A System Dynamics Modeling for Knowledge Management, Culture and Performance (KMCP): Case study in Indonesian Construction Firm

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Abstract

In today's competitive world, knowledge is considered an essential source to improve performance of organizations. Thus, those organizations will be more successful that sustainably manage their knowledge assets through operational activities. The objectives of research are to develop model and to simulate knowledge management, culture and performance of construction firm using system dynamics. This research is an ongoing project and divided into four stages, i.e. develop conceptual model, obtaining data with interview and annual report of firm, develop causal loop diagram, stock flow diagram and simulation on model developed. Data analysis use system dynamics. The model developed is able to demonstrate the relationships between knowledge management, culture and performance to interact each other in the organization. It can be seen employee (staff) skill is growth up 7%, knowledge base is growth up 7% and costumer base is growth up 200%.

Keywords: **Knowledge management, culture, performance, construction firm, system dynamics**

1. Introduction

In knowledge based business era right now, knowledge is an important asset that used to compete in global business. Prijono (2008) said that knowledge management is a concept that has focus on management of knowledge, its process if it run well will be beneficial to business process and will improve firm performance (pp1-2).

Tahir et al. (2010) stated that a positive and significant firm culture influence knowledge management (pp1033-1034). Chen (2007) stated that a positive relationship between knowledge management and firm performance (pp260). Aluko (2003) stated that a positive relationship between firm culture and performance (pp176-177). The obtained results shows that firm culture and knowledge management influence performance of organizations. However, the previous research are a static models. The objectives of research are to develop model and to demonstrate knowledge management, culture and performance of construction firm using system dynamics. This is an ongoing research about relationship between knowledge management, culture and performance using system dynamics. The research model is developed using conceptual model, causal loop diagram and stock flow diagram. However, previous research are static models. The model developed is tested and simulated based on some phenomena.

2. Literature Review

2.1 Knowledge

Widayana (2005) defines that knowledge is an information that completed with relationship mode comprehension from information with individual and group experience. Combination of information, context and experience, looked is as a core competence of organization that can capture, share and utilize for business aspects (pp.9). Munir (2008) stated that in general knowledge is divided into tacit and explicit knowledge. Tacit knowledge is a human knowledge that can be an intuition, judgment, skill, experience, body language, values, belief and rule of thumb. It is very difficult to formulate, to communicate, or to share with other people. Explicit knowledge is a knowledge that can be expressed in words, numbers. It can be added, transferred, distributed and that given in systematic and formal way in data, knowledge formula, product specification, manuals and universal principles (pp.25-27).

2.2 Knowledge Management

Zuhal (2010) defines knowledge management (KM) is a term applied to techniques used for the systematic collection, transfer, security and management of information within organizations. Knowledge management is an organization way to manage knowledge, to create values and to improve competitive advantage or firm performance (pp.76-78). Seleim and Khalil (2007) stated that knowledge management have activities and we can call it knowledge management processes such as knowledge creation, knowledge acquisition, knowledge application, knowledge transfer and knowledge documentation (pp38-39).

2.3 Firm Culture

Suwarto and Koeshartono (2009) explain that culture has elements like assumptions, values, norms and behavioral. Firm culture are unity of people who have objective, beliefs and the same values. Firm culture are values system, beliefs, assumptions or universal norms that agreed and followed by employees, and used to behavioral standard and problem solving of organization. Firm culture are values systemic agreed, followed and believed in organization (pp2-5). In this paper corporate culture are values believed in firm to enable knowledge management processes and to improve performance. In addition, Lee and Choi (2003) stated that firm culture have values like collaboration, teamwork, trust, reward, recognition, and learning development (pp191-192).

2.4 Firm Performance

Lestari and Zulaikha (2007) define that firm performance is a level of achievement and show manager succeess. Performance refers to output and outcome of processes, products, and services that evaluated and compared with objective, standard, the past result and other organization (pp.15-17). Ellitan and Anatan (2009) stated that Performance is a level of organization to achieve business goal. It can be measured by profitability, finance, learning and growth (pp28-29).

2.5 System Dynamics

Susilastuti (2011) said that system dynamics (SD) was firstly introduced by Forrester as a method for modeling and analyzing the behaviour of complex social systems, particularly in an industrial context. It has been used to examine various social, economic, and environmental systems, where a holistic view is important, and feedback loops are critical to the understanding of the interrelationships (pp56-58). Sterman (2000) explains that system dynamics is an approach to understand the behavior of complex systems over time. It deals with internal feedback loops and time delays that affect the behavior of the entire system. What makes using system dynamics is different from other approaches to studying complex systems is the use of cause and effect diagrams and stock and flow diagram. These elements describe how even seemingly simple systems display baffling nonlinearity (pp41-43).

Georgiadis (2005) explains that the structure of a system in system dynamics methodology is exhibited by causal loop (influence) diagrams. The causal loop diagram captures the major feedback mechanisms. These mechanisms are either negative (balancing) or positive feedback (reinforcing) loops. A negative feedback loop exhibits a goal-seeking behavior: after a disturbance, the system seeks to return to an equilibrium situation. In a positive feedback loop an initial disturbance leads to further change, suggesting the presence of an unstable equilibrium. The Causal loop diagrams play two important roles in System Dynamics. First, during model development, they serve as preliminary sketches of causal hypotheses and second, they can simplify as a model representation. The structure of a dynamic system model contains stock (state) and flow (rate) variables. Stock variables are the accumulations (i.e. inventories), within the system, while flow variables represent the flows in the system (i.e. order rate), which are the byproduct of the decision-making process. The model structure and the interrelationships among the variables are represented by stock-flow diagrams. The mathematical mapping of a System Dynamics stock-flow diagram occurs by a system of differential equations, which is numerically solved by simulation. Nowadays, high-level graphical simulation programs (such as i-think, Stella, Vensim, and Powersim) support the analysis and study of these systems (pp353-354)

3. Research Methodology

This research which have done on one of big construction firm in Indonesia, began August-September 2012. This research uses system dynamics method and divided into 4 (four) stages. The first stage is literature review and developing conceptual model. Literature review has done to find research problem and then makes conceptual model that have got from literature study about firm culture, knowledge management and firm performance. Second stage are collecting data with interview and gathering annual reports of firm. Third stage is dynamics modeling. This stage has two activities i.e. developing causal loop diagram and developing stock flow diagram. Final stage is analysis, discussion and conclusion. Model of knowledge management, culture and performance are analysed by system dynamics. Results of simulation showed on table and figure form in order to make

easy to catch messages from this research. And the last activities are discussion and conclusion. All of study stages are shown at figure 1.

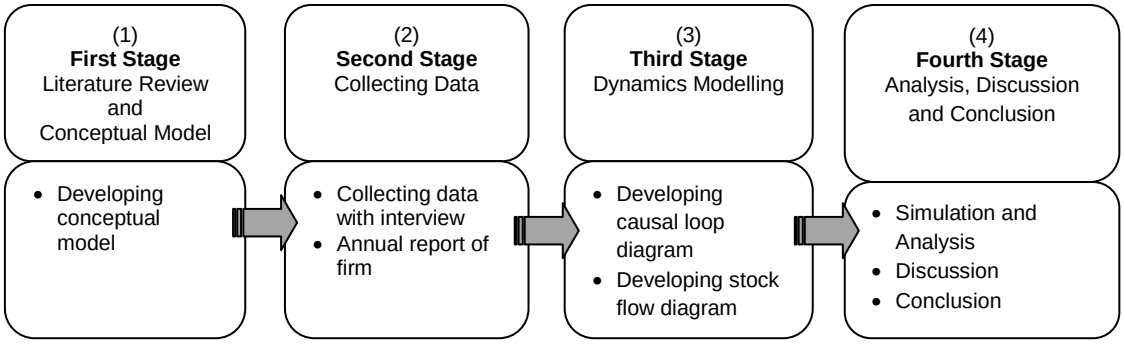

Figure 1. Study Stages

4. Modeling, Analysis and Discussion

4.1 Conceptual Model

Conceptual model of knowledge management culture and performance of construction firm have been gotten by literature study of relationship between firm culture, knowledge management and firm performance. Tahir et al. (2010) stated that a positive and significant firm culture influence knowledge management (pp1033-1034). Chen (2007) stated that a positive relationship between knowledge management and firm performance (pp260). Aluko (2003) stated that a positive relationship between firm culture and performance (pp176-177). Figure 2. displays a conceptual model of knowledge management culture and performance (KMCP).

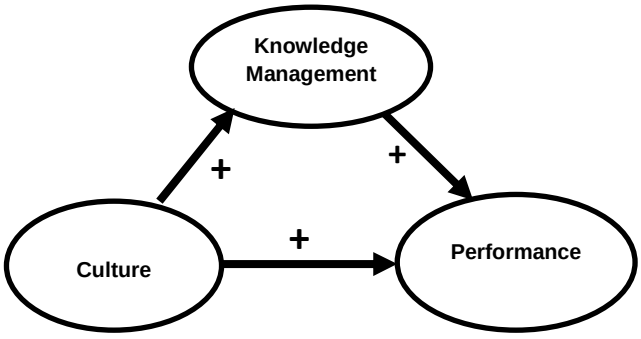

Figure 2. Conceptual Model of Knowledge Management Culture and Performance

4.2 Causal Loop Diagram of Knowledge Management Culture and Performance (CLD-KMCP)

Causal Loop diagrams are used to capture mental models and represent interdependencies and feedback processes in a system. All dynamics arise from the interaction of just two types of feedback loops, i.e. positive loops tend to reinforce or amplify whatever occurring events in the system and negative loops tend to balancing system. The diagram in Figure 3 presents the essential components and interactions in the model of knowledge management culture and performance construction firm.

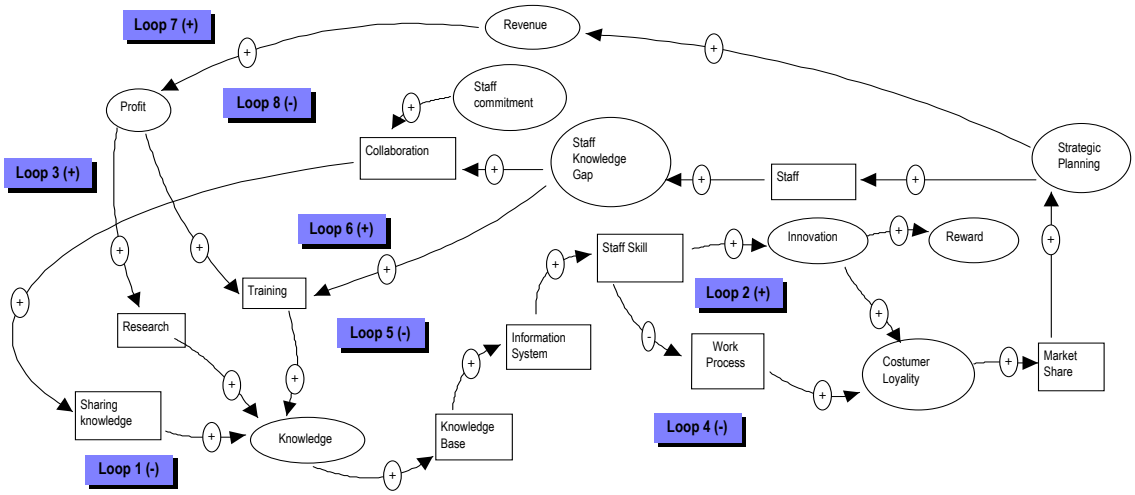

Figure 3. Causal Loop Diagram Knowledge Management, Culture and Performance in Construction Firm

Based on figure 3 causal loop diagram (CLD) knowledge management, culture and firm performance and then developing loop structure, i.e.

a. Loop 1 (-) consists of sharing knowledge - knowledge - knowledge base - information system - staff skill - work process - costumer satisfaction - market share - strategic planning - staff - gap of staff knowledge - collaboration to add knowledge - sharing knowledge;
b. Loop 2 (+) consists of sharing knowledge - knowledge - knowledge base - information system - staff skill - innovation - costumer satisfaction - market share - strategic planning - staff - gap of staff knowledge - collaboration to add knowledge - sharing knowledge;
c. Loop 3 (+) consists of research - knowledge - knowledge base - information system - staff skill - innovation - costumer satisfaction - market share - strategic planning - revenue - profit - research;
d. Loop 4 (-) consists of research - knowledge - knowledge base - information system - staff skill - work process - costumer satisfaction - market share - strategic planning - revenue - profit - research;
e. Loop 5 (-) consists of training - knowledge - knowledge base - information system - staff skill - work process - costumer satisfaction - market share - strategic planning - staff - gap of staff knowledge - collaboration to add knowledge - training;

f. Loop 6 (+) consists of training - knowledge - knowledge base - information system - staff skill - innovation - costumer satisfaction - market share - strategic planning - staff - gap of staff knowledge - training;
g. Loop 7 (+) consists of training - knowledge - knowledge base - information system - staff skill - innovation - costumer satisfaction - market share - strategic planning - revenue - profit - training;
h. Loop 8 (-) consists of training - knowledge - knowledge base - information system - staff skill - work process - costumer satisfaction - market share - strategic planning - revenue - profit - training.

In general, causal loop diagram represents four reinforcing loop and four balancing loopss. System has reinforcing and balancing interaction and if one of the sub systems is uncontrolled, feedback system will happen in order to balancing and reinforcing elements inside the systems.

4.3 Stock Flow Diagram of Knowledge Management Culture and Performance (SFD-KMCP)

The stock and flow model presented below is based on the causal loop diagram in the previous section. A selection of variables from the causal loop diagram was translated into stocks, along with the corresponding relationships. The variables selected were chosen according to their relevance with regard to stock and flow systems, and their potential influence on firm performance. Stock flow diagram of knowledge management, culture and performance can be seen on figure 3.

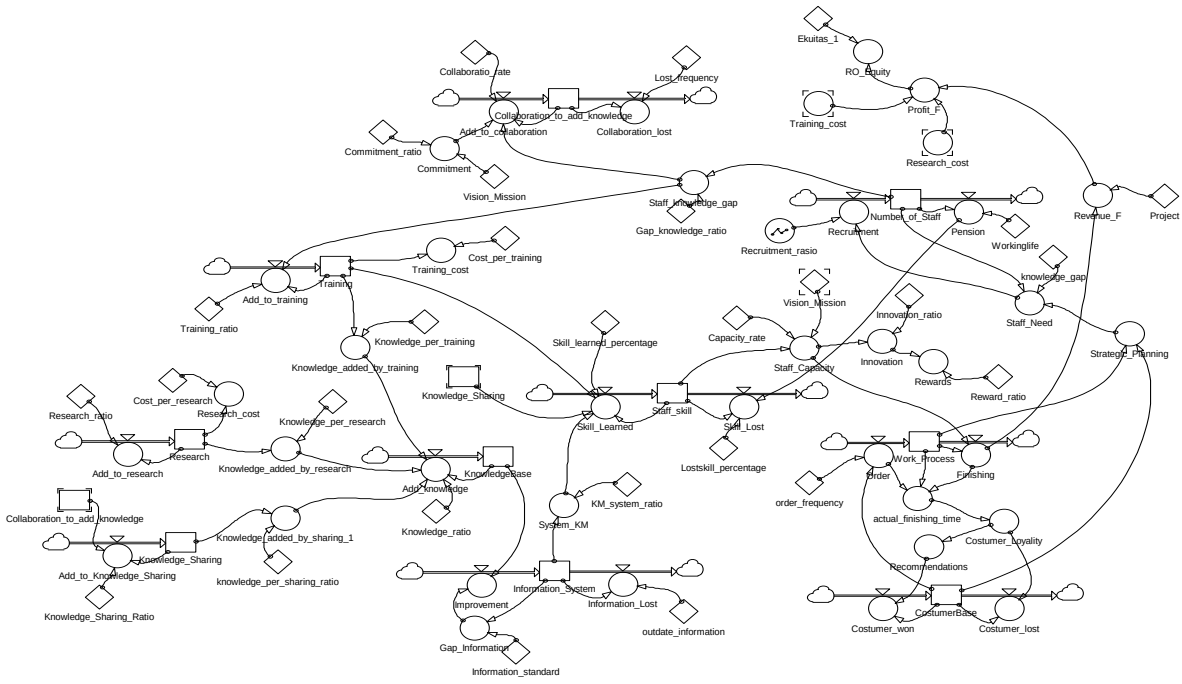

Figure 4. Stock Flow Diagram Knowledge Management, Culture and Performance in Construction Firm

Stock flow diagram (SFD) on figure 4 explain that knowledge management, culture and firm performance is a dynamic modeling and have dynamic connection each other.

4.4 Simulation of Dynamic Model of Knowledge Management Culture and Performance

Figure 4 shows that dynamics model of knowledge management culture and performance consist of ten sub system i.e. collaboration to add knowledge, training, research, knowledge sharing, knowledge base, information system, costumer base, work process, number of staffs (employees), employees (staffs) skill. Based on conceptual model of KMCP and then ten sub system categorized into three variables and showed on figure 5. Simulation of model represents dynamic change and is showed in time graph and time table. Results of simulation can be explained through three sub system, i.e. employee skill is representative of culture, knowledge base is representative of knowledge management, costumer base is representative of performance.

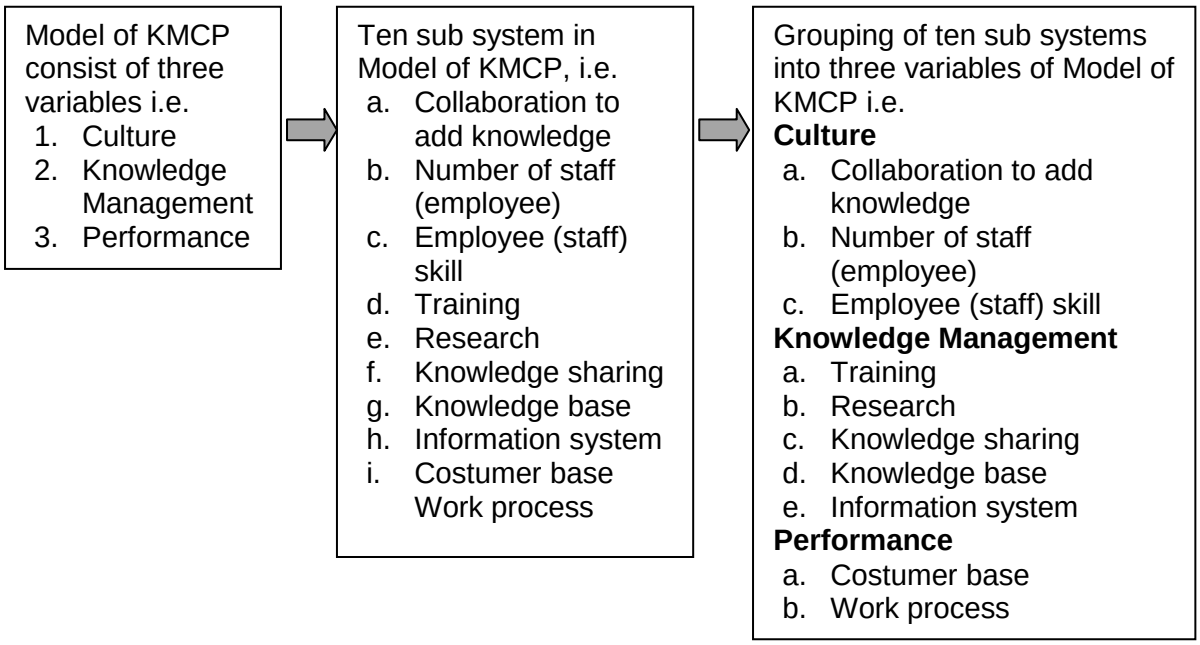

Figure 5. Grouping of Sub System into Variables of Model of Knowledge Management, Culture and Performance in Construction Firm

4.4.1 Employee Skill Sub System

Based on figure 4 can be explained that staff skill sub system comprises with staff skill element as stock variable that gets inflow from skill learned and outflow from lost skill. Skill learned got information from skill learned percentage, knowledge sharing, system knowledge management and staff skill. Skill lost got information from staff skill, lost skill percentage and pension. Result of simulation of dynamic model presented on table 1 and figure 5.

Table 1. Simulation of Employee and Add to Skill

Year	Staff_Skill	Skill_Learned
0	1000000	410671
1	1080671	442939
2	1166989	477467
3	1259349	514411
4	1358175	553941
5	1463918	596238
6	1577063	641496
7	1698129	689922
8	1827669	741738
9	1966276	797182
10	2114587	856506

Figure 6. Simulation Graph of Employee and Add to Skill

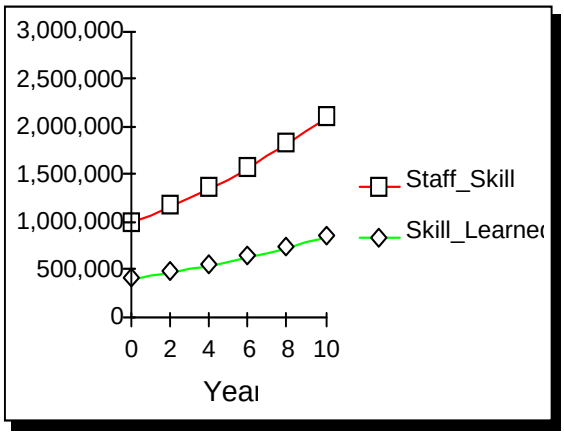

Table 1 and graph 6 shows that staff skill and skill learned growth up significantly from first year until tenth year. Staff skill and skill learned are growth up 7% average every year.

4.4.2 Knowledge Base Sub System

Figure 4 shows that knowledge base sub system comprises with knowledge base element as stock variable that got inflow from add to knowledge. Add to knowledge got information from knowledge added by sharing, research, sharing, knowledge base and knowledge ratio. Result of simulation of dynamic model is presented on table 2 and figure 7.

Table 2. Simulation of Knowledge Base

Year	Knowledge_Base1	Add_to_knowledge
0	50000	30418
1	80418	36502
2	116920	43802
3	160722	52562
4	213284	63075
5	276359	75690
6	352048	90828
7	442876	108993
8	551869	130792
9	682661	156950
10	839611	188340

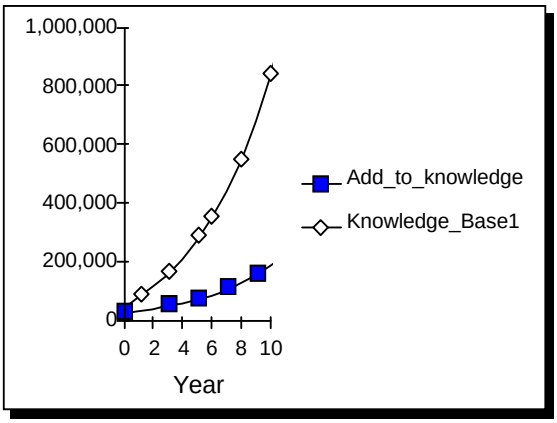

Figure 7. Simulation Graph of Knowledge Base

Based on table 2 and graph 6 can be explained that knowledge base and add to knowledge growth up significantly from first year until tenth year. Knowledge base and add to knowledge are growth up 7% average every year.

4.4.3 Costumer Base Sub System

Based on figure 4 can be explained that costumer base sub system comprises with costumer base element as stock variable that got inflow from costumer won and outflow from costumer lost. Costumer won got information from costumer base and recommendation, costumer lost got information from costumer base and costumer loyalty. Result of simulation of dynamic model presented on table 3 and figure 8.

Table 3. Simulation of Costumer Base

Year	Costumer_Base
0	20,000.00
1	60,000.00
2	180,000.00
3	540,000.00
4	1,620,000.00
5	4,860,000.00
6	14,580,000.00
7	43,740,000.00
8	131,220,000.0
9	393,660,000.0
10	1,180,980,000

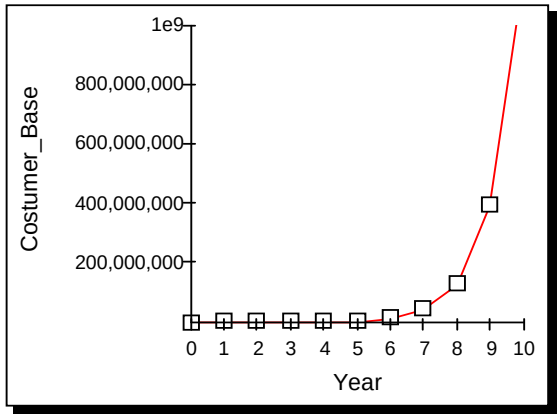

Figure 8. Simulation Graph of Costumer Base

Table 3 and graph 8 presents that costumer base growth up significantly from first year until tenth year. Costumer base is growth up 200% average every year.

4.5 Discussion

The simulation results contribute to the understanding of the dynamics of the system of knowledge management, culture and performance in construction firm. Resulting from the positive effect of culture and knowledge management rises within the simulation time of employee (staff) skill in 10 years. The simulation results show that staff skill rises significantly 7% in average every year. Positive relationship between knowledge management and performance proved by simulation results of costumer base that show rises significantly 200% average every year. And simulation result of knowledge base show rises significantly 7% average every year.

Result of this research support some previous research, i.e. Tahir et al. (2010) stated that a positive and significant firm culture influence knowledge management (pp1033-1034). Chen (2007) defined that a positive relationship between knowledge management and firm performance (pp260). Aluko (2003) stated that a positive relationship between firm culture and performance (pp176-177).

5. Conclusion

The objectives of research are to develop model and to demonstrate knowledge management, culture and performance of construction firm by using system dynamics. By employing the system dynamic simulation tools, diagrams illustrating causal loops and stock and flows have been presented with the intention to demonstrate the different variables and how they affect each other. The model suggested in this research demonstrates the relationships between knowledge management, culture and performance can give improvement. It can be seen from results of employee (staff) skill is growth up 7%, knowledge base is growth up 7% and costumer base is growth up 200%.

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