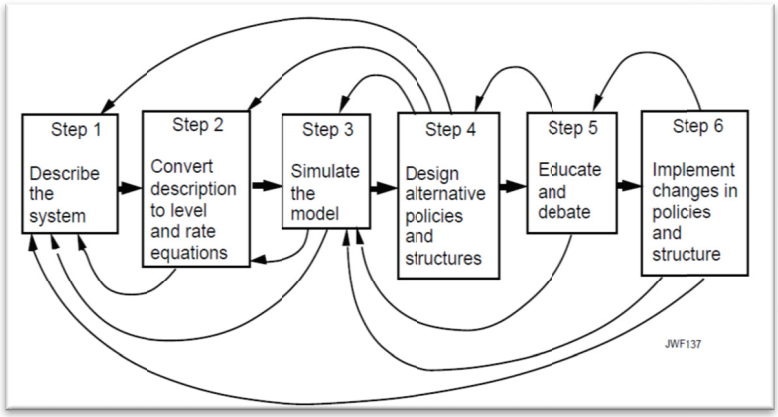

Figure 2. System Dynamic Steps From Problem Symptomps to Improvement [Forrester, 1994]

In step 1, we described the system of flow business on SMEs. We focus on how SMEs capital is influenced by implementation of information technology infrastructure. The information technology that we observed is amount of server that SMEs need. We analyzed how the amount of server affect capital of SMEs. The amount of server itself is affected by level of inventory of material. Because the function of server is to monitor the level of material for production. In step2, we defined the level in each variable. We do some assumptions to define the level of each variable. In step 3, we simulate the model that has been built. After simluated it, we analyzed the structure of the model. And in step 4, we design alternative policies in the model. We modified some variables in the new model and simulated it.In step 5, we analyzed the behavioral of new structure and compared it with the previous model. And then in step 6, we implement the new policies. As we stated earlier, that this model focus on capital and expense. Because one of advantages of cloud computing is change the capital expenditure to operational expenditure.

3.2. Causal Loops/ Causal Relationship

In this paper, we built 2 causal loop diagrams that explain of each condition. Figure 3 explained the causal loop diagram of SMEs that build their own IT infrastructure. They have to buy server by themselves.

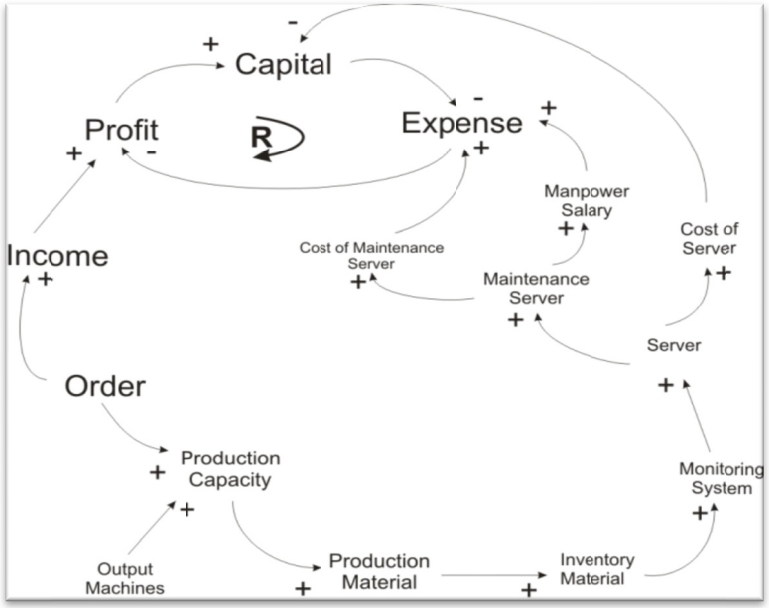

Figure 3. Causal Loop Diagram for Own IT Infrastructure

We assumed that when order is increase, the production capacity will be increased and it will affect the level of inventory material. With the increase of inventory material, the monitoring system have to add their capacity. It will affect the amount of server that SMEs going to use. The amount of server will affect the cost of server, cost maintenance server, and manpower that handle the server.

In figure 3, we see that cost of server affect capital and expense of SMEs. If the amount of server increase it will also increase the expense and decrease the capital. Figure 4 describe the causal loop diagram if we impelement cloud computing. The basic of cloud computing is that SMEs do not have to build their IT infrastructure by themselves. They just have to rent it.

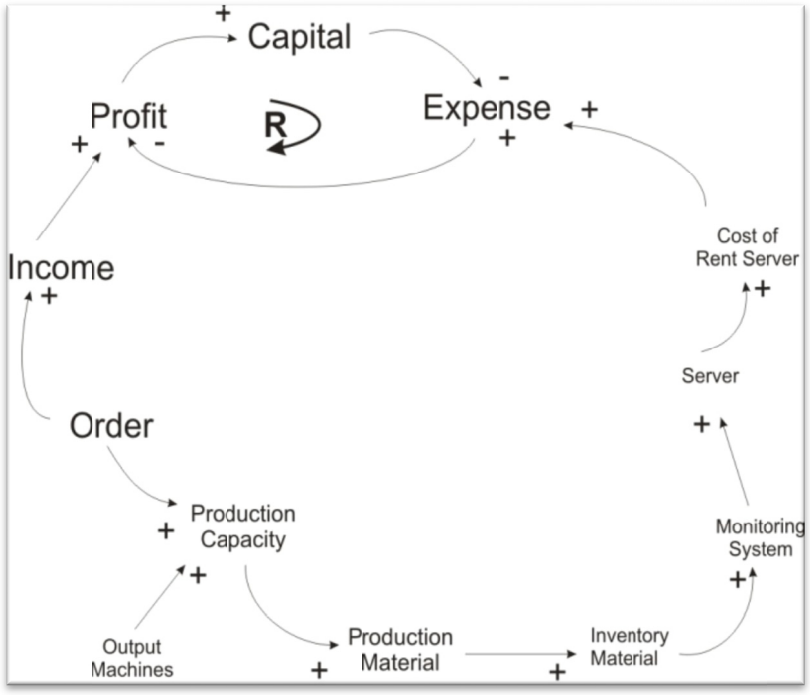

Figure 4. Causal Loop Diagram of Cloud Computing

Because the basic of cloud computing is change IT infrastructure as operational expenditure (OPEX), the cost of server only affect the expense of SMEs. SMEs do not need cost of maintenance and cost of manpower because all costs included in rent cost. Another advantage of cloud computing is the amount of server can inrease or decrease depend on SMEs need. For example, if monitoring system needs big data so the amount of server will be increased. But when the monitoring just needs a few data so the amount of server will be decreased. SMEs just have to ask the cloud provider to decrease the spesification and amount of server.

3..3 SFD/ Main Formulation

In SFD section, we do some limitations to build SFD. We set that sales is only income of SMEs. The price of the product of SMEs is fix. And the amount of order is fix. We set the value of order manually in order to know the effect to the capital and expense. The expense also just affected by IT infrastructure. So the expense just cost of maintenance, manpower of IT infrastructure. Figure 5 describe the stock and flow diagram if SMEs build their own IT infrastructure.

The amount of server in figure 5 is fix or increase. It will affect the amount of capital and increase the expense of SMEs. It is different with cloud computing implementation. We can see in figure 6 how cloud computing affect the capital and the expense of SMEs.

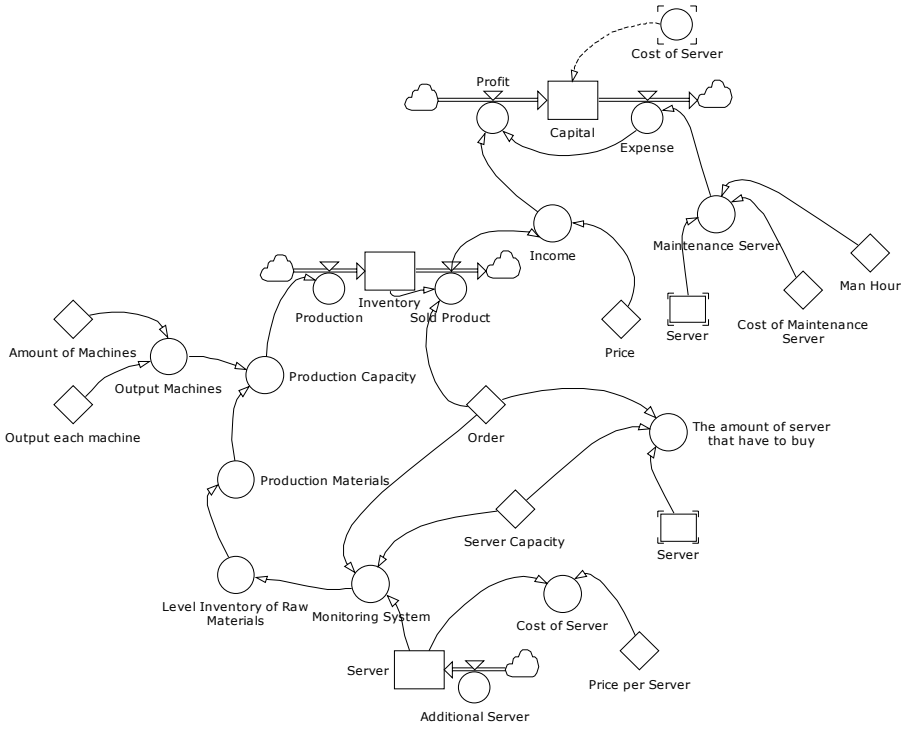

Figure 5. Stock and Flow Diagram for Own IT Infrastructure

Capital is our parameter to differentiate between owning IT infrastructure and implementation of cloud computing for SMEs.

The equation will be :
Capital = Profit – Expense, where
Profit = income * price
Expense (maintenance server) = cost of maintenance server * man hour * amount of servers

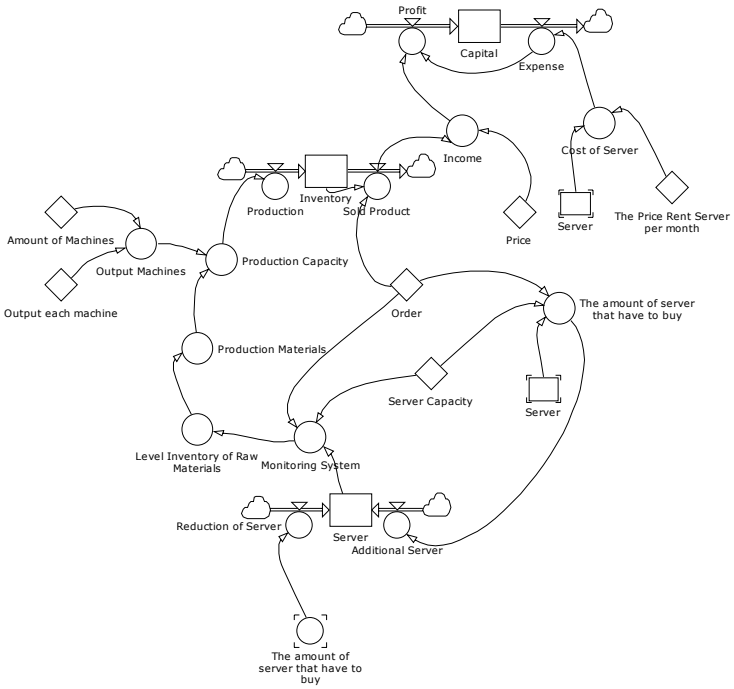

Figure 6. Stock and Flow Diagram The Implementation of Cloud Computing

Based on figure 6, the equation will be,
Capital = Profit – Expense, where
Profit = income*price
Expense (Rent Server) = amount of servers * the price rent server per month

The difference between figure 5 and figure 6 is the amount of server. In figure 5 the amount of server is fix and it could be increased. It is different with figure 6, in figure 6 the amount of server is not fix. It could be increased or decreased depend on the needs of SMEs. With that difference, it will impact to the cost of IT infrastructure (server). The cost of maintenance server and manpower of IT in figure 5 is fix and could be increased. In figure 6 the cost could be increased and decreased depend on the amount of server. It wil save the expense of SMEs.

4. Experiments

In experiment section, we set the order is fix and also server capacity. We just set the amount of order manually. The amount of order could high (bigger than server capacity) or lower than server capacity. And we see the impact to capital and expense. In this experiment we do 2 scenarios in each condition.

1. Condition 1 (SMEs build their own IT infrastructure)
   a. Scenario 1, the amount of order is lower than server capacity
   b. Scenario 2, the amount of order is higher than server capacity
2. Condition 2 (SMEs implement cloud computing)
   a. Scenatio 3, the amount of order is lower than server capacity
   b. Scenario 4, the amount of order is higher than server capacity

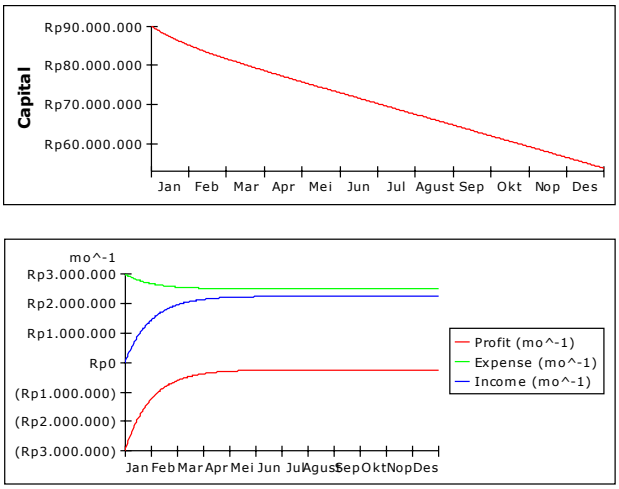

Figure 7. Scenario 1

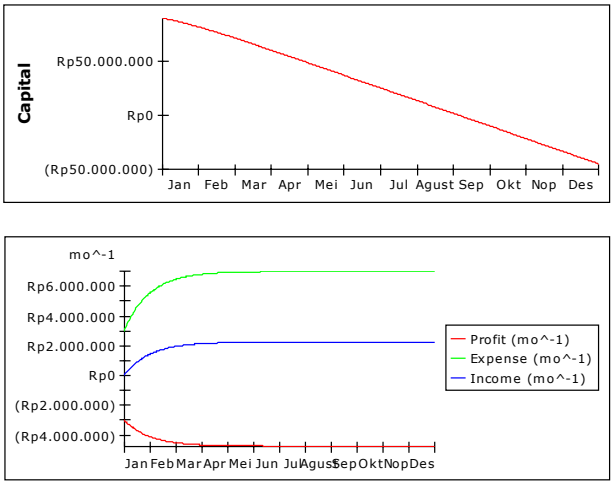

Figure 8. Scenario 2

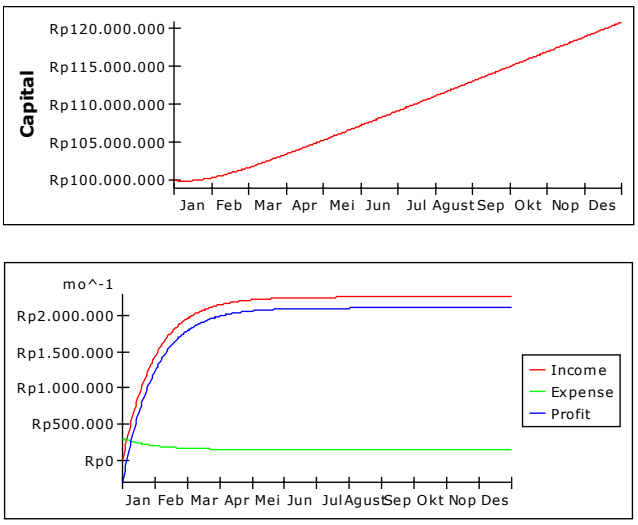

Figure 9. Scenario 3

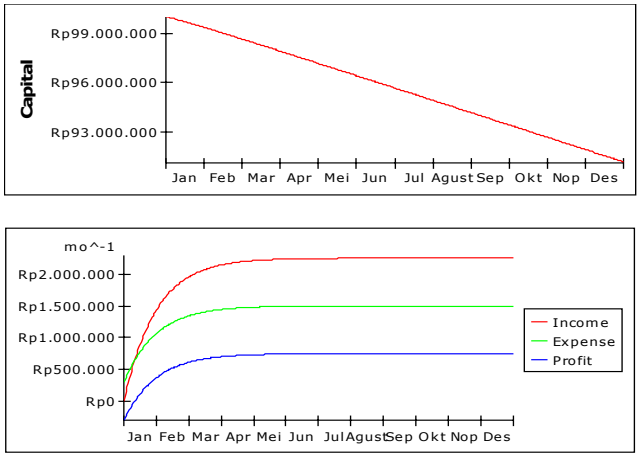

Figure 10. Scenario 4

In scenario 1 and 2 the modal will increase because the amount of cost by server (maintenance, manpower, and server) is fix. It is different with scenario 3 and 4.

5. Conclusions

From the experiment, we can conclude that :

1. Information technology is very useful for SMEs to increase their income and make their business effective and efficient.
2. Cloud computing is one of promising alternative IT solution for SMEs and is useful to be implemented
3. The implementation of cloud computing did not affect capital expenditure of SMEs directly. So compare with build own IT infrastructure, cloud computing is very affordable.

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