Proceedings of 2013 International Conference on
Technology Innovation and Industrial Management
29-31 May 2013, Phuket, Thailand

A SYSTEM DYNAMICS MODEL OF TRUST, KNOWLEDGE SHARING AND STABILITY OF STRATEGIC ALLIANCE

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ABSTRACT

Purpose: *We present a comprehensive framework of the key determinants of the stability in strategic alliances (SAS). Herein the relationship of triad: trust, knowledge sharing and stability is digged dramatically.*
Design/ methodology/approach: *We propose a dynamics framework of stability in SAS based on a review of the literature. The game theory concept is adopted in the conceptual framework. The simulation is based on the system dynamics and characterizes how the constituent elements of the strategic alliance behave.*
Findings: *The major finding of this paper is that result from the literary verbal analysis can be transferred into a dynamics model which can be used to fulfill determinants of the stability of strategic alliance.*
Practical implications: *Based on the framework, a number of propositions are developed to facilitate empirical research on trust, knowledge sharing and stability in SAS. Managerial implications from the framework are also discussed.*
Originality/ value: *The value of this paper is literary verbal analysis can be transferred into a dynamics model which can be used to fulfill determinants of the stability of the strategic alliance. We find out that in case of low trust and high level of the un-balance knowledge sharing the strategic alliance became extremely unstable and vise versa.*

INTRODUCTION

Among the various factors impinging upon making a decision in an uncertain environment, fear and trust are surely crucial ones. Several models for trust have been proposed in the literature preview. Trust, defined as one party is confident that the other party in the exchange relationship will not exploit its vulnerabilities, become a potential variable in research on inter-organizational relationships. Scholars draw on theoretical concepts such as transaction costs, relational governance, and transaction value (McEvily and Zaheer, 2006) just only to explain the positive effects of trust on the success of strategic alliances.

Knowledge, unlike to traditional production-related factors such as labor, capital, and land, has become the key element in the development of enterprises (Gravier et al., 2008) . At the same time, technology innovation is often implemented on a large scale, and involves large systems and socialized cooperation, which means companies will have to stand high costs; the limited

resources of a single enterprise prevent it from satisfying the demands of technological innovation (Ruckman, 2009). The technology innovation alliance (Jiang et al., 2008b) is considered as the main driver of enterprise cooperation in the knowledge economy era. Because of it not only enables access to capital, technology, talent, and information on technology innovation, but also enables new knowledge transfer and the acquisition of complementary resources by effectively using and reintegrating the superior resources of member firms (Butler, 2008, Dussauge et al., 2004) state that given the strategic alliance's inherent properties. Alliance instability is caused by the unplanned alteration of goals, contracts, and control modes in the allied process, as well as by disintegration and mergers (Inkpen and Beamish, 1997). It may also pertain to significant conducts, such as alterations in strategic direction, agreement renegotiation, ownership or governance construction, and changes in cooperative relationship, that influence alliance performance (Yan and Zeng, 1999). The contradictory evolutions of cooperation and competition, structural rigidity and strategic flexibility, as well as short-and long-term goals lead to instability in alliance operations and management(Das and Teng, 2000a, Ernst and Bamford, 2005). Contractual relationships, mutual trust, organizational learning, benefit distribution, and cultural differences also significantly affect alliance stability (Gil and Passino, 2006, Jiang et al., 2008a). To maintain competitive advantage sustainably, firms must embrace knowledge sharing and learning, for which the Strategic Alliance has provided a good opportunity.

We suggest that the possibility of an influence of trust needs to be investigated to clarify our understanding of the role of trust in stability of strategic alliances (SAS) and the associated recommendations with regard to the development of knowledge sharing in SAS under system dynamic perspective. This research is based on a game theory principle (Das and Kumar, 2009) and characterizes the maintenance of strategic alliance

Therefore, this paper may contribute significantly to the field as it develops a dynamic game theoretic model to analyze the interaction of knowledge sharing and trust has on the stability of strategic alliance and characterizes how the constituent elements of the strategic alliance behave. The value of this paper lies in the transformation of verbal model into a quantified simulation model and we learn result from the simulation.

LITERATURE REVIEW

1. Knowledge sharing and trust

Based on the resource-based view (RBV), knowledge sharing and competitive advantage are the competence of a strategic alliance. Heterogeneity and immobility are at the heart of the RBV. For example, the RBV suggests that an industry may be heterogeneous in terms of the resources they control and these resources are imperfectly mobile across firms (Barney, 2001). This essentially suggests that resources are valuable in and of themselves, driving the choice of strategy and that competitive advantage is derived through a combination of unique organizational resources in obtaining virtual monopoly positions in their respective markets (Prahalad and Hamel, 1994). (Das and Teng, 2000b) suggest that the RBV has rarely been applied in examining strategic alliances. They argue that the RBV provides an appropriate

framework for examining alliances as essentially they are formed to gain access to other fir m's valuable resources.

According to (McGee, 2012), alliances enable partners to gain access to each other's resources temporarily and with more flexibility than mergers and acquisitions. The two related but distinct motives for a firm to consider forming a strategic alliance are to obtain resources of others and to retain and develop its own resources by combining them with others' resources. Resources are sometimes classified as property-based resources, which have clear property rights and in which a firm's ownership is absolute and protected by law, and knowledge-based resources, which cover tacit skills and knowledge involved in technological, managerial, and organizational resources. In this paper, we mention to the knowledge-based resources – knowledge sharing effected by the trust in SAS.

The intensification of resource sharing and inter-partner learning within strategic alliances makes trust between alliance partners even more crucial which is why inter-party trust plays an important role within successful strategic alliances (Luo, 2002). The rationale is that when alliance partners have high levels of trust in each other, they will be more likely to be committed to, and persist with, knowledge sharing.

2. Structural Cooperation and Motivational Cooperation

One source of instability in a strategic alliance arises because a partner relationship necessarily involves a situation analogous to the "prisoner's dilemma". In the "prisoner's dilemma" involving a cooperative relationship, betrayal or deviation yields a greater payoff than does cooperation for each firm; therefore, both firms choose betrayal and, as a result, the payoff for each is low. Two conceivable ways of maintaining a strategic alliance exist, namely, the "structural cooperation approach" and the "motivational cooperation approach" (Zeng and Chen, 2003).

The "structural cooperation approach" attempts to resolve the dilemma by changing the payoff structure of the game. Put simply, "changing the payoff structure" means applying some penalty to a player who chooses to deviate. Adding a penalty provides an incentive to choose cooperation. In this sense, such methods attempt to maintain a cooperative relationship through the adoption of a penalty system. For this reason, we call methods that change the payoff structure "structural cooperation." Thus, structural cooperation becomes effective when partners behave opportunistically.

The "motivational cooperation approach" attempts to resolve the dilemma intrinsically, or voluntarily, without using any structural means. Motivational cooperation becomes effective when the game is repeated infinitely, as well as when the expected payoff is sufficiently high. First, in a finitely repeated game, betrayal is optimal for each player, even if the game is played a thousand times. Even if a cooperative relationship continues until the 999-th trial, betrayal is preferred by each player in the final trial, because there is no need to consider the future. Since it is known that deviation will occur in the final trial, the best strategy is deviation from the beginning to the end, whenever the number

of trials is finite. Therefore, in the finitely repeated case, both players choose to deviate, and no cooperative relationship arises. However, in the infinitely repeated case, it is beneficial for both sides to select a cooperative strategy if certain conditions are fulfilled. This fact is generally known as the "Folk Theorem"(Arend and Seale, 2005). The Folk Theorem also makes clear that, if the expected future payoff is sufficiently high, it is more advantageous to select a cooperative strategy than to deviate via betrayal.

That is, even if penalties for betrayal are adopted as an institution, there is no guarantee that all parties to the alliance will comply with it. Rather, it becomes necessary to monitor compliance and to put the penalty system into effect in the case of noncompliance. These activities naturally require some expense. Moreover, if the expense resulting from the implementation of the penalty system exceeds the amount of the additional gain generated by cooperation, it becomes meaningless to create such a system and impose regulations such as monitoring and penalty enforcement. In practice, it is not possible to monitor a business partner accurately. Therefore, it is difficult to maintain a cooperative relationship through structural cooperation.

3. Trust and stability of Alliance

Numerous studies have acknowledged that trust formation is crucial for maintaining strategic alliances. For example, Child and Faulkner (1998) have pointed out that trust is crucial for the success of alliances (joint ventures). The others has clarified empirically that trust between joint-venture partners is crucial for the maintenance of long-term relationships.

"Trust" is defined as "the expectation that the other party will behave cooperatively towards one's self in a situation where there is potential for one's self to suffer losses if the other party behaves selfishly (Das and Teng, 2001b). Deterrence-based trust occurs when a partner is trusted because he will incur a large loss in the case of betrayal. Calculus-based trust occurs when a partner is trusted because he expects to receive a large benefit in the future as a result of his cooperation. In the contexts of these two types of trust, it is difficult to calculate the changes in the gains or losses that occur as uncertainty increases; thus, these concepts differ from a concept of "trust" whereby the partners cooperate, even if they find themselves in an uncertain situation.

4. System Dynamics

System dynamics is a technique for simulating the behavior of complex social systems and was originally an application of automatic control theory (adopted from engineering fields) to issues in the social sciences. Under system dynamics, the simulation of system behavior is carried out in order to elucidate a certain phenomenon in a complex social system; this task is accomplished by using a simplified system created by selecting the things thought to be key factors driving the phenomenon, and by clarifying the causal relationship of these factors. We develop the SD model of an arbitrary job-shop consisting of eight workstations (m = 8) of products. In SD discipline, the model is usually presented as a

stock-flow diagram that captures the model structure and the interrelationships among the variables (Sterman, 2000). The stock-flow diagram is translated into a system of differential equations, which is then solved via numerical simulation. The embedded mathematical equations are divided into stock equations (state equations), which integrate the net flow into a stock, and flow equations (rate equations), defining the inflows and outflows among the stocks as functions of time. Fig. 1 illustrates the generic stock-flow diagram. The SD model is developed using the Vensim software package.

One distinguishing feature of system dynamics is that it facilitates learning about dynamic systems that vary over time. Note that time discrepancies exist in the relationships among factors in real-world systems, as well as differences in the speed of effects. Another distinguishing feature is that system dynamics facilitates learning about complex systems that incorporate feedback. This feature is useful because the relationships among factors in real-world systems are typically not one way.

More technically, complex time-series systems are modeled using simultaneous difference equations or simultaneous ordinary differential equations, and problems are solved by supplying initial values for those equations.

CONCEPTUAL MODEL

The figure illustrates the causal relationship model of the triad: Unbalance in knowledge sharing; Stability in Strategic Alliance and Trust:

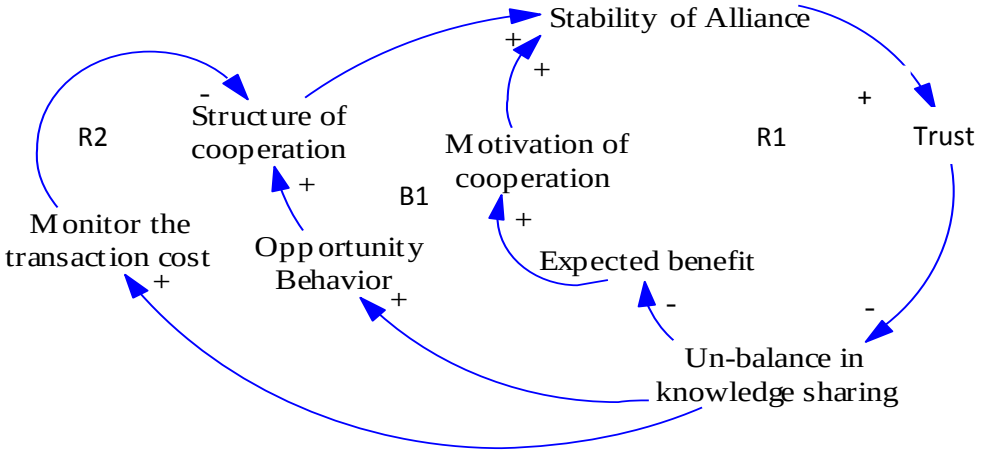

Fig. 1 Causal Relationship Model Concerning the Stability of Strategic Alliance

Figure 1 illustrates a causal relationship model of the factors that affect the stability of a strategic alliance. The model comprises three reinforcement loops (Rl, R2, B1).

Loop Rl

This reinforcement loop comprises un-balance in sharing knowledge, expected payoffs, motivation of cooperation, the stability of the strategic alliance and trust.

Trust in the workplace has been shown to have a strong and robust influence on a variety of organiza-tional phenomena, including job satisfaction, stress,organizational commitment, productivity, and, most relevant to the current research, knowledge sharing(Kramer, 1999, Levin and Cross, 2004). Therefore, if trust is high, then un-balance in sharing knowledge decreases. Outcome expectations that are related to reward systems (Bartol and Srivastava, 2002) are also important factors influencing the decision to share knowledge. According to the economic exchange theory, individuals will behave by rational self-interest, thus, knowledge sharing will occur when its outcomes exceed its costs or are as expected (Constant et al., 1994). This is why practitioners emphasize incentive systems for successful knowledge management., outcome expectations imply that, members of SAS believe that they would receive extrinsic benefits such as monetary rewards, promotion, or educa-tional opportunity from their knowledge sharing, then they would develop a more positive attitude toward knowledge sharing (Bock and Kim, 2002, Kankanhalli et al., 2005). On the other hand, un-balance in sharing knowledge decreases, the expected payoffs increase.

According to the equity theory of motivation, those who perceive themselves as being treated unfairly will be motivated to restore a sense of equity. Similarly, a partner firm, which foresees an inequitable pattern of payoffs, may expect itself or its partners to behave discordantly in the future(Das and Teng, 2001a). If one partner feels that the other partner gains too much from the alliance as compared to its own gain, it may begin to commit itself less, notwithstanding its own stake. As the expected payoffs increase, motivational cooperation increases. It leads to motivational cooperation increases, the stability of the strategic alliance increases. Therefore, the stability of the strategic alliance increases, trust will increases. As trust increases, un-balance in sharing knowledge decreases. Moreover, the stability of the strategic alliance is reinforced through the repetition of this cycle.

In contrast, as the previous research mentioned above we can propose the assumption as following: if trust is low, then un-balance in sharing knowledge increases. As un-balance in sharing knowledge rises, the expected payoffs decrease. As the expected payoffs decrease, motivational cooperation decreases. As motivational cooperation decreases, the stability of the strategic alliance increases. As the stability of the strategic alliance increases, trust decreases. As trust decreases, un-balance in knowledge sharing increases. In addition, the instability of the strategic alliance is reinforced through the repetition of this cycle.

Loop R2

This reinforcement loop comprises un-balance in sharing knowledge, the cost of transaction monitoring, structural cooperation, the stability of the strategic alliance, and trust.

Trust in the workplace has been shown to have a strong and robust influence on a variety of organiza-tional phenomena, including job satisfaction, stress,organizational commitment, productivity, and, most rel-evant to the current research, knowledge sharing(Kramer, 1999, Levin and Cross, 2004). Therefore, if trust is high, then un-balance in sharing knowledge decreases. Outcome expectations that are related to reward systems (Bartol and Srivastava, 2002) are also important factors influencing the decision to share knowledge. According to the economic exchange theory, individuals will behave by rational self-interest, thus, knowledge sharing will occur when its outcomes exceed its costs or are as expected (Constant et al., 1994, Jiang and Hao, 2011). As the monitoring transaction cost decreases, structural cooperation increases. As structural cooperation increases, the stability of the strategic alliance increases. As the stability of the strategic alliance increases, trust increases. As trust increases, un-balance in knowledge sharing decreases. The stability of the strategic alliance is reinforced through the repetition of this cycle.

Based on the above literature review, we describe the causaul loop as followed, if the trust is low, the un-balance in sharing knowledge increases. As un-balance in sharing knowledge increases, the monitoring cost increases. As the monitoring transaction cost increases, structural cooperation decreases. As structural cooperation decreases, the stability of the strategic alliance decreases. As the stability of the strategic alliance decreases, trust decreases. As trust decreases, unbalance in knowledge sharing increases. The instability of the strategic alliance is reinforced through the repetition of this cycle.

Loop B1

This balance loop comprises un-balance in sharing knowledge, opportunistic behavior, structural cooperation, the stability of the strategic alliance, and trust.

As suppoting by previous research, if trust is high, the un-balance in sharing knowledge decreases. As un-balance in sharing knowledge decreases, opportunistic behavior decreases. As opportunistic behavior decreases, structural cooperation decreases. As structural cooperation decreases, the stability of the strategic alliance decreases.

On the other hand, as the stability of the strategic alliance decreases, trust decreases. As trust decreases, the un-balance in sharing knowledge increases. As the un-balance in sharing knowledge increases, opportunistic behavior increases. As opportunistic behavior increases, structural cooperation increases. As structural cooperation increases, the stability of the strategic alliance increases. As the stability of the strategic alliance increases, trust increases. As trust increases, un-balance in sharing knowledge decreases. In this case, therefore, the stability status of the strategic alliance becomes unstable, sometimes increasing and sometimes decreasing, through the repetition of this cycle.

SIMULATION MODEL AND OPERATION

Figure 2 illustrates the simulation model using Vensim (software for simulating system dynamics). The adopted simulation model is qualitative, not quantitative. The numerical values

chosen are all fictitious. Building a more complex model incorporating delay effects or complementary variables lowers the explanatory power of the model. Therefore, the model used for this analysis is simple. The model comprises three features: stocks, flows, and connectors. A stock is a variable that accumulates value as time passes. A flow is a variable that causes a stock to increase or decrease as time passes. A connector indicates the causal direction between variables. There are eight stock variables in the model: the stability of the strategic alliance, motivational cooperation, structural cooperation, the expected payoffs, trust, un-balance in knowledge sharing, opportunistic behavior, and the monitoring cost. There are also eight flow variables in the model, which include the changes in motivational cooperation, structural cooperation, the expected payoffs, trust, environmental uncertainty, opportunistic behavior, and the monitoring cost.

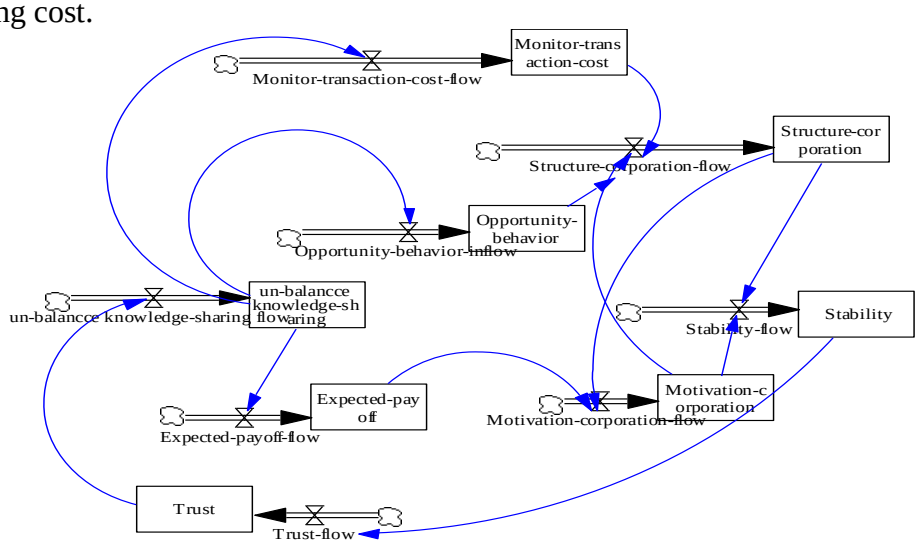

Fig. 2 Stock and flow structure of exploratory system dynamics model

Aas formulated, is that all the numerical values used are fictitious; this fact makes it more likely that the measured results will be large. To resolve this potential problem, it is necessary to prevent the numerical stock values from inflating by restricting all of the numerical flow values to fall within a certain constant range. Therefore, the original data are first transformed using a probit. Then, 0.5 is subtracted from them; this value ensures that all of the original data remain within the range from - 0.5 to 0.5. Thus, if an original datum is equal to zero, the transformed datum is still equal to zero. However, the greater the original datum is relative to zero, the closer the transformed datum comes to 0.5. Similarly, the smaller the original datum is relative to zero, the closer the transformed datum comes to - 0.5.

RESULT

The aim of the study was, primarily, to examine the relationship of triad: trust, knowledge sharing and stability of a strategic alliance. Besides, the motivation cooperation and on structure cooperation are observed how these impact changes over time. However, all of the data and coefficients are fictional; therefore, we established the following two patterns: (1) a high degree

of trust and low un-balance know sharing and (2) a low degree of trust and high un-balance knowledge sharing.

The initial values of the variables other than un-balance in knowledge sharing and trust are set to zero, which represent the state in which the respective variables are neither high nor low.

Scene 1: High trust, low level of the un-balance in knowledge sharing

We conduct this simulation by setting the initial value for trust at 10 and the initial value for un-balance in knowledge sharing at - 10. That the initial value for trust is 10.

Subsequent variations in the trust value indicate variation in trust. In addition, that the initial value for unbalance in knowledge sharing is - 10 indicates, that it is, in fact, close to 0.5; thus, unbalance in knowledge sharing is extremely low in this case.

Figure 3 illustrates the simulation results. First, only motivational cooperation (line 3) increases, while structural cooperation (line 2) decreases. This motion reflects the fact that a trade-off exists between motivational cooperation and structural cooperation. The stability of the alliance increases because the increase in motivational cooperation is greater than the decrease in structural cooperation. This result is in accord with the general prediction that cooperation tends to arise more easily in situations where trust between partners is high and the knowledge sharing is stable.

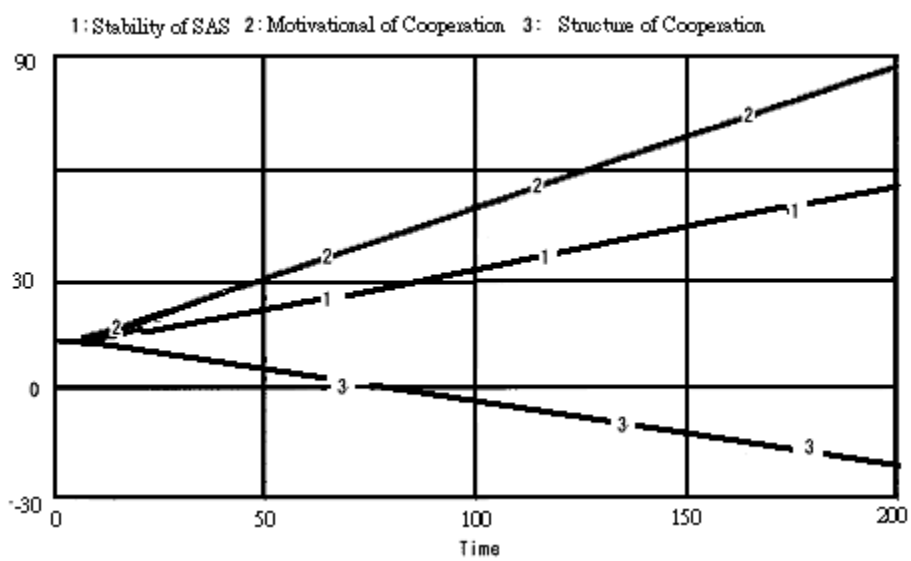

Fig. 3 Simulation result for stability of SAS with high trust, low level knowledge sharing

Scene 2: Low trust, high level of un-balance in knowledge sharing

We stimulate this simulation by setting the initial value for trust at - 10 and the initial value for level of un-balance of knowledge sharing at 10. That the initial value for trust is - 10 means, based on Formula 1, that it is, in fact, close to - 0.5; thus, trust is almost non-existent in this case.

In addition, that the initial value for un-balance of knowledge sharing is 10 indicates, that un-balance of knowledge sharing is extremely high. Figure 4 illustrates the simulation results. First, structural cooperation (line 2) increases about time 40, at which point it decreases. Then, after a time of about 170 has elapsed, it becomes negative. That is, after time 170, structural cooperation causes instability of the strategic alliance, rather than stability. On the other hand, motivational cooperation (line 3) decreases until about time 40, at which point it increases. After time 170, it becomes positive. That is, after time 170, the stabilization of the strategic alliance is promoted. However, the stability of the alliance always takes a negative value between time zero and time 210, and is itself extremely unstable. After time 210, it tends to increase with increases in motivational cooperation. In other words, if cooperation has not resolved by time 210, then the cooperative relationship thereafter becomes stable. This variation may occur in part because the maintenance of a long-term relationship leads to the formation of relational trust, a reduction in un-balance in knowledge sharing, and an increase in motivational cooperation.

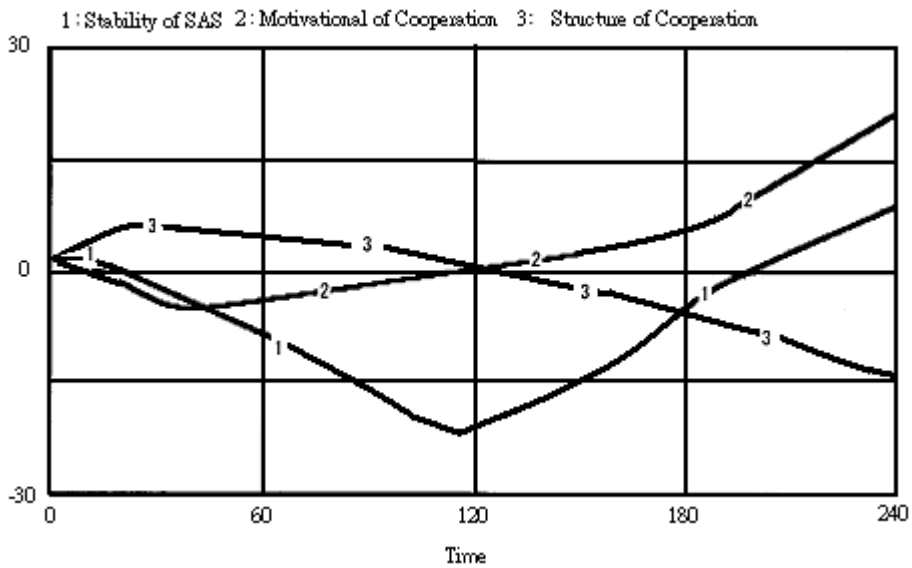

Fig. 4 Simulation result for stability of SAS with high trust, low level knowledge sharing

However, the stability of the alliance always takes a negative value between time zero and time 210, and is itself extremely unstable. After time 210, it tends to increase with increases in motivational cooperation. In other words, if cooperation has not resolved by time 210, then the cooperative relationship thereafter becomes stable. This variation may occur in part because the maintenance of a long-term relationship leads to the formation of relational trust, a reduction in un-balance knowledge sharing, and an increase in motivational cooperation.

CONCLUSION

In this paper, we have considered an analytic framework for the management of strategic alliances over the long term, and have conducted simulations using system dynamics. First, in this regard, we considered the implications of game theory, which provides a theoretical framework by which to examine the stability of the strategic alliance. Then, based on this

theoretical framework, we constructed an analytic model characterizing the stability of the strategic alliance. The key components of this model include motivational cooperation, structural cooperation, opportunistic behavior, a monitoring cost, expected payoffs, unbalance in knowledge sharing, and trust. We pointed out that these form a dynamic system involving feedback.

The major finding of this paper is that result from the literary verbal analysis can be transferred into a dynamics model which can used to fulfill determinants of the stability. We find out that in case of low trust and high level of the un-balance in knowledge sharing the strategic alliance became extremely unstable and vise versa. Based on this analytic model, we designed a simulation model using system dynamics. Assuming two scenes, namely high trust with low unbalance in knowledge sharing and low trust with high unbalance in knowledge sharing, we investigated how the stability of the strategic alliance, structural cooperation, and motivational cooperation behave over time. We found that stability with respect to a strategic alliance can be achieved through motivational cooperation in the case of high trust and low un-balance knowledge sharing. In the case of low trust and high un-balance knowledge sharing, we found that the strategic alliance became extremely unstable. Moreover, when a cooperative relationship is continued in this situation, despite the instability, the possibility exists that it will become stable due to the presence of motivational cooperation.

The contributions of this paper are presented as an analytic framework relating to the maintenance of a strategic alliance, a topic that has previously not attracted much attention. We have also demonstrated, based on the results of our simulations using system dynamics, that motivational cooperation is an effective means of maintaining the stability of the strategic alliance. The research also extend to some future works as following.

Firstable, the presented analytic model is not only a basic model, and more detailed variables should have been incorporated. For example, as trust formation factors, it would be useful in future research to consider partner reputation and the existence of past cooperative relationships.

Secondable, our simulations using system dynamics have been based only on fictitious numerical values. A highly practical simulation model could, in the future, be designed after the relationships between variables had been determined, based on a survey and a multivariate analysis of its results. Thirdly, we have not considered the issue of environment recognition. This paper has not incorporated the recognition patterns of companies themselves, which discriminate between environments, or the environmental uncertainty that exists within companies. With regard to the uncertainty of the external environment, it is conceivable that recognition scence differ across companies. In the future, these points too will need to be considered.

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