MANAGERIAL RELEVANT IMPACT FACTORS ON INTER-ORGANIZATIONAL SUPPLY CHAIN MANAGEMENT - EMPIRICAL FINDINGS FROM QUANTITATIVE RESEARCH

STEFAN WILLUTZKY

University of Latvia, Raiņabulvāris 19, Rīga, LV-1586, Latvia
E-mail: Stefan.Willutzky_Promotion@gmx.de

Abstract- Emanating from the goals and visions of the so-called Internet of Things and the German economic concept of 'Industrie 4.0', virtualization and collaboration among supply chain members are main challenges for creating prospective smart logistic processes. Objects of the real world have to be virtualized to create a so-called physical awareness within the Internet of Things. Therefore, the successful implementation of innovations in supply chain management is necessary to reach this goal. This paper will provide empirical findings regarding managerial relevant impact factors on inter-organizational supply chain management from quantitative research of supply chain members in the German electricity power generation industry.

Keywords- Supply Chain Management, Supply Chain Integration, Supply Chain Visibility, Innovation, Internet Of Things.

I. INTRODUCTION

The improvement of the company's overall performance including supply chain performance is of main interest of all business activities. Therefore, supply chain innovation especially within inter-organizational supply chains is of high interest for today's management decision-makers. In recent research, certain Auto-ID technologies are stated having the potential to support the inter-organizational collaboration between supply chain members. The ongoing evolution of new supply chain technologies such as Radio-Frequency Identification (RFID) technology as well as bar code technology is a further advancement to the idealized vision of supply chain management - the availability of an item in the correct quantity and condition at the correct time and place. Beyond that, the automatic identification of any object anywhere is essential for achieving the so-called vision of the Internet of Things (cf. Pflaum and Hupp (2007), p.107).

In reference to economical and political aspects, several research initiatives have been recently released. The Federal Government of Germany abandoned an action plan for high technology research and innovation projects in Germany. One of the ten projects is named 'Industrie 4.0' which also can be referred as the fourth industrial revolution. Driven from technological innovations of combining real and virtual items in the so-called Internet of things, 'Industrie 4.0' should embrace process innovations for the energy, transport and industry sector (cf. Federal Government of Germany- Federal Ministry of Education and Research (2012), pp. 6,and Gillhuber (2012), pp. 138). This development process has already started and will impact the competitive position of the German economy in ten or fifteen years (cf. Broy (2013), p. 23-24). The identification of items in the Internet of Things and cyber-physical systems in a tag-sensor combination will form the future 'Smart Factory' including 'Smart Logistics' (cf. Broy (2010), pp. 21, and Cain and Lee (2008), p. 61)

Virtualization and collaboration among supply chain members are the main challenges for creating theses prospective smart logistic processes. Objects of the real world have to be virtualized to create a so-called physical awareness within the Internet of Things (cf. Acatech (2012), p. 24, and Geisberger and Broy (2012), p. 129).

Therefore, the successful implementation of innovation in supply chain management is necessary to reach this goal.

The paper will provide empirical findings from qualitative research regarding managerial relevant impact factors on inter-organizational supply chain management of supply chain members in the German electricity power generation industry.

II. MANAGERIAL IMPACT FACTORS OF INNOVATION IN SUPPLY CHAIN INTEGRATION

In the following, relevant managerial impact factors of innovation in supply chain integration, the research question and main thesis for defence as well as the research design will be stated.

2.1. Relevant managerial impact factors of innovation in supply chain integration

In the focus of today's challenges of supply chain management and visions, the author arranges a novel construct of managerial impact factors for supply chain innovation as illustrated in figure 1, which influences the active management of processes, organizational structures as well as enabling

technologies regarding the financial, information and material flow of supply chains. Business managers need to be aware of theses impact factors and actively integrate these within their decision-making process regarding innovation projects.

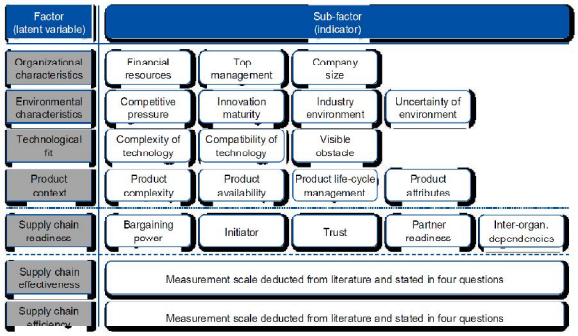


Fig.1. Factors for innovation in inter-organizational supply chain management

Source: derived by author from Patterson et al. (2003), p. 98, Scuopla (2003), p. 64, Kim and Lee (2008), pp. 265, Quetti et al. (2012), pp. 317, Premkumar and Roberts (1999), pp. 470, Zailani et al. (2010), p. 357, Chan et al. (2008), p. 204, Frambach and Schillewaert (2002), p. 165, and Sabbaghi and Vaidyanathan (2008), p. 79

The factor organizational characteristics refers to internal resources that can be assigned to support an innovation. Environmental characteristics focus on external influences such as economic condition, market competition and environmental uncertainty. The factor technological fit evaluates the technological capacities regarding innovation at the administration level of the organization. Product characteristics vary significantly and therefore might influence the innovation as well. Supply chain readiness is identified as an intervening factor for inter-organizational supply chain innovation adoption and highlights the collaboration characteristics of the supply chain and its members.

2.2. Research question and main thesis for defence

The thesis of the main research is stated by addressing the following research question:
What are managerial impact factors for innovation in inter-organizational supply chains?
The main thesis for defence in order to answer the research question is defined as:
The adoption of innovation in inter-organizational supply chains increases the supply chain performance.
The research model consists two latent variables: adoption of innovation in inter-organizational supply chains and increase of supply chain performance.
The independent variable adoption of innovation in inter-organizational supply chains is constructed of four managerial impact factors: organizational characteristics, environmental characteristics, technological fit, and product context. The variable supply chain readiness is stated as an inductive factor of the four factors of innovation adoption.

The dependent variable supply chain performance competes the impact of adoption of innovation on the supply chain performance. Supply chain performance is construct of two factors: supply chain effectiveness and supply chain efficiency.
In the main thesis, the research model is applied to a general view and in addition to two as relevant identified Auto-ID technologies within actual supply chain integration, bar code and RFID technology.

2.3. Research methodology and design

In the main research, the research methodology of testing of hypothesis as well as propositions, sequential triangulation and the comparative research method is applied.
The author applies both, a qualitative and quantitative research method, in sequential typ. In the first stage of the empirical data collection, qualitative research is used to identify the actual stage of research. In addition to a theoretical analysis of literature, semi-structured interviews with experts are carried out. Based on the results and findings of the first stage, a data collection using the quantitative research method self-completion questionnaire survey is planed and executed. Hereby, the author uses comparative research method regarding two enabling technologies within supply chain innovation.

A self-completion questionnaire survey is developed by the author containing 39 for the online and 41 questions for the fair trade survey to measure the impact of the stated managerial factor for innovation adoption in intra-organizational supply chain management on supply chain performance. A five-point Likert scale is used and arranged in polarised way from ‘I do not agree’, ‘neutral’, and ‘I do agree’.

The questionnaire is pre-test with ten experts, using the also the survey monkey platform, and reworked according to received feedback.The self-completion questionnaire is analysed by multivariate analyse technique. The structural equation modelling using partial least squares is performed in the software Smart PLS.

Data were collected via a questionnaire survey in the time period of November 2014 to February 2015. The basic population of this research is the electricity generation industry in Germany – 276 main competitors have been selected by the author. These companies were invited to participate in the survey.
Due to a limited response rate, the author collects additional responses from participants and visitors of the 13th International Trade Fair for Distribution, Materials Handling and Information Flow Logi MAT 2015 in Stuttgart, Germany in February 2015. All

respondents are members or suppliers of the German electricity generation industry.

III. RESULTS AND DISCUSSION

Within this paper, it will be focused on the general view of researching the managerial impact factor of innovation in inter-organizational supply chains. The research results regarding both compared Auto-ID technologies are stated in the author's main thesis.
The results are stated covering the assessment of the reflective measurement as well as formative measurement model and by the assessment of the structural model as stated in figure 2. In detail, the author analysis the criterion R Square, f Square, composite reliability and Cronbach's Alpha.

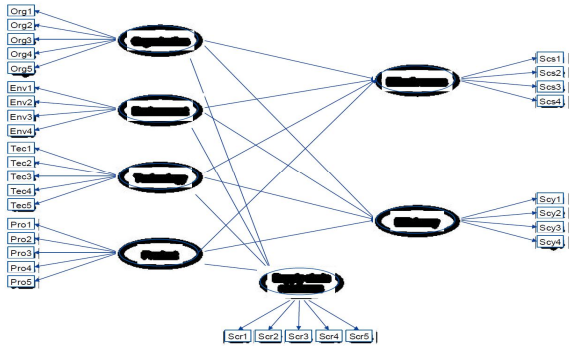


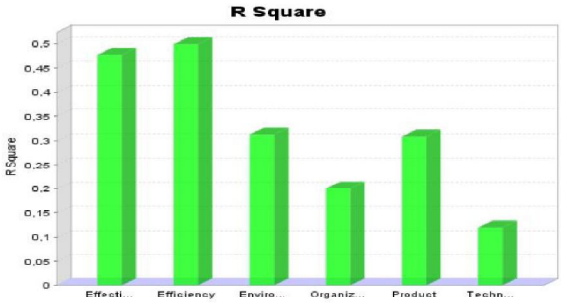
Fig.2. Measurement model (outer model) of the structural equation model

Source: compiled by author

The author applies for the assessment of the structural model the criterion R Square and Cohen's f Square. The author uses for assessing the stated quality criteria reliability and validity the traditional Cronbach's alpha and the alternative measure composite reliability.

R Square is the first essential criterion for the assessment of the PLS structural model equation measuring each endogenous latent variable's coefficient of determination. In other words, R Square measures the relationship of a latent variable's explained variance to its total variance. According to literature, values of approximately 0.670 are considered as substantial, values around 0.333 as average, and values of 0.190 as lower or weak. (cf. Nitzl (2010), p. 32-33 and Urbach and Ahlemann (2011), p. 21)

In figure 3, the PLS structural equation model of the answer variant 'in general' including R Square and its loadings is stated.
In the model 'in general', the R Square is for the variable organizational characteristics (Org) 0.201, environment characteristics (Env) 0.313, technological fit (Tec) 0.121, product context (Pro) 0.309, supply chain effectiveness (Scs) 0.478, and supply chain efficiency (Scy) 0.499. The variable organization consists two and the factors technology and product consist each one indicator with a negative loading, which indicates a negative impact on the adoption of supply chain innovations in inter-organizational supply chains, which also explains a lower model fit assessment criterion of R Square.



	R Square
Effectivness	0,478
Efficiency	0,499
Environment	0,313
Organization	0,201
Product	0,309
Technology	0,121

Figure 3 Variant 'in general' – R Square

Source: compiled by author. Analysis is based on 110 responses to a questionnaire survey (November 2014 to February 2015) from supply chain members of the German electricity power generation industry.

The criterion R Square adjusted, a modified version of R-Square adjusted for the number of predictors in the model, confirms the stated results of R Square due to only very small differences between both criterions. R Square adjusted, always lower than R Square, is for Org 0.194, Env 0.306, Tec 0.113, Pro 0.302, Scs 0.458, and Scy 0.480.
Overall, the model fit can be stated as substantial to good and the model has a good level of explanatory power.

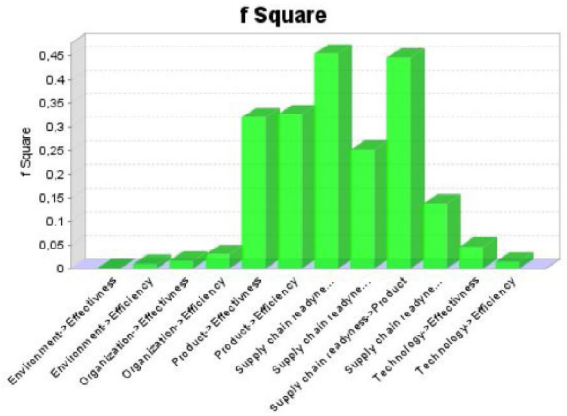
The path coefficients between the models latent variables are analysed in relation to the algebraic sign, the magnitude, and significance.

The path magnitude indicates the strength of the relationship between two latent variables and should exceed 0.100 to account for a certain impact within the model. In order to determine the level of significance, resampling techniques of bootstrapping including the p- and t-values are applied. The standardized p-values around 1 and -1 indicate a weak influence of the casual interconnection, whereas values between 0.2 and -0.2 are identified as highly significant. In addition, t-values, resulting from the bootstrapping approach, equal or greater than 1.65 indicate an error probability of 10 percent whereas values equal or greater than 1.96 indicate an error probability of 5 percent and therefore a higher significance. (cf. Gujarati (1995), pp.124, Nitzl(2010), pp. 29, and Urbach and Ahlemann (2011), p. 21)

In the model 'in general', the path coefficients between the inductive factors supply chain readiness and the four stated factors of innovation adoption are high and indicate a strong impact. The same impact can be stated for the five indicators of supply chain readiness.

The path coefficients between the independent and the dependent variable indicate a certain impact. The coefficients for Org-Scs and Env-Scy are marginal lower as the stated levels in literature. The factor environment indicates a negative impact on supply chain effectiveness with a value of -0.017. As stated above, three indicators also show negative algebraic signs and indicate a negative impact on the adoption of supply chain innovation in inter-organizational supply chain.

The p-values and t-values of the inductive variable supply chain readiness and its indicators can be all stated as significant – all p-values are between 0 and 0.03 and all t-values are greater than 5.458. The four independent variables Org, Env, Tec, and Pro have a lower significant impact on the depended variables Scs and Scy, except the interconnection Tec-Scs (p-value 0,102, t-value 1,64), and the impact of Pro on Scs as well as Sys with p-values of 0 and t-values indicating an error probability of 5 percent.
The indictors Org5 (company's revenue), which most respondent refused to state, Tec5 (visible obstacle) and Pro5 (products attributes) indicate a negative impact but the p- and t-values indicate a less significance influence within the model.

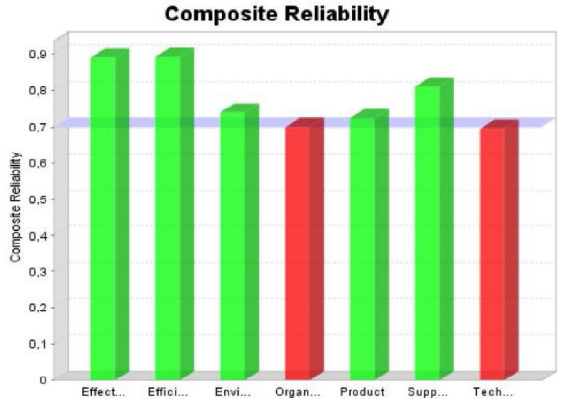


	Effectivness	Efficiency	Environment	Organization	Product	Supply chain readyness	Technology
Effectivness							
Efficiency							
Environment	0,000	0,010					
Organization	0,017	0,030					
Product	0,320	0,326					
Supply chain readyness			0,455	0,252	0,446		0,138

Figure 4. Variant 'in general' – f Square

Source: compiled by author. Analysis is based on 110 responses to a questionnaire survey (November 2014 to February 2015) from supply chain members of the German electricity power generation industry.

F Square is applied by the author for evaluating the effect size in the structural equation model. The Cohens's f Square measure if an independent variable latent variable has a substantial impact on a dependent variable by calculating the increase of in R Square of the latent variable to which its path is connected, relative to the latent variables proportion of unexpected variance. Literature states that values of 0.020, 0.150, and 0.350 indicate the predictor variable's low, medium, or large effect on the structural model. (cf. Urbach and Ahlemann (2011), p. 21 and Nitzl (2010), p. 34-35)
As stated in figure 4 in the model 'in general', all exogenous variables have an influence on the endogenous variable. A high influence with values of 0.350 or higher can be stated for the influence between the inductive variable Scr and Env as well as Pro. A medium effect can be stated in particular for Pro onScs and Scy.



	Composite Reliability
Effectivness	0,890
Efficiency	0,892
Environment	0,739
Organization	0,700
Product	0,723
Supply chain readyness	0,811
Technology	0,695

Figure 5. Variant 'in general' - Composite reliability

Source: compiled by author. Analysis is based on 110 responses to a questionnaire survey (November 2014 to February 2015) from supply chain members of the German electricity power generation industry.

Composite reliability, as an alternative measure to Cronbach's Alpha and its assumption that all indicators are equally reliable, assesses the internal consistency reliability by taking into account that indicators have different loadings. The composite reliability measures the sum of a latent variable's factors loading relative to the sum of the factors loading plus error variance. According to literature, for confirmatory research a proposed threshold value is greater than 0.800 or 0.900 whereas the value must not be lower than 0.600. (cf. Nitzl (2010), p. 25 and Urbach and Ahlemann (2011), p. 18-19)

In the model 'in general' and as stated in figure 5, the composite reliability is for the indicator Org 0.700, Env 0.739, Tec 0.695, Pro 0.723, Scr 0.811, Scs 0.890, and Scy 0.892. The values of Org and Tec are

below the recommended values, however still exceed the minimum values.

Cronbach's Alpha, as a traditional criterion, measures the degree to which the observable and empirically measurable indicator variable's load is simultaneously with the latent variable increase. A high Cronbach's alpha value assumes, that the scores of all items with one construct have the same range and meaning whereas this criterion tends to severely underestimate the internal consistency reliability of the latent variables in the structural equation model.

In the model 'in general', the Cronbach's Alpha is for the indicator Org 0.640, Env 0.583, Tec 0.519, Pro 0.550, Scr 0.722, Scs 0.833, and Scy 0.835.

Overall, the stated latent variables in the structural equation model can be stated as reliable according the composite reliability and Cronbach's Alpha. Due to stated negative path coefficients of the variables' indicators, the latent variables are not continuously consistent.

IV. MAIN FINDINGS

In summary of the structural equation model's assessment for the variant 'in general', it can be stated:

- The exogenous latent variables (Org, Env, Tec, and Pro) explain around 50 % of the variance in each endogenous latent variable supply chain effectiveness (Scs) and efficiency (Scy).
- The inner model path coefficients' sizes and significance suggest that product context (Pro) has the strongest effect on supply chain effectiveness (Scs) followed by technological fit (Tec).
  It also suggested that product context (Pro) has the strongest effect on supply chain efficiency (Scy) followed by a weak effect of organizational characteristics (Org).
- However, the proposed path relationships between Org-Scs, Env-Scs as well as Env-Scy and Tec-Scy are not statically significant.
- Thus the author concludes that product context (Pro) is a moderate substantial predictor of supply chain performance including effectiveness and efficiency.
  The further exogenous latent variables (Org, Env, Tec) do not predict Scs and Scy directly.
- The outer model loadings suggest that Pro3 (product availability) and Pro4 (product life-cycle management) are good indicators of Pro. The indicator Pro5 (product attributes) has a negative impact on Pro.
- The author concludes that supply chain readiness is based on the inner path coefficients sizes and significance levels a moderate substantial and statistical significant inductive variable on the adoption of innovation in inter-organizational supply chains.
  The outer model loadings suggest that Scr1 (bargaining power) and Scr5 (inter-organizational dependencies) are god indicators of Scr.
- Overall it can be stated, that the adoption of innovation in inter-organizational supply chains positively impact the supply chain performance.

The following limitations for the overall research need to be stated:

- Basic population is reduced to German electricity generation industry and its suppliers.
- Further managerial impact factors of supply chain innovation might influence the implementation and the impact on supply chain performance.
- Basic population of interview with experts is limited due to German cartel law.
- Problems/limitations of the applied qualitative and quantitative research method.
- The inductive latent variable supply chain readiness is correlated in this research to the adoption of supply chain innovation in inter-organizational supply chains. Future research might also address supply chain readiness as an exogenous latent variable hypothesising a directly positive and exponentiated effect on supply chain performance including the underlying endogenous latent variables supply chain effectiveness and efficiency.

A further reflection and interpretation of empirical data based research resultsfrom both qualitative and quantitative research is executed by the author in the main thesis.

In summary and in order to answer the research question, the overall thesis improved the in-depths knowledge of managerial impact factors for innovations in inter-organizational supply chains. As one main result of the research process, the author of can empirically partly substantiate the stated main theses for defence, that the adoption of innovation in inter-organizational supply chains increases the supply chain performance.

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