Building A System Dynamics Model for Strategic Knowledge Management in IT Company

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Abstract

IT companies make a lot of efforts for sharing and utilizing of experiences of their members and transforming them into the organizational knowledge as a competitive core. But they face a dilemma that they have to spend time and financial resource to perform activities around knowledge management for the long-term gains, while carrying field-works for making short-term profits.

As an initial attempt to tackle this managerial problem, this paper try to investigate the mechanism of knowledge management in a small IT company in Korea with a synthetic view-point using system dynamics simulation model. It depicts the dynamic behaviors of knowledge management and presents some findings of political leverage. Although it has to be replenished further, the scheme for the dynamism of knowledge management and the findings presented in the paper could be useful for the decision makers particularly of knowledge-intensive organizations

Key Words : Knowledge Management, system dynamics

1. Introduction

Many prior-researches, which emphasize the importance of knowledge management, accentuate that it accelerates collective learning, improves competitiveness and facilitates responsiveness to the market changes. Unlike a financial asset that is exhausted and devaluated as time passes, the intellectual capital provides continuous value to the organization.

Many companies, knowledge-intensive in particular, recognize that the competitiveness largely depends on their ability to create, collect and manage organizational knowledge, and thus run knowledge management programs for developing, transferring, storing and disseminating the knowledge they retain. Yet, managing organizational knowledge as such is a challenging task, considering the variety of factors that affect it over time, including organizational structure; informal social processes; interactions among people, activities, and incentives, and market changes (Hansen, Nohira & Tierney, 1999). Moreover, it is not easy to find an optimum level of investment of scarce resources in knowledge management for the long-term gains, while carrying field-works for making short-term profits.

To tackle these questions, this paper attempts to develop a system dynamics[(1)] (Forrester 1961; Goodman 1989; Richardson and Pugh 1981; Sterman 2000) simulation model for the organizational knowledge management issues of a small IT company in Korea. The paper provides a rigorous framework and the rules for qualitative description, exploration and analysis of systems in terms of their processes, business rules and information feedback, facilitating quantitative simulation modeling and analysis for the design of system structure and control. Some influential factors that accelerate or deteriorate development of the knowledge at a company were also deduced definitely with this trial.

The model in this paper covers many factors in five sectors such as personal knowledge, organizational knowledge, projects, staffs, and finance sector that derive from prior researches and the interviews in company and their interactions are portrayed in a map diagram as shown in Figure 1.

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(1) System dynamics is a methodology for understanding complex problems where there underlies dynamic behavior affected by a certain set of feedback mechanisms. Much of the art of system dynamics modeling (such as casual-loop diagram, stock-flow diagram and simulation model) lies in discovering and representing the feedback processes and other elements of complexity that determine the dynamics of a system (Sterman, 2000).

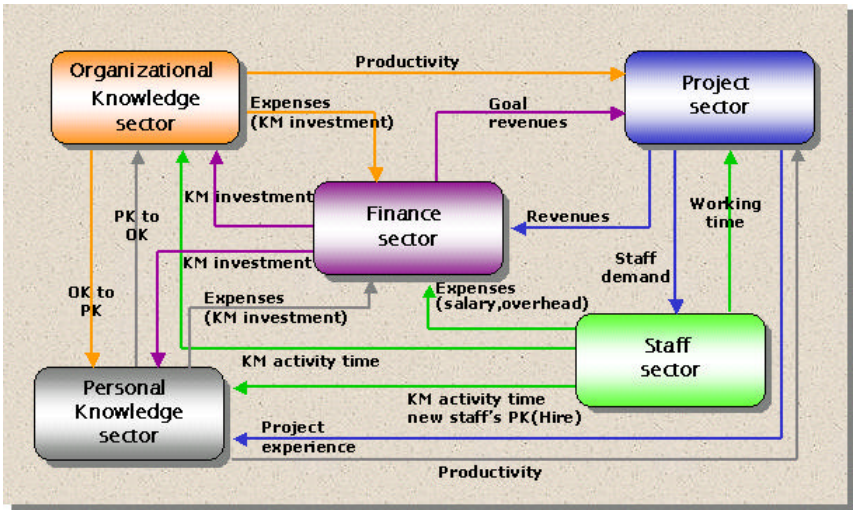

Figure 1 MAP DIAGRAM OF KM

2. System Thinking approach to KM

As stated above, dynamics of knowledge management is perhaps explained by investigating the interactions among five sectors. The authors try to make a through review the dynamics for each sector followed by depicting it with causal-loop diagram.

2.1 The dynamics of organizational knowledge

Personal knowledge contributes to the increase in organizational knowledge(Nonaka, 1991) via various KM activities. The increase in organizational knowledge in turn increases personal knowledge over time. This reciprocal feedback structure leads to closed loops. The behavior represented by these single loops, however, is not a good representation of reality as anything in the real world does not continually increase over time without balancing factors involved.

The dynamic behavior of organizational knowledge is influenced by the change of balancing point between the acquisition and the loss. Acquisition of organizational knowledge is accumulated in the transformation process from personal knowledge to organizational knowledge by KM. The loss of organizational knowledge rises in proportion to quantity of knowledge by obsolescence. Because the obsolescence of knowledge is very fast in the IT industry which is characterized by very low inertia,

rapid technological change, and swift technological obsolescence (Pardue et al, 1999), IT firms have to generate the organizational knowledge more than vanishing of that. But as the stock of organizational knowledge grows, the time to locate relevant knowledge also increases, and the net effect of knowledge diminishes(Rich and Duchessi, 2001).

Time and monetary resources for KM activities are required to resolve the problem of knowledge confusion (see figure 2).

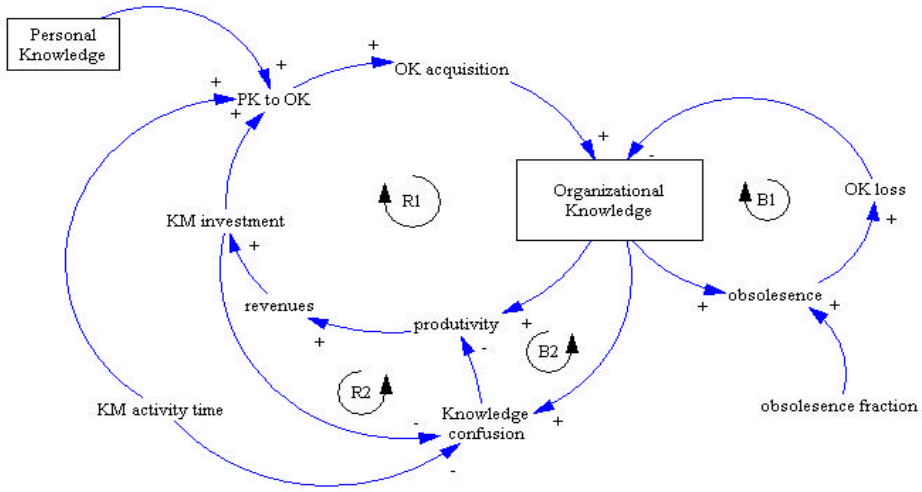

Figure 2 CLD-1: ORGANIZATIONAL KNOWLEDGE SECTOR

The dynamic behavior of this simple system depends on which of these loops dominates over time. If the generation of organizational knowledge is bigger than its loss, the organizational knowledge rises (R1 and B1). Therefore the productivity from the organizational knowledge grows quickly, and then the time to locate knowledge may not be important for some time (R2 and B2). But KM by spending time and monetary resources leads to the decrease of time on work and the increase of expenditure, which in turn make the revenue to go down. As a result, the effort on KM also deceases.

2.2 The dynamics of personal knowledge

The members of organization have various kinds of knowledge such as project execution, management experience, originality, etc. This knowledge as a whole widely effects on their productivity and quality of work. At the same time, they learn by performing various projects, and they elevate their technical skills and increase personal

knowledge. The growth of personal knowledge positively effects on the potential performance of prospective projects. The factors influencing on personal knowledge increase would be summarized as follows (see figure 3):

The first is the increase in the employee's personal knowledge usually gained in four channels(or routes) such as experience from the previous projects(R3, experience), education including self-study, reading etc.(R4, education), knowledge diffusion through networks among members(R5, PK to PK), and transformation from organizational knowledge into personal (R6, OK to PK). The second is the inflow of personal knowledge occurred by employing new workers form outside.

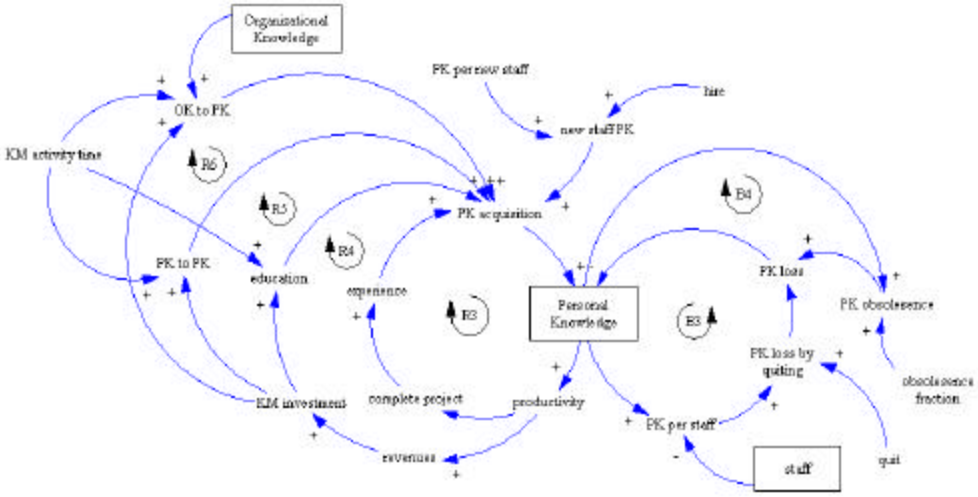

Figure 3 CLD-2: PERSONAL KNOWLEDGE SECTOR

Once personal knowledge is reserved in tacit forms, it remains usable in organization as other organization members are able to access to and obtain it. And thus, the level of personal knowledge would not decrease even if knowledge generator leaves the organization. Meanwhile, secessions among the members result in diminishing the personal knowledge, which will in turn decrease in the organizational knowledge. As the organizational knowledge decreases, personal knowledge also diminishes over time.

2.3 The dynamics of projects

KM policies affects on the change in both stock of knowledge available to the organization and transformation rate of knowledge from organization to persons and

from persons to persons. The knowledge increase by KM policies increases productivity on projects, which in turn increases the firm's reputation in the market to get more projects available. From the perspective of systems thinking, the increase in projects directly leads to the increase of staffs, which in turn increase projects completed. As projects are completed, they increase revenue, which increase investment in KM.

However, resource allotment, especially time allocation of staffs onto the KM activities also decreases the effort on projects that make revenue. In turn, the number of completed projects decreases and thus revenue decreases in short term, which in result, leads to the decrease in KM activities, and so on. This cycle indicates that the overall effects of KM depend on how much time of staff's to allocate onto projects and KM. activities respectively.

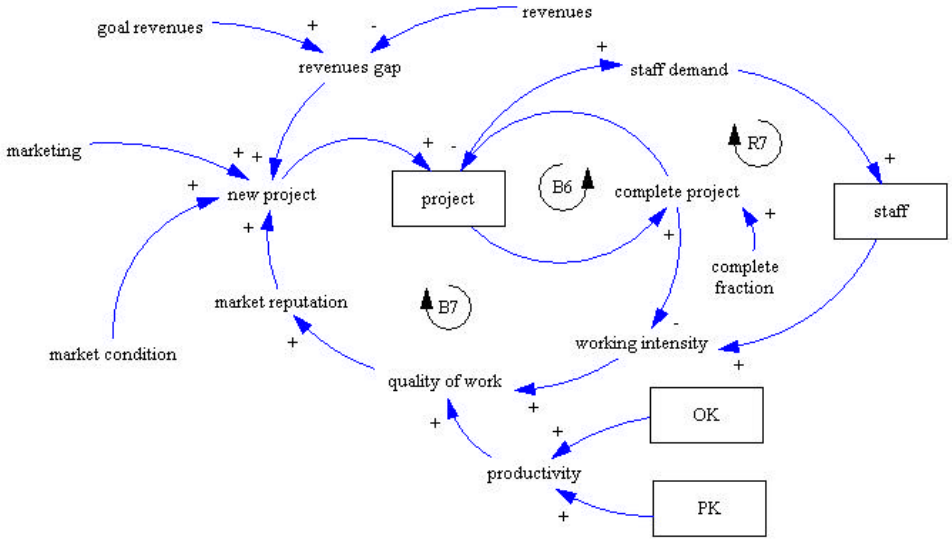

Figure 4 CLD-3: PROJECT SECTOR

2.4 The dynamics of staff

The staff is one of most important source of generating and transforming knowledge in firms. Particularly, when the knowledge resources of the firm are largely tacit, as in the case of IT firms, turnover ratio of employees is critical in that it affects the amount of know-how and know-who available in the firm.

When staffs leave a firm, they take their personal knowledge with them, including

that gained from work experience while at the firm (see Figure 3). To extent that the firm relied on them as a source of knowledge, personal knowledge decreases and in turn organizational knowledge diminishes. Their departure also gives negative impact on the firm's interpersonal network, eliminating the links they provided to others in the firm.

As the departure of skilled staff directly means a loss of knowledge, it is a very important concern of managers in IT firms. In IT industry, the annual turnover rate is estimated to range between 10% and 20% on the average.

Some of the employees newly hired to replenish the departing staff may have work experience and immediately contribute to the firm. Others are inexperienced, recent graduates, who have some general skills but require training and experience to reach proficiency. In many firms, most entrants are of this latter type. They learn required techniques and culture from the experienced staff inside the organization. This adaptation causes the decrease in organizational knowledge temporarily at least and time is needed to recover.

The dynamics of staff clearly affect the collection and retention of knowledge. First, the departure of experienced staff reduces tacit knowledge resources faster than that provided by new inexperienced staff, putting downward pressure on organizational knowledge. Second, the departing staff will have higher individual productivity than the newly hired staff, which exerts pressure to divert more effort to knowledge management activities to counter. As a result, the behavior seeks balance

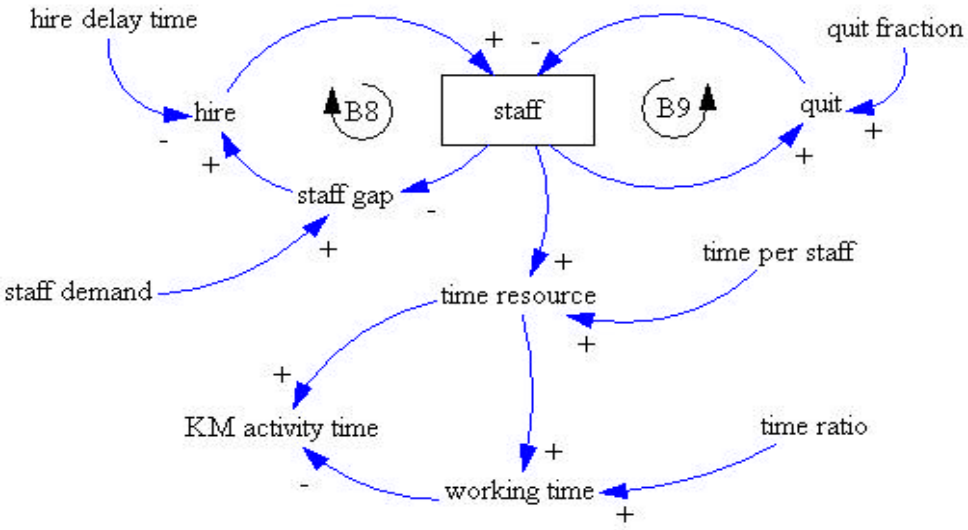

Figure 5 CLD-4: STAFF SECTOR

2.5 The dynamics of financial performance

The ultimate goal of KM is to improve the financial performance of the firm. For that reason, it is required to make a decision on the best policy to increase the financial performance by KM. For the purpose, this paper attempts to make a solution through system dynamics modeling.

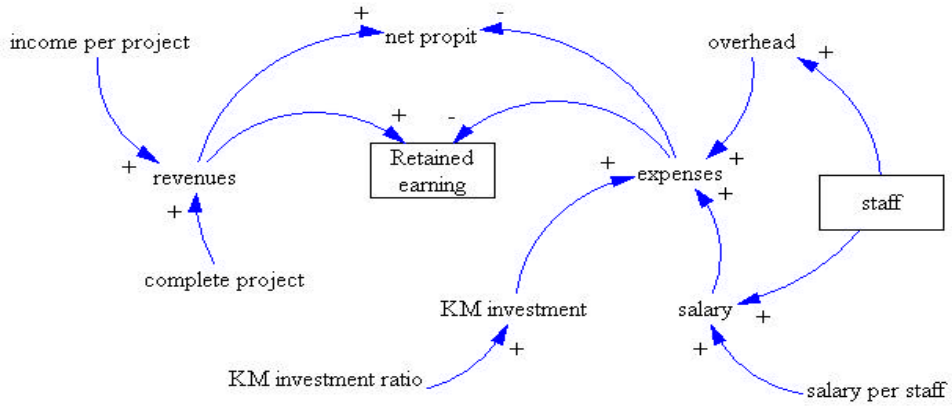

Figure 6 CLD-5: PROJECT SECTOR

A critical source of financial pressure for IT firms mainly comes from the unbalance between the volume of project backlog and the number of workers to perform. Not only pending projects but also new projects with a mixture of short-term and long-term engagements are necessary to meet revenue targets and maintain a certain level of cash flow. However, wrong staffing practices are apt to cause financial problems. Hiring staff too slowly limits the growth of the firm; hiring staff too quickly diminishes productivity. In response to the organizational growth, a hypothetical firm increases its staff with inexperienced employees. These employees are not as productive as those who leave, and are less effective in reducing project backlog. And there also are delays in recognizing backlog and hiring additional staff. Besides, as staff increases the expense also increases. As a result, rapid growth creates a "boom and bust" scenario in the worst case.

KM activities often demand time and monetary resources away from doing projects or field-works for short-term revenue. KM activities are in result regarded not only as the source of revenue increase by achieving project quality with high productivity but also as the source of expenditure through decreasing project quality by low intensity of staffs.

3. Simulation and implications

Based on the discussions thus far, a stock-flow diagram (SFD) is developed for the computer simulation runs. Exogenous variables are those related to the KM investment amount and the time allocation ratio of staffs, which are identified as crucial factors for KM. They are set constant for the initial simulation runs. The other constant variables except conditional variables in the model are developed through interviews with a firm as an example and conditional variables are used by default value.

There were two sessions of computer simulation tried under different situations by changing the values of policy leverages. Net profit reaches the peak at reasonable value when investment ratio is 4.3% and time allocation ratio, 22% (see figure 7). On the other hand, the highest level of organizational knowledge increased as the values increased (see figure 8). The policy implication which result of simulation is suggesting can be summarized as following. Firms decide reasonable levels of activity and investment in KM. And they have to recognize that the behavior of organizational knowledge is ahead that of revenue.

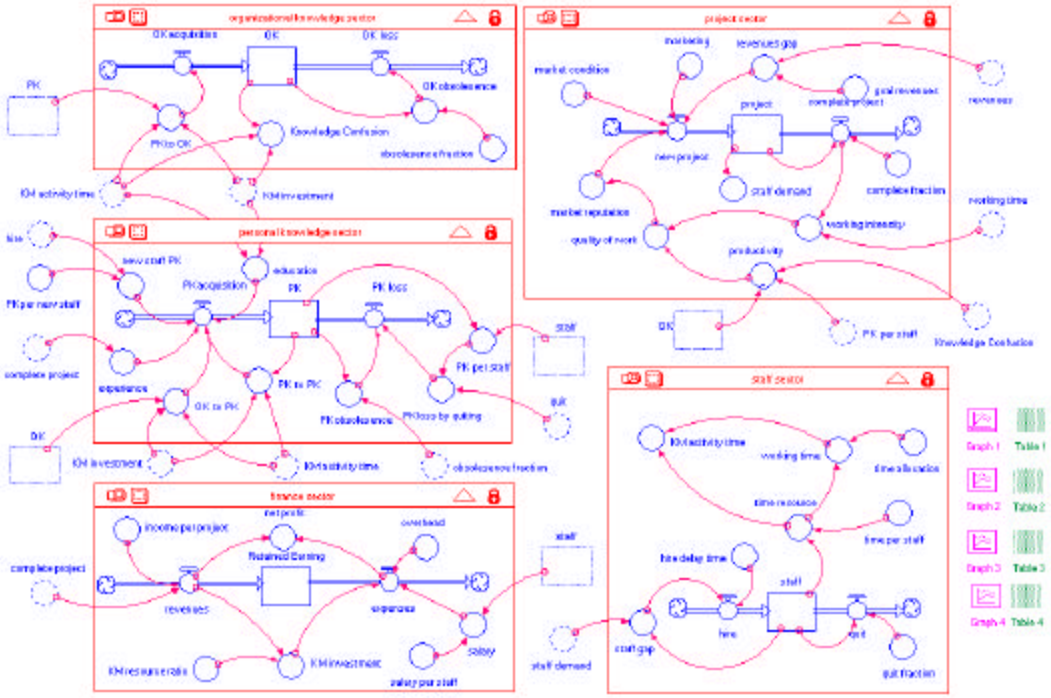

Figure 9 STOCK-FLOW DIAGRAM

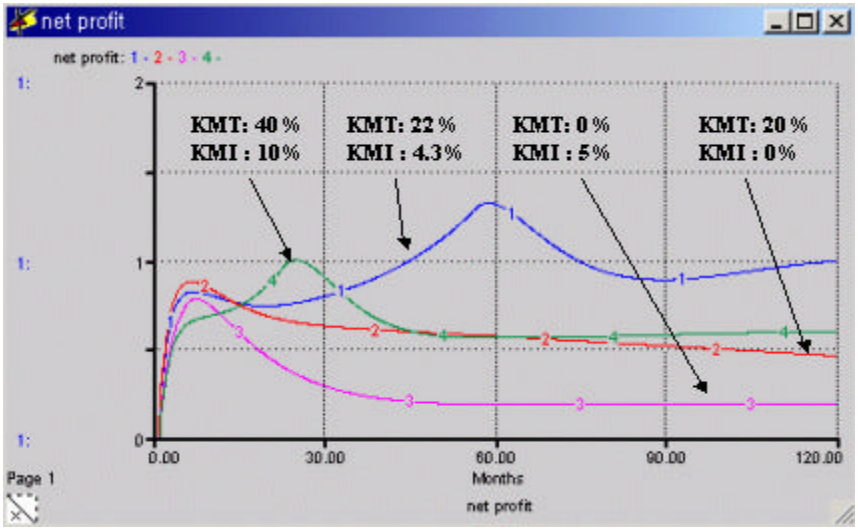

Figure 8 NET PROFIT BEHAVIOR GRAPH

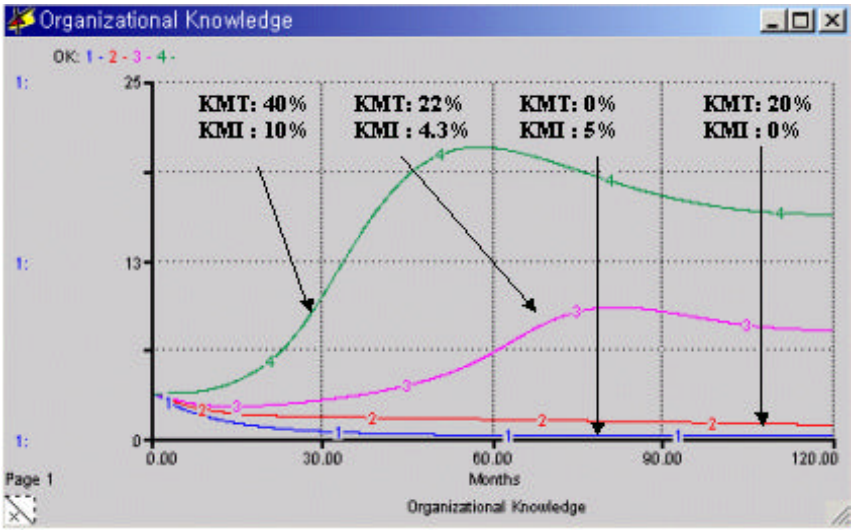

Figure 9 ORGANIZATIONAL KNOWLEDGE BEHAVIOR GRAPH

4. Conclusions and further research

The success of IT firms depends on their ability to manage organizational knowledge. But two critical factors - i.e., the activity and the investment in KM are the origin to make not only revenue in long term but also expenditure in short term. This means it is very important to understanding the dynamics of knowledge management for the best

policy. By introducing the system dynamics approach, this paper tries to explain the dynamics of knowledge management in IT firms. The general scheme for dynamism of KM in firms and the findings presented in the paper would perhaps provide some ideas and directions for further study. However, it has to be admitted that the model is yet to be refined and expanded in greater detail by identifying more variables and factors and analyzing their related data in more rational manner.

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