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MODERATING EFFECT OF EXTERNAL DIFFUSION FROM THE UTILIZATION OF IT IN SCM OF KOREA

The importance of collaborative business is the driving force for many companies to integrate their supply chain networks. Especially among leading global companies, the need to improve the competitiveness of their organizational environment has promoted the use of IT networks to standard practice. This paper analyzes the ways to measure the effects of information technologies on business performance by investigating how leading companies utilize information technologies in their supply chain management. Specifically, this study emphasizes the mediation effects of external diffusion on the interrelationship between organizational environment and the benefits of IT use in supply chain management. The empirical results indicate that organizational environment has a positive effect on benefits from IT use in SCM, while external diffusion does not have any mediation effect in SCM.

Keywords: external diffusion; supply chain management (SCM); moderating effect.

Чанг-Бонг Кім, Йонг-Рок Цой СПОВІЛЬНЮЮЧА ДІЯ ЗОВНІШНЬОЇ ДИФУЗІЇ У ЗАСТОСУВАННІ ІТ ПРИ УПРАВЛІННІ ЛАНЦЮЖКОМ ПОСТАЧАНЬ

У статті розглянуто, що для багатьох підприємств рушійною силою інтеграції ланцюжків постачань є підприємницьке співробітництво. Серед найбільших компаній світу виникла необхідність покращення конкурентоспроможності їхнього організаційного середовища, що сприяє застосуванню ІТ, які вже зараз отримали широке розповсюдження. Проаналізовано способи вимірювання впливу ІТ на підприємницьку діяльність шляхом вивчення того, як провідні фірми використовують ІТ при управлінні ланцюжком постачань. Підкреслено сповільнюючу дію зовнішньої дифузії у стосунках між організаційним середовищем і перевагами застосування ІТ в управлінні ланцюжками постачань. Згідно емпіричних результатів, організаційне середовище позитивно впливає на отримання вигод від використання ІТ в управлінні ланцюжками постачань, у той час як зовнішня дифузія ніякого посередницького впливу на управління ланцюжками постачань не має.

Ключові слова: зовнішня дифузія; управління ланцюжком постачань; згладжуюча дія.

Табл. 3. Рис. 5. Літ. 28.

Чанг-Бонг Ким, Йонг-Рок Цой ЗАМЕДЛЯЮЩЕЕ ДЕЙСТВИЕ ВНЕШНЕЙ ДИФФУЗИИ В ПРИМЕНЕНИИ ИТ ПРИ УПРАВЛЕНИИ ЦЕПОЧКОЙ ПОСТАВОК

В статье рассмотрено, что для многих предприятий движущей силой интеграции цепочек поставок является предпринимательское сотрудничество. Возникающая среди крупнейших предприятий мира необходимость в улучшении конкурентоспособности их организационной среды способствует применению сетей ИТ, которая уже в нынешнее время получила широкое распространение. Проанализированы способы измерения влияния ИТ на предпринимательскую деятельность посредством изучения того, как передовые

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фирмы используют ИТ при управлении цепочками поставок. Подчеркнуто сглаживающее влияние внешней диффузии в отношениях между организационной средой и преимуществами применения ИТ в управлении цепочкой поставок. Согласно эмпирическим результатам, организационная среда оказывает положительное влияние на использование ИТ в управлении цепочкой поставок, в то время как внешняя диффузия никакого сглаживающего влияния на управление цепочкой поставок не дает.

Ключевые слова: внешняя диффузия; управление цепочкой поставок; сглаживающее влияние.

Introduction. As the global networking of business cooperation intensifies worldwide, companies' adoption of information technologies (IT) has increased rapidly. This has changed the business environment of multinational corporations and the structure of global industries. In this setting, the application of IT to SCM has become an essential factor in securing competitiveness and corporate growth. In this study, we focus on the relationship between organizational environment and the benefits realized from utilizing IT in SCM, as well as the effects created from the external diffusion of IT in SCM.

The relationship between organizational environment and the benefits realized from the deployment of IT has been contemplated within SCM theories (Ranganathan et al., 2004), resource-based studies (Bharadwaj, 2000) and institutional theories (Gibbs and Kramer, 2004). This relation has also been contemplated within a technology acceptance model (Zain et al., 2003) and a location-choice model (Rugman and Verbeke, 2008).

The relation between the external diffusion in SCM and the benefits realized from the deployment of IT in SCM has been contemplated within innovation diffusion theories (Rogers, 1995; Melville et al., 2004), innovation diffusion theories (Fichman and Kemerer 1997), and entry-mode theories (Tallman and Li, 1996; Hofstede, 1980).

This study analyzes the benefits to organizational environment realized from the deployment of IT in SCM by adjusting the levels of external diffusion of information technology. The purpose of this study is twofold. First, a structural mediation effect exists within organizational environment, and thus, external diffusion benefits are realized from the deployment of IT in SCM. Second, external diffusion has a partial as well as a complete mediation effect on the relationship between organizational environment and the benefits realized from the deployment of IT in SCM.

Literature review. The organizational environment of SCM has been discussed in the studies on supply chain management function (Dyer, 2001; Ranganathan et al., 2004), resource-based studies (Barney, 1991; Melville et al., 2004; Bharadwaj, 2000) and institutional theories (Berger and Luckmann, 1966; Meyer and Rowan, 1977; Zucker, 1987; Gibbs and Kramer, 2004). Dyer (2001) has emphasized web technologies in supply chain management from the perspective of organizational environment, because corporations can gain collaborative advantage by using extended supplier networks. He has also contended that a close relationship exists between internal assimilation of SCM and web-technologies. From a resource-based standpoint, Barney (1991) and Melville et al. (2004) claim that a corporation can secure a competitive advantage by using valuable, scarce, and irreplaceable resources, and IT is one of these resources. Bharadwaj (2000) stresses close relationship between infor-

mation technology and the resources utilized in its organizational environment. From the perspective of institutional theory, Meyer and Rowan (1977), and Zucker (1977) state that the organizational environment of a corporation can be changed depending on its internal and external environments.

The relation between organizational environment and the benefits realized from deployment of IT in SCM have been covered in the studies on technology acceptance theory (Davis, 1993; Zain et al., 2003), and the location-choice theory (Rugman and Verbeke, 2008). Davis (1993) and Zain et al. (2003) suggest an extended technology acceptance model which points out that external variables affect the utilization of IT. According to them, location as the organizational environment could be affected by the deployment of IT. Based on this reasoning, we can present the following hypothesis.

H1: There is a positive relationship between the organizational environment of SCM and the benefits realized from the utilization of IT in SCM.

There have been diverse external diffusion approaches to SCM in the framework of innovation diffusion theory (Rogers, 1995; Fichman and Kemerer, 1997), resource-based studies (Melville et al., 2004; Zhu and Kraemer, 2005), and institutional theory (DiMaggio and Powell, 1983; Teo et al., 2003). The innovation diffusion theory by Rogers (1995) explains the external diffusion of information technology based on a conceptual model, showing the relationship between evaluation, adoption, and implementation of a technology as a factor of innovation diffusion. Melville et al. (2004) also show, from the resource-based view, that business environment of a corporation is affected by environmental characteristics within the IT industry, its trading partners, and its business processes. The resource-based theory by Zhu and Kraemer (2005) argues that the adoption of IT is affected by external pressures, and thus the evaluation of information technology systems are important for utilization of all the other resources.

External diffusion of IT in SCM is shown through innovation diffusion theory (Fichman and Kemerer, 1997; Premkumar and Ramanurthy, 1995) and entry mode theory (Tallman and Li, 1996; Kidd and Teramoto, 1995; Hofstede, 1980; Sambharya, 1995). The institutional theory by DiMaggio and Powell (1983) claims that the external diffusion of IT in SCM is affected by a coercive, imitative or normative perspective. Gibbs and Kramer (2004), Teo et al. (2003) explain that the diffusion of IT is affected by such factors as coercion, pressure, government promotion, IT legislation, and the adaptation of legitimate re-engineering. Also, the innovation diffusion theory by Grover and Goslar (1993) presents factors on the innovation, adoption and implementation of information technologies in American corporations. Zahra et al. (2000) shows how emerging ventures foster their international diversity, and how those firms try to improve technological learning from their environment, and information technology competence from internal organization through a proper mode of market entry. Based on all these arguments, we can develop the following hypothesis:

H2: There is a positive relationship between external diffusion and the benefits realized from the utilization of IT in SCM.

As we develop the above two hypotheses, we now develop the conceptual model for our study based on the approaches of Ranganathan et al. (2004), Zhang and Dhaliwal (2009). The model is comprised of the factors of organizational environ-

ment, external diffusion, and the benefits realized from the deployment of IT in SCM. To connect all these factors, the following hypothesis on the mediation effect of external diffusion is proposed:

H3: *There is a relation between organizational environment and external diffusion.*

To test all the hypotheses, we also use the comparative model approach. In Model 1, both organizational environment and external diffusion may have an effect on benefits in SCM (Figure 1). In Model 2, we assume there are no direct relations between organizational environment and benefits, but an indirect effect exists only through the mediation effect of external diffusion (Figure 2).

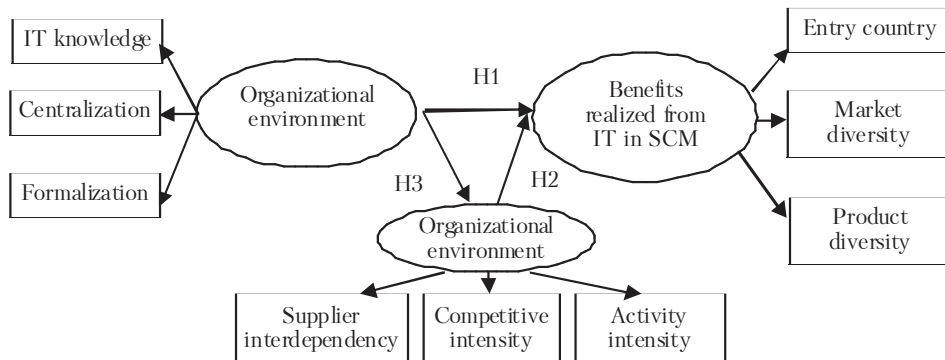


Figure 1. Research hypotheses and structural model (Model 1)

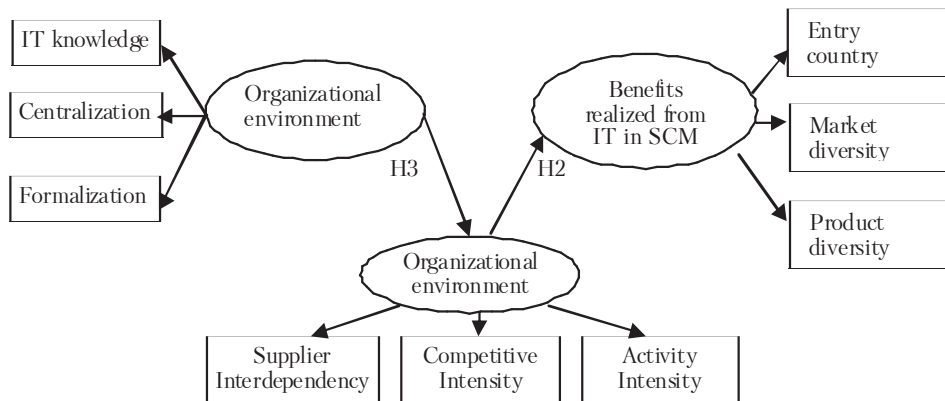


Figure 2. Research hypotheses and structural model (Model 2)

For the measurement of proxy variables, organizational environment is measured with the variables of IT management, IT knowledge, centralization, and formalization. Moreover, external diffusion is measured with variables of supplier interdependency, competitive intensity, and activity intensity. The benefits realized from the deployment of IT in SCM are measured by the variables of entry country, product diversity, and market diversity. All these arguments are based on the studies as discussed above.

Empirical analysis.

Sample and data. Based on the comparative Models 1 and 2, we analyzed the relationships between organizational environment, external diffusion, and the bene-

fits realized from the utilization of IT in SCM. The survey had been conducted with corporations which have an established SCM, from December 1, 2010 to March 30, 2011. Among 1000 questionnaires distributed, 501 were completed. From the 501 responses, 420 were used in the empirical analysis, 81 questionnaires could not be used due to inappropriate responses and/or input errors.

As shown in Table 1, the frequency analysis for the 420 survey responses shows the following distribution patterns of the categories. In the "industry group" category, the machine and parts industry shows the highest distribution with 153 (36.4%), while the chemical industry shows the lowest distribution with 83 (19.8%). In the "Number of Employees" category, companies with "less than 100 employees" shows the highest distribution with 106 (25.2%), while companies with "501 to 100 employees" shows the lowest distribution with 22 (5.2%). In the "number of years engaged in oversee business" category, "less than 1 year" shows the highest distribution with 79 (18.8%), while "16 to 20 years" shows the lowest distribution with 30 (7.1%). In the "market diversity" category, "less than one country" shows the highest distribution with 130 (31.0%), while "16 to 20 countries" shows the lowest distribution.

Table 1. Frequency analysis of the sample

| Category | Frequency | Percent (%) | |
|--------------------------------------------------|-------------------------------|-------------|------|
| Industry group | Machine and parts industry | 153 | 36.4 |
| | Electric/ Electronic industry | 117 | 27.9 |
| | Distribution industry | 67 | 16.0 |
| | Chemical industry | 83 | 19.8 |
| Number of employees | Less than 100 employees | 106 | 25.2 |
| | 101 to 500 employees | 94 | 22.4 |
| | 501 to 1000 employees | 22 | 5.2 |
| | 1001 to 3000 employees | 74 | 17.6 |
| | 3001 to 5000 employees | 29 | 6.9 |
| | 5001 to 10000 employees | 26 | 6.2 |
| | more than 10001 employees | 69 | 16.4 |
| Number of the years engaged in overseas business | Less than 1 year | 79 | 18.8 |
| | 2 to 5 years | 76 | 18.1 |
| | 6 to 10 years | 64 | 15.2 |
| | 11 to 15 years | 48 | 11.4 |
| | 16 to 20 years | 30 | 7.1 |
| | 21 to 30 years | 68 | 16.2 |
| | More than 31 years | 55 | 13.1 |
| Market diversity | Less than 1 country | 130 | 31.0 |
| | 2 to 3 countries | 76 | 18.1 |
| | 4 to 5 countries | 59 | 14.0 |
| | 6 to 10 countries | 39 | 9.3 |
| | 11 to 15 countries | 39 | 9.3 |
| | 16 to 20 countries | 18 | 4.3 |
| | More than 21 countries | 59 | 14.0 |
| Total | 420 | 100.0 | |

Reliability analysis. For the reliability of organizational environment, the total of 8 items were measured; 3 items related to the managerial IT knowledge, 3 items related to centralization, and 2 items related to formalization. The Eigen value of the sub-variable of organizational environment is verified for IT knowledge (Eigen value = 2.827), centralization (Eigen value = 2.610) and formalization (Eigen value = 1.846). Since all Eigen values are larger than one, the variables are accepted for reliability.

For the explanatory variance on the sub-variable of organizational environment (percent change in variance), managerial IT knowledge shows 33.33%, centralization 32.63%, and formalization 23.07%. All of these variances account for more than 70% of the total variance, and thus the feasibility of the explanatory variance is acceptable. For the reliability analysis on the sub-variable of organizational environment, it is verified for managerial IT knowledge (Cronbach's alpha = 0.919), centralization (variance % = 0.941), and formalization (variance % = 0.958) respectively. Therefore, the reliability on the sub-variable of organizational environment proves to be appropriate.

Regarding the reliability of external diffusion, the total of 6 items were measured, with 2 items related to supplier interdependency, 2 items related to competitive intensity, and 2 items related to activity intensity. In the same manner as discussed above, the Eigen value for the sub-variable of external diffusion is verified for supplier interdependency (Eigen value = 2.144), competitive intensity (Eigen value = 2.041), and activity intensity (Eigen value = 1.456). For the explanatory variance on the sub-variable of external diffusion, supplier interdependency shows 35.73%, competitive intensity 34.01%, and activity intensity 24.26%. The sum of all the explanatory variances on the sub-variable of external diffusion is verified as 94.00%. For the reliability analysis on the sub-variable of external diffusion, it is verified for supplier interdependency (Cronbach's alpha = 0.926), competitive intensity (variance % = 0.953), and activity intensity (variance % = 0.889) respectively. Therefore, the reliability on the sub-variable of external diffusion proves to be appropriate.

Validity analysis. The study conducted a confirmation factor analysis prior to validity analysis. As the result of the confirmation factor analysis for 3 variables (e.g., organizational environment, external diffusion, and the benefits realized from utilizing IT in SCM) and for 9 observed sub-variables, the goodness of fit level is shown to be statistically appropriate, except for the goodness of fit index on Chi-square and root mean square residual (RMR). Overall, our model is verified to be appropriate in validity (Table 2).

Table 2. Results of Confirmed Factor Analysis

| Classification | | Statistics | Criteria | Test |
|----------------|--------------------------------------|---------------------------------|----------|----------|
| χ^2 | Chi-square | 117.960 (df = 24, p = 0.000) | p > 0.05 | Rejected |
| GFI | Goodness of Fit Index | 0.942 | ≥ 0.90 | Accepted |
| AGFI | Adjusted GOF Index | 0.891 | ≥ 0.90 | Accepted |
| RMR | Root Mean Square Residual | 0.153 | ≤ 0.05 | Rejected |
| RMSEA | Root Mean Square Error Approximation | 0.097 | 0.10 | Accepted |
| NFI | Normal Fit Index | 0.958 | ≥ 0.90 | Accepted |
| RFI | Relative Fit Index | 0.937 | ≥ 0.90 | Accepted |
| IFI | Incremental Fit Index | 0.966 | ≥ 0.90 | Accepted |
| TLI | Tucker-Lewis Index | 0.949 | ≥ 0.90 | Accepted |
| CFI | Comparative Fit Index | 0.966 | ≥ 0.90 | Accepted |

Structural Equation Modeling. The structural equation model (SEM) is used frequently to analyze the changes on an organizational environment caused by the external diffusion and benefits realized from the utilization of IT in SCM. AMOS 4.0 is used for SEM as shown in Figures 1 and 2.

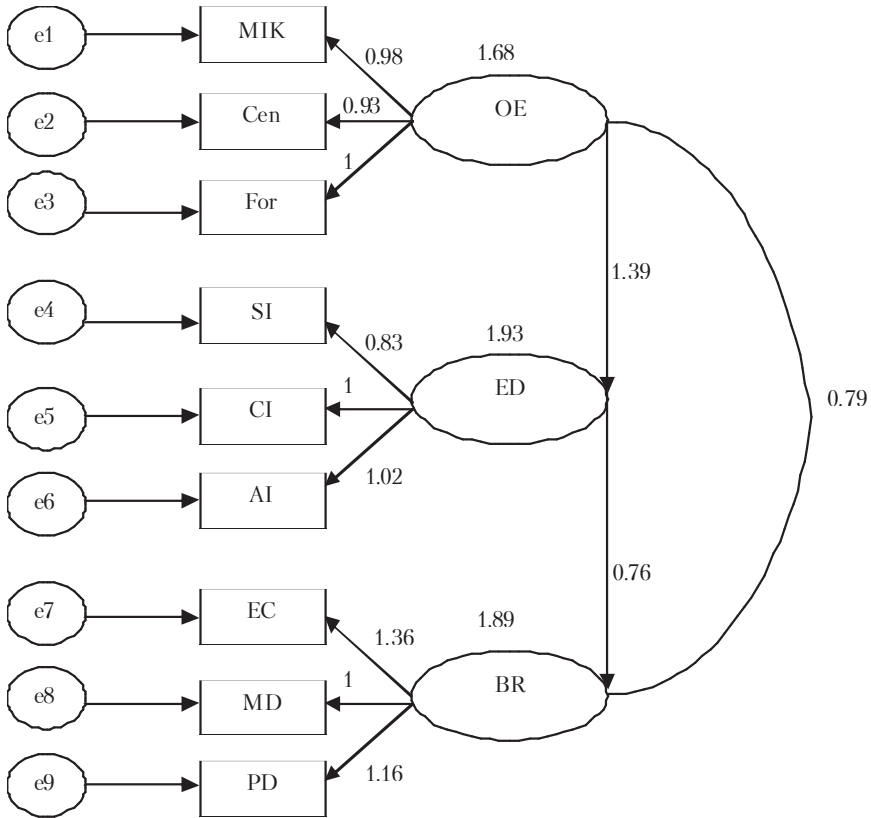


Figure 3. Graphical Illustration of Confirmation Factor Analysis

For the fitness of the model, we get Chi-square = 117.960, GFI Index = 0.942, AGFI (adjusted goodness of fit index) = 0.891, RMR (root mean square residual) = 0.153, RMSEA (root mean square error approximation) = 0.097, NFI (Normal Fit Index) = 0.958, RFI (Relative Fit Index) = 0.937, IFI (Incremental Fit Index) = 0.966, TLI (Tucker-Lewis index) = 0.949 CFI (comparative fit index) = 0.966. All these test statistics are higher than critical values and thus the goodness of fit of the model is verified to be properly structured.

The hypothesis H1 is accepted. That is to say, organizational environment has a positive effect on benefits from IT use in SCM. The hypothesis H2 is rejected, which means that external diffusion does not have any effect on the benefits from IT use in SCM. Meanwhile, the hypothesis H3 is accepted. This means that organizational environment has a positive impact on external diffusion, but the external diffusion does not have any mediation effect on the benefits of IT use.

For Model 2, the goodness of fitness indicators are as follows: Chi-square = 132.060, GFI Index = 0.935, AGFI = 0.884, RMR = 0.193, RMSEA = 0.101, NFI = 0.953, RFI = 0.932, IFI = 0.961, TLI = 0.944. CFI = 0.961. All these indicators are better than critical values, and thus the goodness of fit of Model 2 proves to be properly structured.

Table 3. Results of Structured Equation Model

| Hypothesis | Measurement paths | Estimate | S.E. | C.R. | P |
|------------|-----------------------------------------------------------------------------|----------|-------|--------|---------|
| H1 | Benefits realized from deployment of IT in SCM < Organizational environment | 0.485 | 0.126 | 3.834 | 0.00*** |
| H2 | Benefits realized from deployment of IT in SCM < External diffusion | 0.188 | 0.117 | 1.616 | 0.106 |
| H3 | External diffusion < Organizational environment | 0.826 | 0.043 | 19.407 | 0.00*** |

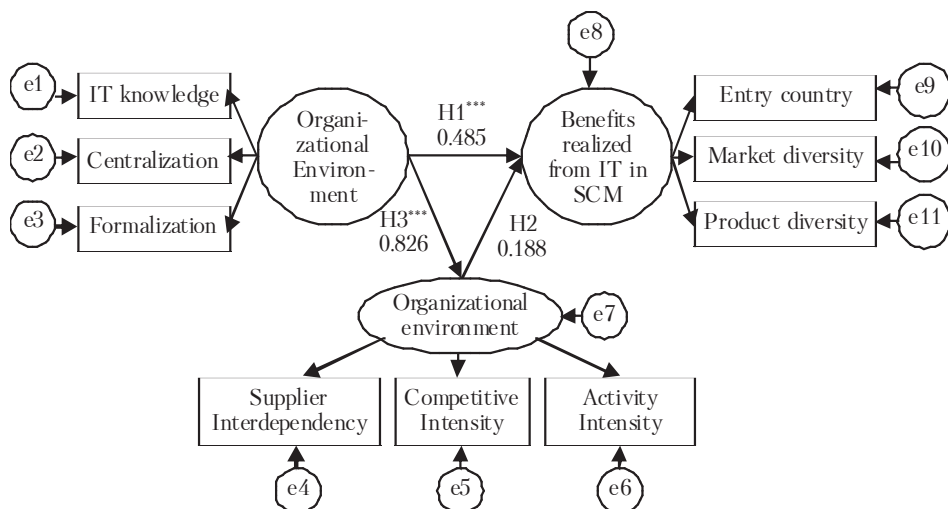


Figure 4. Structural Equation Model for Model 1

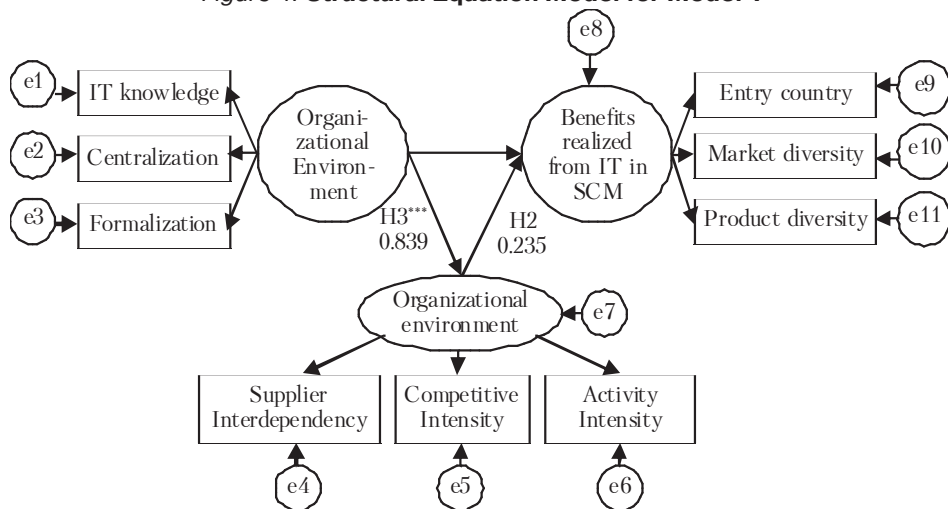


Figure 5. Structural Equation Model for Model 2

On the estimation of Model 2, the hypothesis H3 is accepted and thus the organizational environment has a positive effect on external diffusion. Meanwhile, the hypothesis H2 is rejected. This means that the external diffusion does not any effect

on benefits of IT use in SCM. Therefore, we can conclude that the external diffusion variable has no mediation effect in both Model 1 and Model 2.

Conclusion. This comparative study examines the role of mediation by external diffusion on the relationship between organizational environment and the benefits realized from the deployment of IT in SCM. Contrary to previous studies, this study empirically analyzes the relationships between organizational environment, external diffusion, and the benefits realized from the deployment of IT in SCM.

Our study concludes that H1 is supported, with a positive effect of organizational environment on the benefits from IT use in SCM. In both Model 1 and Model 2, the H2 is not supported, indicating that external diffusion does not have any mediation effect on the benefits from IT use in SCM, directly or indirectly, depending on Model 1 and 2. In both Model 1 and Model 2, H3 is supported, which means that organizational environment has a positive effect on external diffusion.

This study emphasizes the importance of supplier interdependencies, competitive intensity and indepth activity. All of this interdependent performance depends on management of external diffusion. Unfortunately, in our study, there are no mediation effects from external diffusion, and thus the interdependence on SCM is so fragile that all activities of partners on SCM are just instantaneous or business relationships driven by major manufacturers. It is not sustainable, and thus all members of SCM are not partners, but just "helpers" for some major leading companies in SCM. This kind of uneven partnership across the SCM network could sometimes create a zero-sum game of profit competition among participants, resulting in bipolarization of participants. The increasing profit rate of car manufacturing, compared with the decreasing profit rate of other participants in SCM, may cause a terrible mishap such as the massive global Toyota recall accident in August, 2009.

The management of external diffusion in terms of competitive intensity should focus on tracking new initiatives for all partners, not just the helper, to actively participate in innovations. This paper concludes that it's now time when leading network managers of SCM should share the value created by IT use in SCM, and this win-win game rule of external diffusion should result in the full effects of meta-mediation (Choi, 2012a, 2012b).

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Стаття надійшла до редакції 28.05.2012.