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가상실행공동체에서의 지식공유촉진에 대한 협력 형태와 사회적 관계 크기의 효과*

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Promoting Knowledge Sharing in Virtual Communities of Practice : Effects of the Cooperative Type and Tie Strength*

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■ Abstract ■

The degree to which people share knowledge has major impacts on the effectiveness of virtual community of practice (VCoP). As an extension to the previous study which investigated the effect of individual cooperative types (cooperator, reciprocator, and free rider) on knowledge sharing, it is investigated how much increase in the degree of cooperation will enhance knowledge sharing when there are more knowledge contributors and strong ties exist across the community. Simulation method is adopted to measure the effect of the cooperative type and tie strength on knowledge sharing. The results reveal that the tie strength positively affects knowledge contribution in VCoP and strongly tied VCoP generates equivalent level of knowledge contribution as that of weakly-tied VCoP with 5% more contributors.

Keyword : Knowledge Sharing, Virtual Communities of Practice, Tie Strength, Cooperative Type, Reciprocity

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1. Introduction

Knowledge management involves individuals cooperating to solve organizational problems. In communities of practice (CoP), members share knowledge related to common interests to solve organizational problems and tasks [8, 13, 29]. Rational choice and Nash equilibrium models assume that rational participants can use information from others because generating new knowledge requires time and effort, and rational self-interest choice seeks benefits without incurring costs [21]. However, in real world settings interaction and information exchange take place. Three types of cooperative behaviors toward public goods have been identified : cooperators, reciprocators and free riders [10, 15, 17]. Shared knowledge in online communities has been viewed as a type of public good [6]. The public good dilemma is where free riders will take advantage of publicly provided goods without contributing to the development of these goods, thus resulting in suboptimal outcomes for all [22].

Virtual Community of Practice (VCoP) produces a variety of collective knowledge by allowing members to come together in online environment, helping them exchange ideas and coordinate their activities, and providing the kind of identification and feeling of membership found in face-to-face interaction [5, 28]. In the process, however, there are familiar problems of defection, free riding and other forms of disruptive behavior [24].

This study examines expected knowledge sharing behavior by investigating the effect of knowledge sharing under reasonable assumptions such as weak and strong tie relationships among VCoP members. In the previous study [15], the effects of cooperator fraction; direct and indirect effects (through reciprocators) on knowledge sharing using the reciprocity function were considered .In this study, the first simulation is expanded by considering two different tie strengths of the online community (strong tie and weak tie) and the change of its effect on the behaviors of contributors and reciprocators.

2. Promoting Knowledge Sharing in Vcop

2.1 Three Cooperative Types of VCoP Knowledge Sharing

Knowledge shared in a VCoP can be regarded as a public good. They are non-competitive because multiple people can consume the knowledge at the same time and non-excludable because it is not possible to exclude people who did not pay for the knowledge from consuming them [6]. As long as people maximize their own utility, no public goods can exist. However, some people make contributions to VCoP knowledge bases regardless of the contributions of others. Thus, there are people who do not free-ride and these individuals' behaviors are not explained by utility maximization theory [21] or by theory of impure altruism [1, 2].

Two theories could explain this inconsistency. Margolis' theory of altruism [18] argued that individuals act non-selfishly and are motivated by a concern for group members' welfare. Theory of reciprocity takes the position that individuals choose the level of effort that they most prefer when all other group members are making at least a certain amount of effect in the production of a public good [25, 26]. Theory of altruism and

theory of reciprocity hold that one is never required to contribute more than other people in the group, overcoming the unfairness which arises from free-riding behavior on shared knowledge in VCoP. From these theories on voluntary contribution to public goods, individuals can be categorized as free riders when they always maximize their own utility function by not contributing to other group members, cooperators if they always contribute towards public goods regardless of other's behavior, and reciprocators if they always contribute no more than others contribute.

2.2 Reciprocity and Knowledge Sharing

Kankanhalli et al. [14] found that reciprocity impacts knowledge sharing in electronic knowledge repositories. Cross and Prusak [9] argued that reciprocity can be used as a payment for knowledge sharing, leading to knowledge sharing behavior. Morrison and Rabellotti [20] found that firms exchange knowledge exclusively where ties are strong and reciprocity is high. In result, average reciprocity level in strong tie networks is expected to be higher than in weak tie networks and high levels of reciprocity increase knowledge sharing.

2.3 Strength of Tie and Reciprocity in VCoP

Axelrod [4] identified three conditions that encourage reciprocity; a) if there is a strong chance of meeting the person again-predictability, b) if the person can be identified, and c) if the person's past behavior is known. Strong tie networks provide an environment fulfilling such conditions. Strong tie networks provide an environment fulfilling such conditions. In a strong tie network, people will have more chance of meeting again and they can trace one's knowledge sharing behavior which builds knowledge sharing reputation. Coleman [7] argued that a reputation mechanism requires density of the structure with which Granovetter [12] associated strong ties.

In the VCoP context, individuals may perceive relationships as weak or strong ties. Empirical evidence has shown that in a weak tie relationship (e.g., anonymous situations) people show less reciprocity and cooperation. McGinn et al. [19] found that face-to-face interaction enhances reciprocity and cooperation in text-based communication. As more sparsely connected by weak ties, larger online social networks (e.g., VCoP) would make normative control more difficult and lead to low contribution behavior compared to offline networks [30]. Therefore, the strength of tie in VCoP may be relatively weaker than that in face-to-face CoP and the level of reciprocity of VCoP may also be weaker than that of face-to-face CoP, which may lead to less knowledge sharing in a VCoP than in face-to-face CoP.

2.4 Approaches in Promoting Knowledge Sharing in VCoP

In the previous study [15], reciprocity function which explains reciprocators' knowledge sharing behavior patterns was developed based on their positive interactions with cooperators and negative interactions with free riders. Laboratory experiments and simulations have shown how certain types of individuals behave differently in terms of their voluntary contribution tendency toward public goods when their identities are

anonymous. The simulation parameters for contributions of the group for three types are adopted from these controlled laboratory experiments and simulation [3, 10, 11]. As more positive interactions occur, reciprocators share more knowledge. Since most members of VCoP belong to the reciprocator category [10, 17] and this group of people can alter their knowledge sharing behavior unlike cooperators and free-riders [31], this study limits its focus on possible implications that may affect this particular group of people. Approaches of increasing reciprocators' positive interactions, resulting in the increase of knowledge sharing are two-fold; increasing cooperators or tie strength. More cooperators will increase the chance for reciprocators to experience positive feedback from them. Reciprocators, then, will increase their knowledge sharing pattern. Strengthened tie of VCoP means that reciprocators (who are altering their behavior pattern based on others) are more affected by the social control mechanism such as the reputation system or feedback system.

3. Research Method

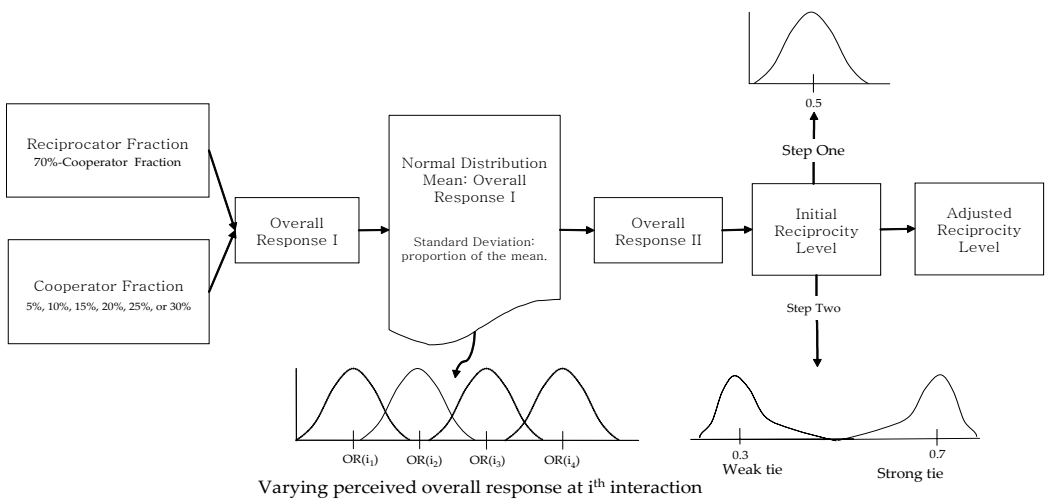
To investigate how the varying cooperator fraction and reciprocity level affect knowledge sharing in the network, the probability modeling method (simulation) is adopted because simulation provides information on how various types of actors in the social network behave under different conditions such as weak ties and strong ties in VCoP through an imitating process.

3.1 Simulation Design

A simulation using system dynamics model was designed and conducted to examine the effect of tie strength on knowledge sharing. <Figure 1> depicts the overall simulation procedure. Following sections discuss the details of simulation design in <Figure 1>.

3.1.1 Perceived Overall Response

In VCoP, people interact with other people by posting questions or looking up some answers



[Figure 1] Simulation Design

they search. For each interaction in VCoP, the overall response people perceive may vary. Reciprocators share knowledge at different rate based upon the perceived overall response, which is represented as reciprocity function. To represent the variation of reciprocators' perceived overall response, probability density function of the normal distribution was used.

3.1.2 Varying Reciprocity Level

It is assumed that reciprocators will perceive varying reciprocity levels for each interaction while the overall reciprocity level (in average) is somewhat similar, and that the overall reciprocity level of weakly-tied community is lower than that from strongly-tied community [23]. To represent the varying reciprocity level in weakly- and strongly-tied VCoP, two Weibull distributions are used (one is positively skewed for weak ties and the other is negatively skewed one for strong ties). Under this distribution function, weaker reciprocators (between 0 to 30% reciprocity level) takes about half of entire population (52.03%) while moderate reciprocators (between 30% to 60% reciprocity level) takes about 42% of the population. There are only few stronger reciprocators (5.15%) whose reciprocity level ranges from 60% to 100%.

3.1.3 Varying Cooperator Fraction

To understand the effect of cooperator fraction in VCoP, varying combinations of cooperative types (shown in <Table 1>) are used. As a control group, a VCoP without any intervention is assumed to have 5% cooperators, 65% reciprocators, and 30% free riders [15]. As experimental groups, five possible cooperator policies with varying target fractions of cooperators and reciprocators are prepared. Then, the amount of shared knowledge between natural setting and other policies is compared with the analysis of variance to check whether the difference of the amount of shared knowledge is statistically significant.

〈Table 1〉 Natural Setting and Cooperator Policies

(%)

Combination	Cooperators	Reciprocator	Free rider
Natural Setting	5	65	30
Policy1	10	60	30
Policy2	15	55	30
Policy3	20	50	30
Policy4	25	45	30
Policy5	30	40	30

3.2 Simulation Result

There are three cooperative types (cooperators, reciprocators, and free-riders) in VCoP. In the simulation of 100 interactions, each cooperative member has a chance to contribute knowledge to VCoP. A cooperator contributes a piece of knowledge to VCoP, while a reciprocator shares partial knowledge based on the perceived reciprocity level.[1] The cooperator fraction and measured the effect of tie strength on knowledge sharing is controlled. As expected, knowledge contribution from cooperators did not change significantly regardless of the tie strength, while reciprocators' knowledge contribution as well as total knowledge contribution is significantly changed between the weak tie setting and the strong tie setting. This result implies that reciprocators make significantly different knowledge

1) Perceived reciprocity level is found through mathematical calculation [15].

contributions when tie strength is changed from weak to strong environment and reciprocators' additional knowledge contribution may increase the total shared knowledge in VCoP. <Table 2> summarizes the analysis of variance (ANOVA) on the amount of shared knowledge from different tie strength.

3.2.1 Interaction Effect of Cooperator Fraction and Reciprocity Level

The two tie strength groups are compared to see how much the cooperator fraction affects the level of knowledge sharing. To achieve the same level of knowledge sharing, strongly-tied VCoP is supposed to require a smaller fraction of cooperators than weakly tied VCoP since reciprocators will reciprocate at a much higher reciprocity level. From the simulation result, it is observed that the same level of knowledge sharing was achieved at different level of tie strength and cooperator fraction, from which the term 'knowledge sharing equivalence' is coined. <Table 3> shows the result of the knowledge sharing equivalence analysis. <Table 3> shows the comparison among the knowledge contribution from cooperators (a), reciprocators (b), and total knowledge contribution (c) between two tie strengths, and between two cooperator fractions.

〈Table 2〉 ANOVA Result of Strongly- and Weakly-tied VCoP

Interaction	Knowledge Contribution (Cooperator)			Knowledge Contribution (Reciprocator)			Knowledge Contribution (Total)		
	F	Sig.	Decision	F	Sig.	Decision	F	Sig.	Decision
10^{th}	.000	.983	No difference	786.531	.000	Significant	36.391	.000	Significant
20^{th}	.002	.961	No difference	822.516	.000	Significant	36.586	.000	Significant
30^{th}	.003	.954	No difference	1089.603	.000	Significant	41.227	.000	Significant
40^{th}	.006	.938	No difference	1209.899	.000	Significant	42.673	.000	Significant
50^{th}	.009	.923	No difference	1194.831	.000	Significant	42.642	.000	Significant
60^{th}	.009	.925	No difference	1168.504	.000	Significant	41.578	.000	Significant
70^{th}	.008	.928	No difference	1163.915	.000	Significant	41.103	.000	Significant
80^{th}	.008	.929	No difference	1108.979	.000	Significant	40.401	.000	Significant
90^{th}	.009	.927	No difference	1148.489	.000	Significant	40.841	.000	Significant
100^{th}	.010	.922	No difference	1086.481	.000	Significant	39.752	.000	Significant

〈Table 3〉 Result of Knowledge Sharing Equivalence

Equivalent Cooperator Fraction	Knowledge Contribution from Cooperator (a)	Knowledge Contribution from Reciprocator (b)	Total Knowledge Contribution (c)
Strong 5% vs. Weak 10%*	0	56	7
Strong 10% vs. Weak 15%*	2	0	39
Strong 15% vs. Weak 20%*	6	0	52
Strong 20% vs. Weak 25%*	6	0	53
Strong 25% vs. Weak 30%*	6	0	66

To accomplished these comparisons, the shared knowledge amount from six different settings (from natural to Policy 5) was sorted in an ascending order and compared the values to find where the equivalent knowledge sharing amount is achieved from the strong tie or weak tie setting at which level of the cooperator fraction. Since 100 simulation was run for each cooperator fraction level, 100 comparisons was made for each setting of 5% vs. 10%, 10% vs. 15%, etc.

In the comparison of 5% cooperator fraction in strong tie (SCF5) vs. 10% cooperator fraction in weak tie (WCF10), strong ties helped achieve equivalent knowledge contribution from reciprocators with 5% less cooperator fraction (this occurs 56 times). This means that the same amount of shared knowledge with a less cooperator fraction was achieved with the increase of the tie strength from weak to strong.

In the total knowledge contribution, seven knowledge sharing equivalences (out of 100 comparisons) are found from the comparison of SCF5 vs. WCF10, 39 Type I equivalences from SCF10 vs. WCF15, 52 from SCF15 vs. WCF20, 53 from SCF20 vs. WCF25, and 66 from SCF25 vs. WCF30. These results clearly show that the increment in tie strength has a similar positive effect on knowledge sharing as 5% cooperator fraction increment does. This implies that after achieving 10% of cooperator fraction, if the tie strength was increased from weak to strong, the total knowledge contribution in VCoP would increase (e.g., 39%, 52%, 53%, and 66%, respectively) and this increased amount of shared knowledge is equivalent to that from 5% cooperator fraction increment, implying that strengthening tie in VCoP has equivalent effect of 5% cooperator fraction.

4. Implications, Limitation, Future Research

As tie strength is changed from weak to strong, reciprocators significantly increase knowledge sharing in online CoP. As Kollock [16] identified such condition for knowledge sharing, on-line CoP may implement social control mechanism for improving persistent identification and defining group boundary. The reputation system, like a feedback system, is such mechanism. Such system may require each online CoP member a name for identification, tracking their sharing behaviors (e.g., past questions and answers) for reputation building, and scoring them based on recommendations from other members for feedback. Responding to such social control mechanism, reciprocators are not only encouraged by positive interactions from cooperators, but also encouraged by positive interactions from other reciprocators with fewer cooperators in online CoP. Such system may also reduce the free rider fraction since the shared knowledge in CoP is somewhat traceable with such mechanism and free riders can benefit not only from shared knowledge itself, but also the reputation built from sharing behavior. This additional benefit may encourage free riders alter their behaviors toward knowledge sharing in online CoP.

Although the research model is designed carefully based on theoretical background from existing literature, the results of this study must be interpreted in the context of its limitations. First, free riders are assumed not to be affected by any condition. However, this may not be true. For the simulation settings, the free rider fraction is set at 30%. The average fraction of contribution type may not be constant. The tie

strength can also affect the fraction of free riders in on-line CoP. Social control mechanisms such as a reputation system reveal the identity and existence of free riders as well as cooperators. Therefore, the free rider fraction will be reduced in strong tie online CoP. Second, the unit of shared knowledge is arbitrarily selected and applied to cooperators and reciprocators. However, some cooperators may contribute more knowledge both in terms of quality and quantity than other cooperators and this also might be the case for reciprocators. Lastly, the Weibull distribution is an arbitrary choice for the weakly-tied and strongly-tied VCoP setting. Varying share and scale parameters of the Weibull distribution may result in varying conclusions. This bisection of the tie strength is somewhat arbitrary and a narrower division of the tie strength and comparisons of them will provide more detailed information in depth about the effect of the tie strength.

5. Conclusion

Improving knowledge contribution is one of the most fruitful outcomes from VCoP since the members share interest in relevant tasks and most organizational knowledge resides inside its members. This paper investigates knowledge sharing behavior in VCoP through cooperative type and tie strength. The reciprocity function explains reciprocators' knowledge sharing behavior patterns based on their positive interactions with cooperators and negative interactions with free riders. To promote knowledge sharing in VCoP, two approaches of increasing reciprocator's positive interactions was tested; (1) increasing cooperator fraction, and (2) increasing tie strength. Analysis of variance shows that raising the cooperator fraction by 5% will significantly increase total shared knowledge in CoP, not only due to more cooperators, but also due to the higher reciprocity level of reciprocators. Therefore, CoP can benefit by attracting more cooperators into the system where they share more knowledge as well as positively influence reciprocators. Tie strengths also found to have positive effect on reciprocators' knowledge contribution, which lead to the increase in the total knowledge contribution. One interesting finding is the replacement effect of the tie strength to the cooperator fraction. The increment of tie strength generates an equivalent amount of shared knowledge, and this replacement effect occurs quite often, roughly 50 percent of the time. Therefore, increasing the tie strength would be a viable alternative to increasing cooperator in VCoP for the purpose of knowledge sharing promotion.

References

[1] Andreoni, J., "Giving with Impure Altruism : Applications to Charity and Ricardian Equivalence", *Journal of Political Economy*, Vol.97, No.6(1989), pp.1447-1458.

[2] Andreoni, J., "Impure Altruism and Donations to Public Goods : a Theory of Warm-glow Giving", *Economic Journal*, Vol.100, (1990), pp.464-477.

[3] Aviv, R., Z. Erlich, G. Ravid, "Reciprocity Analysis of Online Learning Networks", *Journal of Asynchronous Learning Network*, Vol.9, No.4(2005), pp.1-10.

[4] Axelrod, R., *The Evolution of Cooperation*, Basic Books, New York, 1990.

[5] Brown, J. S. and P. Duguid, "Knowledge and Organization : a Social-practice Perspective", *Organization Science*, Vol.12, No.2 (2001), pp.198-213.

[6] Cabrera, A. and E. F. Cabrera, "Knowledge-sharing Dilemmas", *Organization Studies*, Vol.23, No.5(2002), pp.687-710.

[7] Coleman, J. S., "Social Capital in the Creation of Human Capital", *American Journal of Sociology*, Vol.94(1988), pp.95-120.

[8] Constant, D., L. Sproull, and S. Kiesler, "The Kindness of Strangers : the Usefulness of Electronic Weak Ties for Technical Advice", *Organization Science*, Vol.7, No.2(1996), pp. 119-135.

[9] Cross, R. and L. Prusak, "The Political Economy of Knowledge Markets in Organizations", in Mark Easterby-Smith and Marjorie A. Lyles (Eds.), *Handbook of Organizational Learning and Knowledge Management*, Blackwell, Oxford, (2003), pp.454-472.

[10] Engle-Warnick, J. and R. L. Slonim, "Learning to Trust in Indefinitely Repeated Games", *Journal of Economic Perspectives*, Vol.14 (2006), pp.159-181.

[11] Fehr, E. and S. Gächter, "Fairness and Retaliation : The Economics of Reciprocity", *Journal of Economic Perspectives*, Vol.14 (2000), pp.159-181.

[12] Granovetter, M., "The Strength of Weak Ties", *American Journal of Sociology*, Vol.78, No.6 (1973), pp.1360-1380.

[13] Hiltz, S. R., K. Johnson, and M. Turoff, "Experiments in Group Decision Making : Communication Process and Outcome in Face-to-face versus Computerized Conferences", *Human Communication Research*, Vol.13, No.2(1986), pp.225-252.

[14] Kankanhalli, A., B. C. Y. Tan, and K. K. Wei, "Contributing Knowledge to Electronic Knowledge Repositories : an Empirical Investigation", *MIS Quarterly*, Vol.29, No.1 (2005), pp.113-43.

[15] Kim, J., S. M. Lee, and D. L. Olson, "Knowledge Sharing : Effects of Cooperative Type and Reciprocity Level", *International Journal of Knowledge Management*, Vol.2, No.4 (2006), pp.1-16.

[16] Kollock, P. The Economics of Online Cooperation : Gifts and Public Goods in Cyberspace in Marc A. Smith and Peter Kollock (Eds.), *Communities in Cyberspace*, Routledge, London, 1999.

[17] Kurzban, R. and D. Houser, "Experiments Investigating Cooperative Types in Humans : A Complement to Evolutionary Theory and Simulations", *Proceedings of the National Academy of Sciences of the United States of America*, Vol.102(2005), pp.1803-1807.

[18] Margolis, H. Selfishness, Altruism and Rationality : a Theory of Social Choice, Cambridge University Press, Cambridge, UK, 1982.

[19] McGinn, K., L. Thompson, and M. Bazerman, "Dyadic Processes of Disclosure and Reciprocity in Bargaining with Communication", *Journal of Behavioral Decision Making*, Vol.16(2003), pp.17-34.

[20] Morrison, A. and R. Rabellotti, "Knowledge Dissemination and Informal Contacts in an Italian Wine Local System", Working paper. Retrieved Oct 1, 2010 from http://www.eco.unipmn.it/biblioteca/pdf/semeq/semeq97.pdf.

[21] Nash, J. F., "Equilibrium Points in N-person Games", *Proceedings of the National*

Academy of Sciences, Vol.36(1950), pp.48-49.

[22] Ostrom, E., "A Behavioral Approach to the Rational-choice Theory of Collective Action", *American Political Science Review*, Vol.92, No.1(1998), pp.1-22.

[23] Petroczi, A., T. Nepusz, and F. Bazso, "Measuring Tie-strength in Virtual Social Networks", *Connections*, Vol.27, No.2(2007), pp. 39-52.

[24] Sharp, J., "Communities of Practice : a Review of the Literature", Retrieved Oct 20, 2005 from http://www.tfriend.com/cop.htm 1997.

[25] Sugden, R., "Reciprocity : the Supply of Public Goods through Voluntary Contributions", *Economic Journal*, Vol.94(1984), pp.772-787.

[26] Sugden, R., *Altruistically inclined? The Behavioral Sciences*, Evolutionary Theory, and the Origins of Reciprocity, University of Michigan Press : Ann Arbor, MI, 2002.

[27] Walther, J. B., "Anticipated Ongoing Interaction versus Channel Effects on Relational Communication in Computer-mediated Interaction", *Human Communication Research*, Vol.20(1994), pp.473-501.

[28] Wasko, M. M. and S. Faraj, "Why should I share? Examining Social Capital and Knowledge Contribution in Electronic Networks of Practice", *MIS Quarterly*, Vol.29, No.1 (2005), pp.35-57.

[29] Wellman, B. and M. Gulia, "Virtual Communities as Communities : Net Surfers Don't Ride Alone", in Peter Kollock and Marc Smith (Eds.) *Communities in Cyberspace*, Routledge, New York, 1999.

[30] Wellman, B., A. Quan, J. Witte, and K. Hampton, "Does the Internet Increase, Decrease or Supplement Social Capital?", *American Behavioral Scientist*, Vol.45, No.3(2001), pp.436-455.

[31] Zeggelink, E. P. H., Strangers into Friends : the Evolution of Friendship Networks Using an Individual Oriented Modeling Approach, Amsterdam : Thesis Publishers, 1993.

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