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The Application of Structural Holes Theory to Supply Chain Network Information Flow Analysis

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Abstract: This study used Honda supply chain as an illustrative case based on the social network perspective. We firstly examined the extent of structural holes of the chain members and then applied a heuristic approach to alleviate structural holes effects. Two important results were obtained as follows: (1) Many structural holes during the network structure for Honda supply chain because those members do not have many connections with each other. (2) A heuristic based on bridge-building concept was proposed to effectively resolve the structural holes problem of Honda supply chain.

Key words: Supply chain management, information sharing, social network analysis, structural holes theory, bullwhip effect

INTRODUCTION

Recently, the study of social networks has developed rapidly and the important issues addressing structural holes and small-world network theory are also widely applied into other fields (Kim *et al*., 2006; Kiet and Kim, 2008; Cornwell, 2009). In this study, we tended to examine the information asymmetry in Honda supply chain through structural holes and further used the concept of bridge to solve the problem of structural holes. Information asymmetry is one of major causes of inefficiency in a supply chain. Besides, a node (i.e., the structural hole) in supply chain which has important information without sharing to its upstream and downstream counterparts will cause the bullwhip effect problem (Muketha *et al*., 2010). If there are many structure holes in a supply chain, the overall performance of chain will be significantly affected by them (Burt, 1992). In order to analyze the real effect of structure hole on a supply chain, we initially examined the extent of structural holes of the chain members and then apply the concept of bridge to alleviate structural holes effects. Several different perspectives were applied into analyze the information sharing problem in the supply chain. In this study, the useful management recommendations can be obtained after analyzing the structure hole in a supply chain.

INSTRUMENTS

In this study, all data were collected from Choi and Hong (2002). In their study, those data are gathered in visits to companies from 1997 to 2000 and they came primarily from three sources: semi-structured interviews, documents and observations. Honda of America and Daimler-Chrysler, known for their supplier management, were selected to maximize usefulness of the final results. Three different product lines were chosen: family car (Honda Accord), luxury car (Acura CL/TL) and jeep/truck (DaimlerChrysler Grand Cherokee). Two assemblies of center console for the supply chain network of Honda was the primary focus in this study. Because these two networks have some similar suppliers, we combine them into one large supply chain network. As shown in Fig. 1, this network has two hub network structures. The detailed information can be referred to Choi and Hong (2002).

EXAMINATION OF STRUCTURAL HOLES

After reviewing relating literatures, two indexes- network constraint index and effective size can be recognized as whether a network has the phenomenon of structural holes and the degree of structural holes (Burt, 1992).

Network constraint index which can be viewed as an estimation index for social capital was provided by Burt (1992). To put it briefly, the index value ranges from zero to one. If the value is one, the ego node connects only one contact, so the degree of structural holes is low. In other words, the network almost does not have structural holes. On the contrary, if the value is very low, such as zero, then the ego node connects many other nodes in this network and has many structural holes because those nodes it connects do not connect each other.

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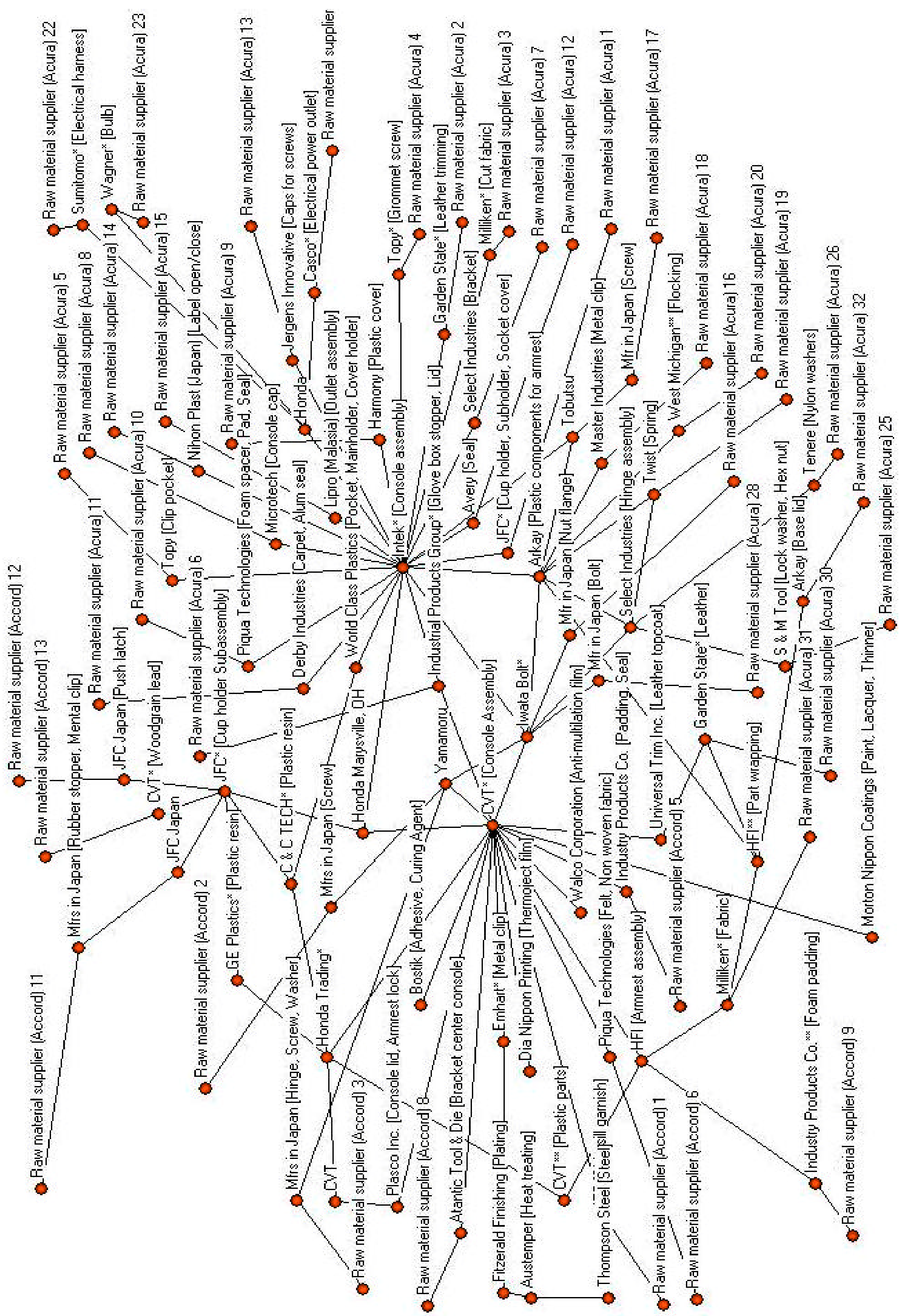

Fig. 1: The structure of the supply chain network in center console of Honda

Table 1: The measure of structural holes in Honda supply chain

	Structural holes measures	
Supplier name	Effective size	Constraint
Intek* [Console Assembly]	20.81	0.051
CVT* [Console Assembly]	16.882	0.062
JFC* [Cup holder Subassembly]	6	0.167
Arkay [Plastic components for armrest]	7	0.178943
Iwata Bolt*	6.143	0.179008
Honda Trading*	5	0.2
Honda	4	0.25
HFI** [Part wrapping]	4	0.25
HFI [Armrest assembly]	4	0.25
Select Industries [Hinge assembly]	4.2	0.268
Yamamoru	3.5	0.277
Honda Marysville, OH	3	0.333
Industrial Products Group* [Glove box stopper, Lid]	3	0.333
C & C TECH* [Plastic resin]	3	0.333
Garden State* [Leather]	3	0.333
Milliken* [Fabric]	3	0.333
Tobutsu	2.333	0.374
Twist [Spring]	2.333	0.412
JFC* [Cup holder, Subholder, Socket cover]	2	0.5
Garden State* [Leather trimming]	2	0.5
...	...	...
Thompson Steel [Steel]	1	1
Raw material supplier (Accord) 2	1	1

*Sourced directly by Honda, **Sourced directly by Intek

Another index, i.e., (Burt, 1992), is designed to denote the effective size which represents from subtracting the total repetition degree from the total connections. The more Effective size increases, the lower the repetition degree becomes. Namely, the degree of structural holes becomes higher in this network.

Table 1 provides the results of two indexes that are computed by UCINET 6.0 software. In network constraint index, the maximum value is 1 and the minimum value is 0.051. There are eighteen suppliers' values less than 0.5. That is to say, those suppliers have more structural holes in this network. Among the eighteen suppliers, the two that have the most structural holes are Intek* and CVT* (Fig. 2, 3). Their values are respectively 0.051 and 0.062. By the same token, the highest value are also Intek* (20.81) and CVT* (16.882) in effective size. To put it another way, they have more heterogeneous resources. This result shows if the two suppliers controlling most information flows do not want to share important information with other nodes, the information sharing problem will happen.

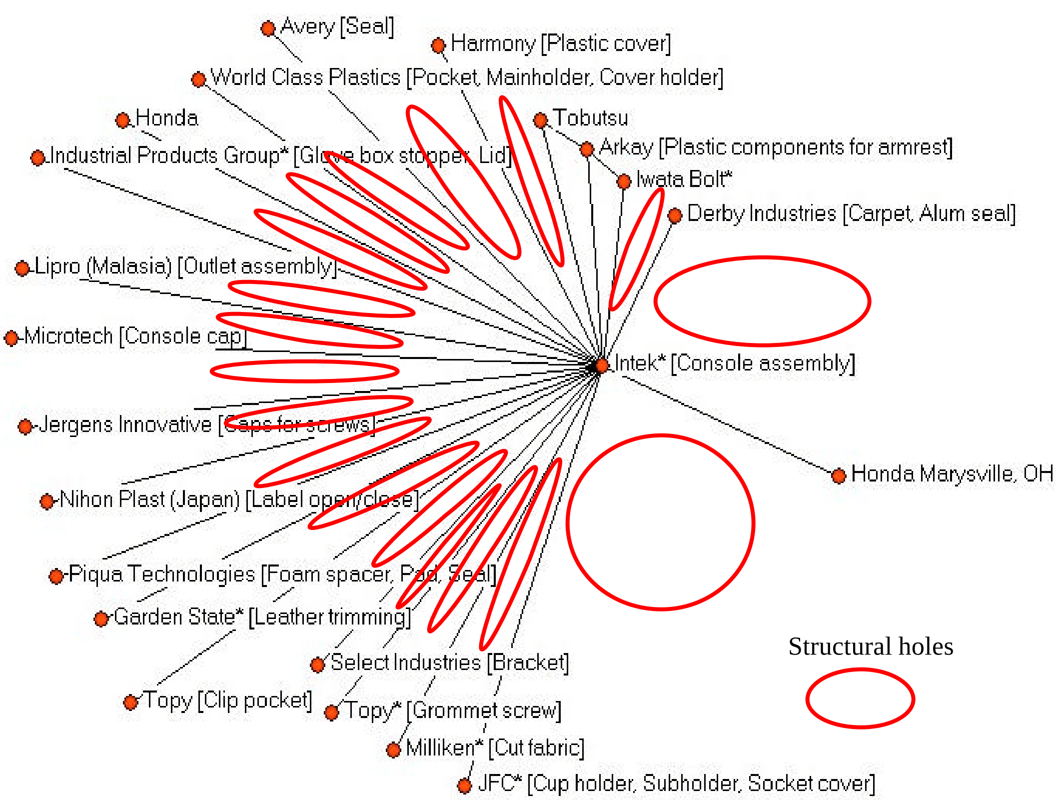

Fig. 2: The structural holes of Intek* in the supply chain of Honda

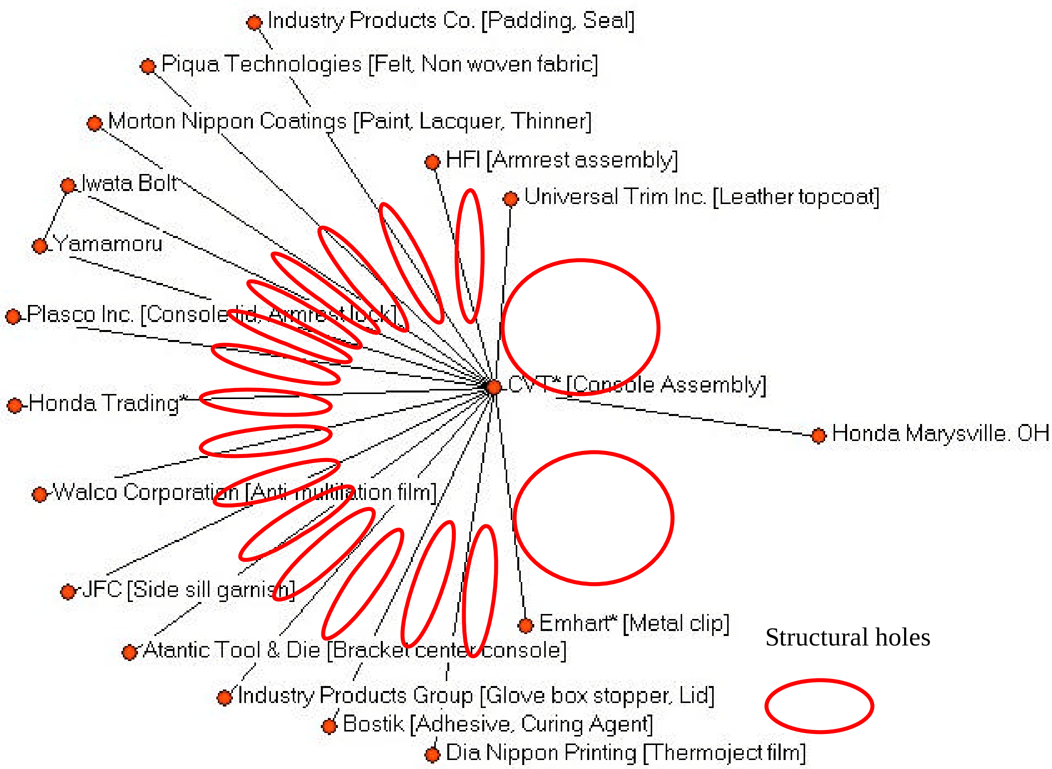

Fig. 3: The structural holes of CVT* in the supply chain of Honda

SOLVING THE STRUCTURAL HOLES PROBLEM

As mentioned above, we use two indexes provided by Burt (1992) to observe the phenomenon of structural holes in Honda supply chain network. As this review has shown, the phenomenon of structural holes will cause ripple effect, bullwhip effect, halo effect in the supply chain network (Sterman, 1989; Lin and Shaw, 1998; Dalton, 1999). Although, substantial studies have been focused on the concept of bridge that solves the structural holes problem, up to this point, there are few empirical studies or approaches of resolving the structural holes problem. In this study, we want to provide an approach to solve the structural holes problem. The steps of our approach are as follows:

- **Step 1: Find out the nodes with relatively higher degree of structural holes in the supply chain network:** When we neglect the cost of bridge, it is easy to bridge all nodes in the network. However, the cost is always an issue in practice, so we must choose only a few nodes to bridge after examination. First, we compute all Network Constraint Index and Effective Size of nodes in the supply chain network. Second, we sort the indexes from small to large. Based on the sorting result, we can know which the highest structural hole is. In this case, we use the social network analysis software --- UCINET to compute all indexes
- **Step 2: Apply bridge to cross these structural holes:** Which nodes should we choose to bridge? Should we choose the node with higher value of the Network Constraint Index or the one with lower value? We explain this question with a simplified supply chain shown in Fig. 4. The circles represent nodes and the lines represent information flows. This supply chain has 12 nodes (from A to L). We compute these node indexes and Table 2 shows the network constraint index values in this supply chain

Based on Table 2, we know that node G has the lowest value of Network Constraint Index. It also represents node G has the highest degree of structural holes. Node G is a structural hole in the middle of node C, D, K and L. First circumstance, we choose the node that has higher value of Network Constraint Index. The values of node K and L are the same, so we random choose them and the result will still be the same. In this case, we

Table 2: The sorting results of network constraint index

Node	G	C	E	B	D	F	A	H	I	J	K	L
Network constraint index	0.25	0.333	0.333	0.5	0.5	0.5	1	1	1	1	1	1

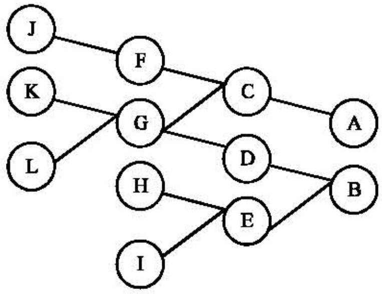

Fig. 4: The simplified supply chain example

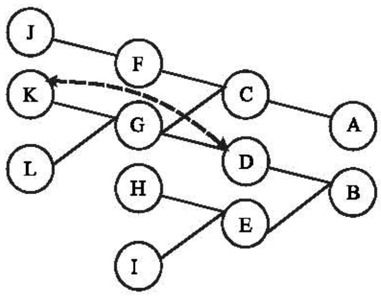

Fig. 5: Bridging between node D and node K

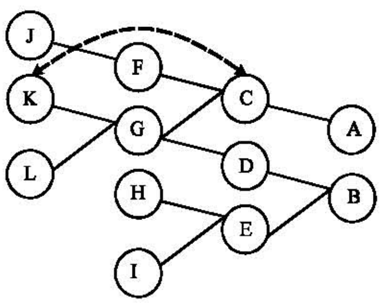

Fig. 6: Bridging between node C and node K

choose to bridge node K and node D (Fig. 5). After bridging, we recomputed the Network Constraint Indexes. The final value of node G is 0.377. Second circumstance, we choose the node that has lower value of Network Constraint Index-- node C and node K (Fig. 6). After bridging, we recomputed the network constraint indexes and the final value of node G is 0.363. As we have seen, when we choose the node that has higher value of network constraint index, the final result becomes more effective with the degree of structural holes reduced.

As shown in Table 1, we know the lowest value of network constraint index is intek* and its values of network constraint index which connect other nodes in the same network are shown in Table 3. In this study, we choose the six suppliers with highest values to bridge and they are Lipro, Nihon, Jergens, Avery, Derby and Piqua, having the same value (0.5) in this network. As shown in Table 4, we clearly know the approach which we provide has been effectively reducing the values of network constraint index.

Table 3: Sorting network constraint index of upstream suppliers of Intek*

Supplier name	Network constraint index
Arkay [Plastic components for armrest]	0.178943
Iwata Bolt*	0.179008
Honda	0.25
Industrial Products Group* [Glove box stopper, Lid]	0.333
Tobutsu	0.374
JFC* [Cup holder, Subholder, Socket cover]	0.5
Garden State* [Leather trimming]	0.5
Milloken*[Cut fabric]	0.5
Topy*[Grommet screw]	0.5
Topy[Clip pocket]	0.5
World Class Plastics [Pocket, Mainholder, Cover holder]	0.5
Select Industries[Bracket]	0.5
Microtech[Console cap]	0.5
Harmony[Plastic cover]	0.5
Piqua Technologies[Foam spacer, Pad, Seal]	0.5
Derby Industries[Carpet, Alum seal]	0.5
Avery[Seal]	0.5
Jergens Innovative[Caps for screws]	0.5
Nihon Plast (Japan)[Label open/close]	0.5
Lipro (Malasia)[Outlet assembly]	0.5

*Sourced directly by Honda. **Sourced directly by Intek

Table 4: The changing of network constraint index after bridge from Intek*

Changing	Network constraint index
Before bridge	0.051
After bridge (order)	
Lipro	0.055
Nihon	0.558
Jergens	0.061
Avery	0.065
Derby	0.070
Piqua	0.075

DISCUSSION

In recent years, most studies explored and discussed the issues about supply chain management (Yang *et al*., 2007; Kazemi and Zarandi, 2008), the empirical studies or approaches to the structural holes problem were seldom mentioned. In this study, we applied two indexes to measure the degree of structural holes in the supply chain network and a recommended solution to the structural holes problem with the cost consideration is proposed.

Aside from valuable insights into the structural holes problem, our research still has some limitations. The first limitation is the variety of the data set. The data set in our study is Honda supply chain, but different industries may have different degrees of structural holes, requirements and motivations of information sharing. That is, our approach may not be suitable for all the industries. The second limitation is the frequency of measure. We measure only once, so the result may not be reliable. In following parts of the research, we can observe the relationship between the supply chain network and structural holes based on multiple times. Lastly, we also can use other indexes of social networks to measure the supply chain network in the next study, such as subgroups, roles and positions and centrality.

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REFERENCES

Burt, R.S., 1992. Structural Holes: The Social Structure of Competition. 1st Edn., Harvard University Press, Cambridge, MA., pp: 323.

Choi, T.Y. and Y. Hong, 2002. Unveiling the structure of supply networks: Case studies in honda, acura and daimlerchrysler J. Operat. Manage., 20: 469-493.

Cornwell, B., 2009. Good health and the bridging of structural holes. Soc. Network, 31: 92-103.

Dalton, G., 1999. Globalization- global gravity. Inform. Week, 18: 38-48.

Kazemi, A. and M.H. Zarandi, 2008. An agent-based framework for building decision support system in supply chain management. J. Applied Sci., 8: 1125-1137.

Kiet, H.A.T. and B.J. Kim, 2008. Network marketing with bounded rationality and partial information. Phys. A: Stat. Mech. Appl., 387: 4896-4902.

Kim, B.J., T. Jun, J.Y. Kim and M.Y. Choi, 2006. Network marketing on a small-world network. Phys. A: Stat. Mech. Appl., 360: 493-504.

Lin, F.R. and M.J. Shaw, 1998. Reengineering the order fulfillment process in supply chain networks. Int. J. Flexible Manuf. Syst., 10: 197-229.

Muketha, G.M., A.A.A. Ghani, M.H. Selamat and R. Atan, 2010. Complexity metrics for executable business processes. Inform. Technol. J., 9: 1317-1326.

Sterman, J.D., 1989. Modeling managerial behavior: Misperceptions of feedback in a dynamic decision making experiment. Manage. Sci., 35: 321-339.

Yang, W.K., H. -Fu Huang, Y.C. Tu and Y.F. Huang, 2007. Powerful retailer`s ordering policy under two-level delay permitted in supply chain derived without derivatives. J. Applied Sci., 7: 4018-4022.