Prediction of Virtual Enterprise and Supply Chain Agility Relation and Their Effect on Business Performance

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Abstract: Academic and corporate interest in the affiliation of VE to achieve agility has increased considerably in recent years. This paper aims to investigate the relationship between virtual enterprises (VEs) and agility in supply chains (SCs), to provide further insights into the enhancement of business performance and into factors that have impact on the relation. A conceptual hypothetical model is proposed to demonstrate the impacts of three factors on agility in SCs. To clarify the relationships among factors, a structural equation model (SEM) is developed to examine the hypotheses based on observed data. The results provide empirical evidence of the beneficial impacts of VE on the agility in SC.

Keywords: Virtual Enterprise, Agility in Supply Chain, ICT, Structural Equation Modeling

1. INTRODUCTION

Nowadays business environment, organizations face accelerating change, resulting in increasing levels of uncertainty, instability, turbulence and insecurity. As a result of technological developments, changing customer demands and global competition, product life cycles are decreasing, product lines are proliferating and profit margins are shrinking. It is becoming difficult and expensive for one company handling all market issues to adapt in the competitive context. Therefore, many companies are paying more attention to the area of inter-organizational co-operation, and investing in more flexible logistics processes and supply chain (SC) networks, supported by ICT technologies. The emerging new collaborative and integrated business strategy is geared towards maximizing the benefits of the relatively narrow windows of opportunity yielded by increasingly volatile global markets, and optimally sharing the risks and resources through collaborations. Many existing collaborative networks including SCs, dynamic alliances, e-businesses, extended enterprises, and virtual enterprises. But ICT developments push enterprises to collaborate and integrate temporarily to achieve momentary goals, based on core competencies and despite geographic locations. Actually, virtual enterprises (VE) respond to this target. VEs integration and organization in SCs is one of the main issues in competitive SCs. By adopting the idea of highly flexible organizations and by reconfiguring themselves to cope with the needs and opportunities of the business environment, enterprises have been able to obtain a number of benefits such as agility, complementary roles, operational dimensions, competitiveness, resource optimization, and innovation (Camarinha-Matos and Afsarmanesh, 2003). Even so, many studies envisage that there is some kind of association between VE and agility exists.

This study argues that while some studies investigate only the relationship between VE and ICT and the effects on business performance (Cao and Dowlatshahi, 2005) while others explore only the empirical evidence of the drivers, providers and capabilities of agility e.g.

Ngai et al. (2011) and Liu et al. (2013). There is a consequent lack of evidence empirically proving how a strategy of joining in VE affiliation influences agility in SC and business performance.

Therefore, this paper aims to investigate the factors that cause the implementation of VE strategies to provide agility in SC, and the relation between VE affiliation and agility in SCs, and their impact on business performance in developing countries, especially in the Mongolian case.

The rest of paper is organized as follows. Section 2 provides the overview of VE and agility in SC. Based on literature, theoretical hypotheses are developed. The research methodology and design are illustrated in Section 3. Data analysis and discussion are then conducted in Section 4. The assessment of measurement quality and evaluation of research hypotheses are considered in same section. Conclusions and suggestions for future researches are finally provided in Section 5.

2. THEORETICAL BASIS AND HYPOTHESES DEVELOPMENT

2.1. VE and Agility in SCM

Since the concept of VE emerged in late 1980s, researchers distinguish VE from a mere collaboration and integration of business entities in outsourcing, and see VE as technology-driven dynamic alliances formed based on the sharing of information systems (ISs) (Esposito and Evangelista 2014). Initially, VE was defined as a virtual corporation (Davidow and Malone, 1993) and a VE model has been indicated as suitable for addressing changing market conditions together with proper partners based on ICT. According to the NIIIP Consortium a VE is a temporary consortium or alliance of companies formed to exploit fast-changing opportunities. Members bring a wealth of experience and technology and also they share costs and skills to create the necessary support infrastructure (Bolton, 1996).

Many researchers from different fields defined VE from different perspectives; but it is still difficult to find a unique definition. In synthesis, definitions show a number of shared viewpoints. Generally, authors agree on that a VE has following essential characteristics that distinguish VE formation from traditional alliance (Samdantsoodol et al., 2017):

- Virtuality. It usually highly relies on ICT. Utilization of ICT enables geographically dispersed enterprises to join in VE to keep their time and cost to achieve business goal. A VE owns no inventoried resources, assets, plants, factories or warehouses itself, ICT support to coordinate members owned assets.
- Dynamics. VE is highly dynamic and may have short life cycles. The temporary structure can be formulated again with same or different partners, multi periodically, to exploit new coming business opportunities in the market.
- Flexibility. VE has a strategic objective to maximise flexibility and adaptability to environmental changes.
- Autonomy. To design an effective enterprise collaboration, workflow and information flows need to be controlled by a well-defined knowledge management system. To respond fast changing environment and enable flexibility, an automatically negotiating and decision making system is mostly adopted for VE. Most researches rely on a multi agent system that interacts to solve problems which are beyond the individual capacities or knowledge and makes decision as quick and correct as possible in VE.

- Heterogeneity and immobility. VE is affiliated based on resource and core competencies of different firms by sharing different information, knowledge, and skills to obtain competitive advantages in a short run. New market opportunities no longer exist profitable, thus forming VE could be defined as a heterogeneity and immobility organizational process.

Modern companies increasingly focus on knowledge development and distribution and using ICT and software to drive an "innovation explosion". Internet and mobile technologies are definitely major ingredients in transforming a set of SMEs into a VE with an inter-organizational network, virtual organization, vertical and horizontal integration, and flexible collaboration (Chituc, Azevedo, & Toscano, 2009; Wang & Chan, 2010). To design an effective enterprise collaboration, workflow and information flows need to be controlled by a well-defined decision-making process and coordination (Meixell & Wu, 2005; Yoon & Nof, 2011). According to Esposito and Evangelista (2014), two structural models for VE including hierarchical and holarchical found in the literatures. However, they assumed a hybrid form that has some characteristics in common with the two models identified and shares the relationships among peers with the holarchical model, and the presence of a coordinating firm with the hierarchical model.

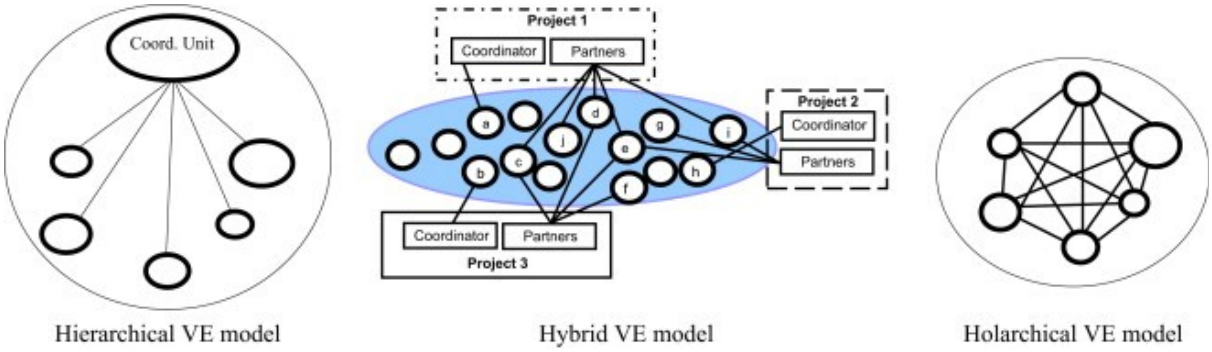

Figure 1. Taxonomy of VE models (Adopted from Esposito and Evangelista (2014))

A large number of research publications focus on the potential success brought in by VE. Successful completion of temporary collaboration brings many benefits (Samdantsoodol, 2017). These shared benefit issues suggest the VE possesses a number of significant advantages over the conventional traditional enterprises. These advantages include:

- Agility. VE is one of key enablers of agility and it is essential to develop VE in a more productive way by reducing the time and cost as well as delivering goods/services in a competitive manner in global markets (Gunasekaran and Yusuf, 2002). This temporary collaboration leverages an ability to recognize unpredictable changes and rapidly react and cope to it exploiting business opportunities in short period with high quality and less investment. To implement agility, some capabilities have received attention from researchers that includes: responsiveness, speed, flexibility and competency (Zhang and Sharifi, 2007).
- Increase efficiency and effectiveness. The VE is formed based on ICT networks that improve the operational effectiveness by speeding up and simplifying the exchange of information across the value chain. With the integrated VE both the information and material flows will be simplified, streamlined and optimised reducing waste and lead times (Naylor et al., 1999). Through more economical connections with partners, enterprises able to obtain greater opportunities to create revenue, more efficient

operations, and growth of market while sharing costs and risks. The combination of specialization and outsourcing not only makes the VE more economically efficient to the enterprises to avoid having additional capital commitments, such as new plants and infrastructure, that are not directly associated with their core business, it allows globally optimized performance.

- Enhance dynamism and adaptability. When market requirements are changed, a new class of products or an improved version of the product should be turned out to meet the new market requirements. In this case, the principal enterprise may seek for a new combination of collaborating enterprises that are more suitable to manufacture the new class of products: thus the main aspect of VE is dynamic logic of organization and reorganization of collaboration (Davidrajuh, 2003). Grefen et al., (2009) envisaged the shortened life cycle of products makes the VEs need to have a dynamic or agile character: they are formed for new products and must be dismantled when products are abandoned again. To stay competitive in modern markets, the creation of dynamic VEs must be performed swiftly. VEs are characterized to maximise adaptability to environmental changes (Gunasekaran et al., 2008). When joining to VE, enterprises able to obtain adaptability ability to change something or oneself to fit to occurring changes and cope with unexpected disturbances in the environment. On the other word, enterprises benefits from the potential to adjust to changes in the selection environment.
- Maintain competitive advantages. From the resource perspective, dynamic and flexible alliance of VE formation is not easy to duplicate, thus it may contribute network resource heterogeneity and sustain the competitive advantage. Besides, VE has innovative potential and create ideas and produce innovative products and services combining communication, electronic commerce and business process automation to provide effective and low cost customer service worldwide. As a temporary alliance VE is perceived as an implementing strategy for enterprises that is not simultaneously being implemented by other potential competitors thus sustains the competitive advantages.

As an one of the main benefit of VE, the agility concept, introduced by the Iacocca Institute (Nagal and Dove, 1991), has received considerable focus from researchers in the last two decades. It has been defined as , “the ability to thrive in an environment of continuous and often unanticipated change” (Sarkis, 2001) by the Advanced Research Programs Agency (ARPA) and the Agility Forum. Agility is accepted as a new way to manage enterprises for quick and effective reaction to changing markets, driven by customer-designed products and services, has become the dominant vehicle for competition (Zhang and Sharifi, 2007).

SC agility is defined as a firm's ability to effectively collaborate with channel partners to respond to market changes in a rapid manner (Braunscheidel and Suresh, 2009). Researchers conceptualize SC agility with two features of (i) the exploration and exploitation of market opportunities; and (ii) the ability to deliver innovative products and services in a timely and cost-effective manner (Ngai et al., 2011). To explore market opportunities, tight collaboration with partners (Agarwal et al., 2007; Braunscheidel and Suresh, 2009) and communication with customers (Christopher, 2000; Braunscheidel and Suresh, 2009) have been perceived basis of agility in SC. To provide ability to be responsive, flexible and quick, the adoption of ICT (Liu et al., 2013; DeGroote and Marx, 2013) and ICT based integrated organization structures (Ngai et al., 2011; Braunscheidel and Suresh, 2009) have received wide attention from academics and practitioner.

2.2. Hypotheses Development

On the basis of the literature, the factors affecting VE and agility in SC are defined as shown in Figure 2. This paper examines the impact of enterprise capability, ICT adoption on VE affiliation and agility in SC, relationship between VE and agility in SC, and their causes on business performances. Binder and Clegg (2007) considered that core competencies/ enterprise capability are main drivers of VE affiliation. Yusuf et al., (2012) envisage agility must be supported by flexible people, processes and technologies to effect changes in firms systems, structure and organization with an objective being competitive. Therefore, enterprise capability has an impact both on VE and agility in SC. Core competencies or internal capabilities are identified the internal skills, knowledge, and attitudes that support enterprises to adopt advanced ICT. On the other hand, vast of literatures suggests that ICT is the essential foundation for the formation and management of VEs (Cao and Dowlatshahi, 2005) and key for agility in SC (DeGroote and Marx, 2013; Liu et al., 2013; Esposito and Evangelista, 2014) by speeding up the information flow, shortening the response time to customer needs, providing enhanced coordination and collaboration and sharing the risks as well as the benefits. Therefore, the adoption of ICT influences on VE and agility in SC. VE is one of the enablers of agility (Cao and Dowlatshahi, 2005). Finally, the performance of businesses has been impacted by VE (Cao and Dowlatshahi, 2005) and agility (Ngai et al., 2011; DeGroote and Marx, 2013; Liu et al., 2013). Based on the literature review, following hypotheses were developed.

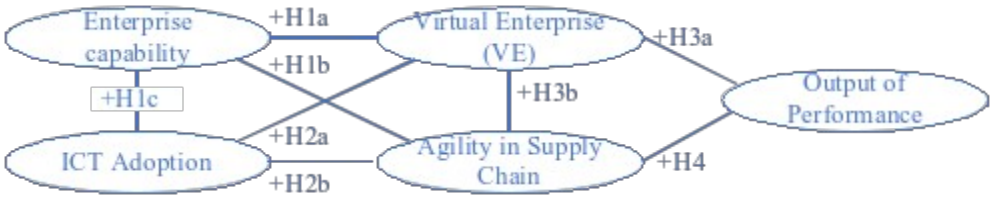

Figure 2. A conceptual model of relation between VE and agility in SC

H1a: Enterprises capability positively influence to VE affiliation.
H1b: Enterprises capability positively influence to agility in SC.
H1c: Enterprises capability positively influences ICT adoption.
H2a: ICT adoption positively influences VE affiliation.
H2b: ICT adoption positively influences SC agility.
H3a: VE positively influences output of performance
H3b: VE positively influences SC agility.
H4: Agile SC positively influences output of performance.

3. RESEARCH METHODOLOGY AND DESIGN

The proposed hypothetical conceptual model in Figure 2 was tested by the empirical study based on the questionnaire. The survey was targeted at logistics companies who are responsible for planning, coordinating, control, realising and monitoring of all internal and network-wide material and product flow, with the necessary information flow, in industrial and trading sectors along the complete value-added chain for the purpose of conforming to customer requirements in Ulaanbaatar (Mongolian city) The hard and soft copies of

questionnaires were conveniently distributed to the companies included in list, which received collected from Mongolian Yellow Page site[1].

5 draft questionnaires were submitted to the focus group in order to check the readability and possible ambiguity of the questionnaire and 4 of them are replied. Minor changes were made based on this pilot survey.

The main study uses a three-part research questionnaire. Part one consists of basic profile information of participators. The second part includes questions related to drivers, enablers of VE and capabilities of agile SC. Part three covers questions related to successes through SC agility. Based on a literature review, questions were ranked with a 5 point Likert scale (very low rate to very high rate) used in order to reduce skewing of the statistical problem in the second and third parts.

In the first round 200 questionnaires were distributed with cover letters in a single mailing and 113 responses were received (a 56.5% response rate). In the second round, another 100 questionnaires with cover letters were distributed and 54 questionnaires returned. Out of 167 responses, 153 were usable, resulting in an actual response rate of 91.6%. The other 14 unusable responses did not contain sufficient data for further analysis. Although this response rate is not unusual, 153 responses cannot cover the total business firms in the whole market. The characteristics of the participants in this study are presented in Table 1.

Table 1. Profile of Respondents

Type of industry/ company profile	Frequency	Percentage
Total	153	100.0
Type of industry[a]		
Manufacturing/ Processing	42	27.5
Transport & Freight Forwarder	26	17
Mining & Quarrying	23	15
Wholesale & Retail trade	15	9.8
Construction & Materials	13	8.5
Hotels & Restaurants	11	7.2
Information & Communication	9	5.9
Other services	7	4.6
Tourism	5	3.3
Oils & Gas	2	1.3
Number of employees[b]		
1-9	36	23.5
10-19	38	24.8
20-49	25	16.3
50-199	21	13.7
over 200	33	21.6
Company annual turnover (tugrug) [b]		
Less than 250 million	52	34
Less than 1 billion	43	28.1
Less than 1.5 billion	15	9.8
More than 1.5 billion	43	28.1
Designation of respondents		
CEO, Director	59	38.6
Manager	88	57.5
Others (Master, Planner, Leader)	6	3.9

[a] Type of industry was defined based on Mongolian Statistical Yearbook 2010

[b] Classification of SMEs regarding to the Mongolian Law on Small and Medium Enterprises

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4. DATA ANALYSIS AND DISCUSSION

A structural equation model (SEM) has been increasingly seen as a useful quantitative technique for specifying, estimating, and testing hypothesized models describing relationships among a set of meaningful variables (Sohn, Kim, & Moon, 2007). Therefore, the SEM has been chosen to analyze the relationship between enterprise capability, ICT adoption, VE affiliation, agility in SC and success on performance in this work. The SEM was introduced with two parts, 1) the measurement model and 2) the structural model proposed in the early 1970s by Joreskig (Su and Yang, 2010). The measurement model specifies how latent variables or hypothetical constructs depend upon or are indicated by the observed variables. The Exploratory and Confirmatory factor analysis models are included in the measurement model which describes the measurement properties (reliabilities and validities) of the observed variables. On the other hand, the structural model specifies the causal relationships among the latent variables, describes the casual effects, and assigns the explained and unexplained variance using path diagrams.

4.1. Assessment of Measurement Quality

An exploratory factor analysis (EFA) was performed using SPSS 20.0 (for Windows) to determine the relationships among measurement variables and the latent variables shown in Table 2. Principle component analysis (PCA) was used for factor extraction. The factors were rotated using varimax rotation to maximize the variance of the squared loadings of a factor on all the variables in a factor matrix, which has the effect of differentiating the original variables by an extracted factor. Some variables without strong correlations are eliminated from the data set. Then the rest of the variables are distributed into 5 factors. In the same table, the internal consistency reliability for all constructs was tested via Cronbach's alpha. The Cronbach's alpha ranges from .778 to .886 for factors, all in accepted scale indicating acceptable range given by(Kline 2011).

Table 2. Result of exploratory study

Latent variables	Measurement variables	Factor loadings	Cronbach's α
Enterprise capability	EC1: Human related competency	.824	.778
	EC2: Information capability	.660	
	EC3: Technology competency	.540	
ICT adoption	ICT1: Usage of information technology	.818	.824
	ICT2: Smart technology	.732	
	ICT3: Communication network	.723	
	ICT4: Information system	.533	
VE	VE1: Ability to share a business opportunity	.751	.879
	VE2: Ability to share information and knowledge	.726	
	VE3: Ability to affiliate or organize the VE	.710	
	VE4: Strategy	.624	
	VE5: System integration competency	.607	
Agility in SC	ASC1: Quality	.762	.841
	ASC2: Quickness/ speed	.682	
	ASC3: Cost reduction	.640	
Output of performance	OP1: Customer satisfaction	.890	.886
	OP2: New product introduction	.759	
	OP3: Responsibility	.703	
	OP4: Flexibility and adaptability	.684	
	OP5: Competency	.670	

4.2. Evaluation and Discussion of Research Hypothesis

In this section the structural model was established and confirmatory factor analysis (CFA) has been executed. Based on the covariance matrices between two variables, the maximum likelihood method (MLM) (Hair, 2010) was used for calculating the covariance in a structural model. The AMOS 20.0 software was used to calculate the formation of the causal relationship among the concepts that comprise the hypothetical model, and to analyze the level of influence among the causal relationships. This study confirmed the SEM by verifying its appropriateness from the results of the covariance structural analysis. Several goodness of fit (GOF) indices of the measurement model are presented in Table 3. Generally, the ratio for χ^2/df (degree of freedom), the goodness-of-fit index (GFI), the normed fit index (NFI), the Tucker-Lewis index, also known as the non-normed fit index (NNFI), the comparative index (CFI), and the root mean square error of approximation (RMSEA) have been used to verify the appropriateness of SEM.

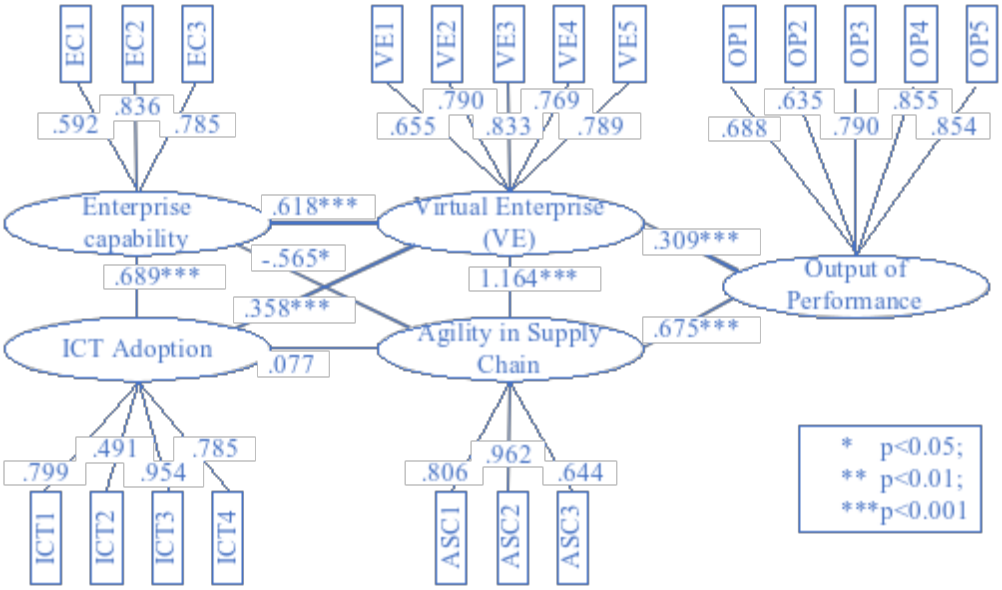
Table 3.Fit Indices of Structural Models

GOF measure	Threshold	Hypothetical SEM	Moderated SEM
χ^2/df	<3 (Hair, 2010)	430.1/160=2.688	326.7/150=2.178
GFI	>.90 (Byrne, 1994)	.786	.833
Normed fit index (NFI)	>.90 (Byrne, 1994)	.814	.859
Tucker–Lewis index (TLI)	>.80 (Hooper et al., 2008)	.849	.895
Comparative fit index (CFI)	>.85 (Bollen and Long, 1993)	.873	.917
RMR	<.08 (Bollen and Long, 1993)	.064	.058
RMSEA	<.08 (Hair, 2010)	.105	.088
Lower bound		.093	.075
Upper bound		.117	.101

As shown in Table 3 the hypothetical model was revised to come up with a model that has better level of appropriateness of the GOF. In order to moderate the model, two methods were considered. The first method involved deleting the path that showed a low causal relationship, and the second method involved an additional causal relationship (Cho et al., 2009). The second method has been chosen by establishing an additional causal relationship to the hypothetical model. The GOF of the improved model has compared to the hypothetical model. The GPI and NFI are still tolerable. However both of those indices are sensitive to sample size, underestimating fit for samples of less than 200 (Hooper et al., 2008). Also small sampling size and degree of freedom gives higher values of the RMSEA. Other GOF measures are within in the recommended ranges.

The final structural model is shown in Figure 3 with path coefficients and statistical significance. The structural model yields a chi-square value of 348.599 with 155 degrees-of-freedom ($p < 0.001$). The ratio of chi-square to degrees of-freedom is 2.249, which is below the suggested value of 3.0 (Hair, 2010). The squared multiple correlation (R^2) values for dependent variables are calculated to test hypotheses. The results indicated that the enterprise capability influences positively and significantly on VE and ICT adoption but negatively and significantly on agility in SC. Enterprise capability contributes 47.5% (R^2=0.475) of total variance of ICT adoption. The result supports the H1c hypothesis. Although ICT adoption has positive and significant influence on VE but does not have significant influence on agility in SC. Predictors of enterprise capability and ICT adoption have 81.4% (R^2=0.814) of variance of the VE. These results support the H1a and H2a hypotheses. VE has a strong, positive and

significant influence on agility in SC. These three predictors contribute 46.3% (R^2=0.463) of variance of the agility in SC. The results support the H1b and H3b hypotheses but not H2b. Finally, VE and agility in SC have a positive and significant influence on business performance and explain 80.7% (R^2=0.807) of total variance of output of performance. Thus the results support both H3a and H4 hypotheses.



Notes: The meanings of the abbreviation are demonstrated in Table 2.

Figure 3. Result of Structural Equation Model

On the other hand, Figure 2 illustrate that the enterprise capability positively influences three variables: (i) Technology competency (standard coefficient=0.785); (ii) Information capability (standard coefficient=0.836, p<0.001); and (iii) Human related competency (standard coefficient=0.592, p<0.001).

In the measurement component, the ICT adoption positively influences (i) The communication network (standard coefficient=0.954); (ii) The smart technology (standard coefficient=0.491, p<0.001); and (iii) The usage of information technology (standard coefficient=0.799, p<0.001); and (iv) The information system (standard coefficient=0.785, p<0.001).

VE positively influences five measurement components: (i) The ability to share a business opportunity (standard coefficient=0.655); (ii) The ability to share information and knowledge (standard coefficient=0.790, p<0.001); (iii) The ability to affiliate or organize the VE (standard coefficient=0.833, p<0.001); (iv) The strategy (standard coefficient=0.769, p<0.006); and (v) The system integration competency (standard coefficient=0.789, p<0.006).

SC agility has a positive influence on three measuring variables: (i) The quality (standard coefficient=0.806, p<0.001); (ii) The quickness/ speed (standard coefficient=0.962, p<0.001); and (iii) The cost reduction (standard coefficient=0.644).

Finally, the result indicates that the output of performance positively influences its five measurement variables: (i) Customer satisfaction (standard coefficient=0.688); (ii) New product introduction (standard coefficient=0.635, p<0.001); (iii) Responsibility (standard coefficient=0.854, p<0.001); (iv) Flexibility and adaptability (standard coefficient=0.855, p<0.001); and (v) Competency (standard coefficient=0.854, p<0.001).

The standardized effects of latent variables on performance have been calculated and

demonstrated in Table 4. Total effect is represented by the sum of direct and indirect effects (Sohn, Kim, & Moon, 2007). While VE has most strong direct effect on agility in SC, the enterprise capability and ICT adoption has a negative effect on the agility in SC. Indirect effects involve one or more intervening variables, or mediator variables (Kline 2011). The enterprise capability has the highest indirect effect on agility in SC. In a short time period, controlling VE operation is efficient for the improvement of agility in SC index. For a long time, the improvement of enterprise capability provides good achievement of a high agility in SC index (Sohn, Kim, & Moon, 2007). On the other hand, while the agility in SC has strongest direct effect on performance, the VE has highest indirect effect on business performance. It means when the value of agility in SC goes up by 1, the performance goes up by 0.675 (Kline 2011). As previously discussed, for a short period paying attention to agility in SC gives a good performance, then for a long period controlling VE affiliation and operation achieves success on business performance.

Table 4. Standardized Effects of Latent Variables on Some Endogenous Variables

Latent factor	Direct effect	Indirect effect	Total effect
Effect on agility in SC			
Enterprise capability	-0.565	0.953	0.388
ICT adoption	-0.077	0.417	0.339
VE	1.164	0	1.164
Effect on output of performance			
Enterprise capability	0	0.528	0.528
ICT adoption	0	0.339	0.339
VE	0.309	0.786	1.094
Agility in SC	0.675	0	0.675

This study has the following limitations. First, the small sample size could have an effect on popular fit indices. Therefore when the further questionnaires are to be collected by the researcher, the survey will be improved. Secondly, the study is targeted only in logistics companies in Mongolia. Next time, the targeted group or country could be changed and the results are compared with each other.

5. CONCLUSIONS

In order to survive in the recent turbulent, uncertain and instable market, SMEs need to increase their competitiveness. Based on their own capabilities, most SMEs interested collaborate with other related SMEs within their SC. On the other hand, to exploit fast changing market opportunities and increase business performance, SMEs need to affiliate temporarily and to collaborate in order to achieve agility through their SC. Therefore this study has investigated the influences of enterprise capability and ICT adoption on VE affiliation in order to achieve agility in SC, and their effect on business performance.

A conceptual hypothetical model was developed based on a literature review. In order to test this model the SEM was applied to improve the business performance by considering the relationship among the various factors. Analysis was conducted using two models, the measurement model and the structural model. Exploratory and confirmatory factor analyses were conducted as a measurement model. Factor analysis was performed using SPSS 20.0, and this illustrated the measurement properties of the observed variables via reliabilities and validities. In the second step, the structural model was established using the AMOS 20.0. Software based on calculated specific GOF indices, the model was verified and hypotheses

were validated through path coefficient and squared multiple correlation (R^2).

Enterprise capability has positive and significant influences on VE affiliation, and negative and significant influence on agility in SC, but enterprise capability has a higher and positive direct effect on agility in SC. This means that controlling enterprise internal capability for a long time helps to achieve agility, but for short period the enterprise capability could affect negatively agility in SC. However ICT adoption has a strong positive and significant influence on VE affiliation to build up robust cooperation. ICT adoption has no significant influence on agility in SC. The temporary affiliation of SMEs as a VE has the strongest positive and significant influence on providing agility in SC. Finally, business performance has been positively influenced by both VE affiliation and agility in the SC.

As the concept of the relation of VE and agility in SC is complex and is influenced by many factors, its entire domain is difficult to in single study. Therefore further research can expand the conceptual model considering additional factors and their relationships. Also the sample size can be increased to improve the depth and variety of the analysis.

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REFERENCES

Agarwal, A., Shankar, R., Tiwari, M.K., 2007. Modeling agility of supply chain. Industrial Marketing Management. 36, 443–457.

Binder, M., Clegg, B., 2007. Enterprise management: A new frontier for organisations. International Journal of Production Economics. 106, 409–430.

Bollen, K.A., Long, J.S., 1993. Alternative ways of assessing model fit, in: Bollen, K.A., Long, J.S. (Eds.), Testing Structural Equation Models. SAGE, Newsbury Park, CA, pp. 136–162.

Bolton, R., 1996. The National Industrial Information Infrastructure Protocols Project (NIIIP). RASSP Dig.

Braunscheidel, M.J., Suresh, N.C., 2009. The organizational antecedents of a firm's supply chain agility for risk mitigation and response. Journal of Operation Management. 27, 119–140.

Byrne, B.M., 1994. Structural equation modeling with EQS and EQS/Windows: basic concepts, applications, and programming. Sage Publications, Thousand Oaks.

Camarinha-Matos, L.M., Afsarmanesh, H., 2003. Elements of a base VE infrastructure. Computers in Industry. 51, 139–163.

Cao, Q., Dowlatshahi, S., 2005. The impact of alignment between virtual enterprise and information technology on business performance in an agile manufacturing environment. Journal of Operation Management. 23, 531–550.

Chituc, C.M., Azevedo, A., Toscano, C., 2009. Collaborative business frameworks comparison, analysis and selection: an analytic perspective. International Journal of Production Research. 47, 4855–4883.

Cho, K., Hong, T., Hyun, C., 2009. Effect of project characteristics on project performance in construction projects based on structural equation model. Expert System Application. 36, 10461–10470.

Christopher, M., 2000. The Agile Supply Chain: Competing in Volatile Markets. Industrial Marketing Management. 29, 37–44.
Davidow, W.H., Malone, M.S., 1993. The Virtual Corporation: Structuring and Revitalizing the Corporation for the 21st Century. Harper Business.
Davidrajuh, R., 2003. Realizing a new e-commerce tool for formation of a virtual enterprise. Industrial Management and Data Systems. 103, 434–445.
DeGroote, S.E., Marx, T.G., 2013. The impact of IT on supply chain agility and firm performance: An empirical investigation. International Journal of Information Management. 33, 909–916.
Esposito, E., Evangelista, P., 2014. Investigating virtual enterprise models: literature review and empirical findings. International Journal of Production Economics. 148, 145–157.
Grefen, P., Mehandjiev, N., Kouvas, G., Weichhart, G., Eshuis, R., 2009. Dynamic business network process management in instant virtual enterprises. Computers in Industry. 60, 86–103.
Gunasekaran, A., Lai, K., Edwincheng, T., 2008. Responsive supply chain: A competitive strategy in a networked economy. Omega 36, 549–564.
Gunasekaran, A., Yusuf, Y.Y., 2002. Agile manufacturing: A taxonomy of strategic and technological imperatives. International Journal of Production Research. 40, 1357–1385.
Hair, J.F., 2010. Multivariate data analysis. Prentice Hall, Upper Saddle River, NJ.
Hooper, D., Coughlan, J., Mullen, M., 2008. Structural equation modelling: guidelines for determining model fit. Electronic Journal of Business Research Methods. 6, 53–60.
Kline, R.B., 2011. Principles and Practice of Structural Equation Modeling. Guilford Press.
Liu, H., Ke, W., Wei, K.K., Hua, Z., 2013. The impact of IT capabilities on firm performance: The mediating roles of absorptive capacity and supply chain agility. Decision Support System. 54, 1452–1462.
Meixell, M.J., Wu, S.D., 2005. Demand propagation in the extended enterprise: a comparative analysis of product and process design policies. International Journal of Production Research. 43, 4169–4189.
Nagal, R., Dove, R., 1991. 21st century manufacturing enterprise strategy: an industry-led view. Iacocca Institute, Lehigh University.
Naylor, Ben.J., Naim, M.M., Berry, D., 1999. Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain. International Journal of Production Economics. 62, 107–118.
Ngai, E.W.T., Chau, D.C.K., Chan, T.L.A., 2011. Information technology, operational, and management competencies for supply chain agility: Findings from case studies. The Journal of Strategic Information Systems. 20, 232–249.
Samdantsoodol, A., 2017. An Adaptive Framework for Improving the Effectiveness of Virtual Enterprises in the Supply Chain. Staffordshire University, Staffordshire.
Samdantsoodol, A., Cang, S., Yu, H., Eardley, A., Buyantsogt, A., 2017. Predicting the relationships between virtual enterprises and agility in supply chains. Expert System Application. 84, 58–73.
Sarkis, J., 2001. Benchmarking for agility. Benchmarking: An International Journal. 8, 88–107.

Sohn, S.Y., Kim, H.S., Moon, T.H., 2007. Predicting the financial performance index of technology fund for SME using structural equation model. Expert System Application. 32, 890–898.

Su, Y., Yang, C., 2010. A structural equation model for analyzing the impact of ERP on SCM. Expert System Application. 37, 456–469.

Wang, W.Y.C., Chan, H.K., 2010. Virtual organization for supply chain integration: Two cases in the textile and fashion retailing industry. International Journal of Production Economics. 127, 333–342.

Yoon, S.W., Nof, S.Y., 2011. Affiliation/dissociation decision models in demand and capacity sharing collaborative network. International Journal of Production Economics. 130, 135–143.

Yusuf, Y.Y., Gunasekaran, A., Musa, A., Dauda, M., El-Berishy, N., Cang, S., 2012. A relational study of supply chain agility, competitiveness and business performance in the oil and gas industry. International Journal of Production Economics.

Zhang, Z. (David), Sharifi, H., 2007. Towards Theory Building in Agile Manufacturing Strategy: A Taxonomical Approach. IEEE Transactions on Engineering Management. 54, 351–370.