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Adoption of Fourth Party Logistics in the Sector of German Agricultural Bulk Logistics

- A Technology-Organization-Environment Framework Approach

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Abstract. This article aims at developing an understanding of the factors that promote the adoption of fourth party logistics (4PL) within German agricultural bulk logistics; hereafter referred to as diffusion factors. In order to elaborate upon the diffusion factors, we based our research on an exploratory study, and applied the Technology-Organization-Environment (TOE) framework. Within the scope of our research, we extracted those factors (e.g. external and internal logistics information technology, technology, size, services) predominantly contributing to the adoption of a 4PL approach. The study concentrates on the sector of German agricultural bulk logistics in which the 4PL approach is not implemented yet. The findings have important implications for the development of a 4PL approach within the sector. Our study provides an overview of prevailing characteristics of further diffusion factors in view of the main technologies, organizational structures and environmental influences.

Keywords: Fourth Party Logistics (4PL), Technology-Organization-Environment Framework (TOE), diffusion factors,

1 Introduction and Motivation

The agricultural sector of the European Union is in the process of structural change. In Germany this has led to a 33% reduction of holdings during the period of 2000 to 2010 [1]. The total cultivated area, however, remained unchanged which is due to the introduction of industrial structures such as increased employment, improved harvesting technologies and enhanced methods of the processing of the harvest. One key element of the harvesting process is the post-harvest transport logistic. While in the early 90s companies and traders tended to outsource logistics activities, and thus contributed to a propagation of logistics service providers [2], this trend occurred only sporadically in the agricultural sector [3]. This may be a result of the traditional structures within the agriculture. The current agricultural value chain in the bulk segment is characterized by the activities of various actors (producers, local traders, freight forwarders, carriers, wholesalers, processors) who perform various logistical tasks e.g. including transport, storage, procurement and distribution of goods. Those actors

possess the required transport and storage resources. Each actor is responsible for an efficient use of his own resources. The opportunity of saving logistics costs based upon a cooperation with external logistic providers (1-4PL) has been neglected [4]. Expert interviews with wholesale traders and dispatchers in August 2012 revealed the following characteristics for the German sector of agricultural bulk logistics:

- 2PL Service Provider (shippers) and 3PLs (contract logistics providers) have already established themselves in the sector in form of SME
- The area of activity mainly extends to freight transport with occasional support services such as warehousing;
- There is no 4PL acting as network integrator with respect to industrial transport planning or increasing the efficiency of transport.

Companies such as Corus [5] or even complete branches [6] work with a 4PL as a Supply Chain Manager. In the German agricultural sector, there are similar structures, however, without focus on supply chain management. The agricultural sector consists of a wholesale level which consolidates the harvest volumes for the internal market. Hence, transport activities are generated. Currently, there is no effort towards transport optimization. Each actor of the agricultural sector tries to handle the freight-age of traded goods. This results in empty runs and high costs. Exploratory studies that examine the 4PL approach in agricultural bulk logistics have not been endeavored so far. This paper presents the first exploratory study of German agricultural bulk logistics with focus on the 4PL approach. The addressed research question is:

- RQ: What are the main diffusion factors of the 4PL approach in the sector of German agricultural bulk logistics?

This research question emerges from two main questions in the relevant literature:

1. What is the role of a 4PL [7] [8] including the actors of the transport network [9]?
2. What are preconditions to manage the supply chain [10] and what are the reasons of cooperation and outsourcing of transport activities in the examined sector [11]?

The research effort is presented as follows: section 2 provides background, problems and basic concepts. Section 3 addresses the TOE framework. Thereafter in section 4, the research model is described. In section 5 the empirical effort is described. Section 6 presents the survey results. Prior to the detailed presentation and discussion of the hypothesis in section 7. Section 8 summarizes limitations, further research and the main contributions.

2 Background

According to Bauknight and Miller [12] the company Accenture coined the 4PL approach. During the late 90s, this approach was sporadically discussed in the literature. However, since 2002, an increasing number publications explore the approach. Especially, conference papers describe developments of 4PL platforms [13] [14].

Definitions of the 4PL approach are relatively uniform. The Accenture definition by Jensen [15] and Olander & Norman [16] states that: “A supply chain integrator that assembles and manages the resources, capabilities and technology of its own organization with those of complementary service providers to deliver a comprehensive supply chain solution.” Win [7] supplements the aforementioned definition with criteria of asset freedom and an operational perspective. Mukhopadhyay & Setaputra [17] defining 4PL as a strategic partner and a supply chain integrator, which focuses on the resources, capabilities and technologies of its own organization and complementary service providers to provide a comprehensive supply chain solution.

In all these definitions 4PL is described as an element of a network that can contribute to a total supply chain solution. In this context 4PL may perceive various tasks. According to Gattorna and Selen [18] 4PL may be seen as a supply chain (SC) visionary, as SC planner and optimizer, project manager, service, system and information integrator [19]. 4PL should therefore include technological, collaborative and economic aspects in order to provide the features described operationally and strategically. From a strategic point of view, 4PL is supposed to manage the supply chain as well as support the cooperation of actors within that supply chain. From an operational point of view, the core capability of a 4PL comprises the supply of an IT-Infrastructure as well as the information and communication technology. The aim is to provide an information flow that enables actors in a supply chain to better network and thus participate in a complex and far-reaching transport planning process [49] Only with the support of IS and IT a 4PL is capable of mastering the challenges and complexity of a supply chain, which classifies 4PL as a relevant artefact [30].

A common information platform is necessary for the implementation of the desired tasks and for an information management within a network of actors [20]. One challenge of a 4PL is its role in implementing the skills required by customers and transportation providers (3PL), shippers (2PL) and producers with their own logistics equipment (1PL) in terms of desired services, technological connectivity and motivation of cooperation [21]. Prior to the introduction of 4PL, available services have to be implemented in a more efficient way than previously accomplished by solitary actors within the network. On the one hand, the arrangement of transportation should result in its increase in efficiency (due to a larger number of freightage commissions on the 4PL level), and on the other hand this has to be an outsourced service. Finally, the gradation between 3PL and 4PL is fluent the main difference is the asset freedom of a 4PL. Since none the 4PL has not been implemented within the sector of German agricultural bulk logistics yet, this will be an innovative step. In order to implement that, various actor perspectives have to be analyzed [50]. The TOE framework is an approach that is capable of such an analysis, and therefore is being applied.

3 TOE-Framework

The TOE Framework introduced by Tornatzky and Fleischer [22] was developed to study the adoption of technological innovations. It is divided into three elements (technology, organization and environment) that may affect the introduction of a

technological innovation. The technology aspect refers to the available technology within a company (internal) and a market (external). The organizational aspect covers descriptive characteristics such as company size, the number of employees and internal and external resources. The environmental aspect describes the influences of the industry, trade partners and the competition situation. The literature provides a number of examples in how the TOE framework supported an analysis of technological innovation in various research contexts. For example, Bernroider and Schmöllerl [23] analyzed the impacts of operations research applications on decision support systems in the field of IT decisions. In another example the framework helped to examine the influence of mobile commerce [24] and e-business [25] on companies. Ghobakhloo et al. [26] generated a data base for using the TOE framework based upon their own surveys and interviews in the context of the adaption of electronic commerce. In the field of logistics the framework was used to investigate issues and impact of EDI [27] or RFID [28]. In this study the 4PL approach within the sector of German agricultural bulk logistics was analyzed. Only those TOE-related diffusion factors are analyzed that assume the willingness of companies to introduce innovations [29]. The 4PL approach within the annotated sector is an innovative attempt. Based upon the TOE framework seven different hypotheses have been elaborated. These hypotheses examine the diffusion of 4PL in the light of criteria that have been derived from the elements Technology, Organization and Environment of the TOE framework.

4 Hypotheses and Research Model

For the identification of relevant diffusion factors of a 4PL, the elements of the TOE framework are examined to generate hypotheses. This way a methodological consistency between TOE framework including its elements and the 4PL approach is achieved.

4.1 Technological context

An important aspect of developing the 4PL approach is an increased networking of actors and their focus on the information flow. This way a 4PL can work as an integrator [17]. IT Platforms with various interfaces serving as connectors among multiple actors are described and conceptualized in the literature [30] [13]. The application of IT in the supply chain is as a benefit that companies mainly use for the operational execution of business processes [31]. IT consists of internal logistic information technology (LIT) and external LIT [32]. Internal LIT includes the technology used internally for inter-departmental communication, information exchange and the implementation of internal processes. Examples of internal information technology are e.g. enterprise resource planning (ERP) systems.

External LIT facilitates communication and information that may be shared with supply chain partners. This includes interfaces, transmission media and software applications which allow an efficient exchange of information with supply chain partners. Due to the high number of small and medium enterprises (SME) in the agricul-

tural sector, various technologies must be considered based upon insights from SME research [33]. This results in a division of external LIT in telephone, fax, mobile phone, email, online portal, EDI and others to provide a variety of technologies depending on the development stage of a company. For the 4PL as an integral entity in a supply chain the available technology of the supply chain partners is important for handling tasks such as transport planning. At the same time, these technologies can cohere with the support of a 4PL. If such systems are already implemented on a company level the request for 4PL might be significantly lower. Under these circumstances the assumption can be made that there is a relationship between the external LIT and the diffusion of the 4PL approach when communication and information sharing infrastructures are used. Therefore the following hypothesis is derived:

H1.1 A more extensive use of the existing external LIT is related to the diffusion of the 4PL approach in the sector of agricultural bulk logistics.

In terms of internal LIT we assumed no relationship with the diffusion of the 4PL because a 4PL approach represents an optional service. Every network participant has a choice to use that offer. The internal LIT implies internal systems whereby the 4PL approach has more an external character, which results in the second hypothesis:

H1.2 A more extensive use of the existing internal LIT has no impact upon the diffusion of the 4PL approach in the sector of agricultural bulk logistics.

4.2 Organizational context

The size of a company is an important organizational factor for the adoption and readiness to apply new technologies and methods [22] [34]. Zhu et al [25] state that larger organizations tend to adopt innovative approaches more slowly due to their inertia. Nevertheless, they can provide greater financial resources for the introduction of new technologies. Smaller companies expect a resources-saving implementation with less communication and less cooperation than large enterprises. In terms of logistics, information management via Internet is one possibility for the performance improvement [35]. Especially SMEs are not always ready for new or internet-based technologies [36]. The internet-based 4PL approach with the provision of a common platform is of particular importance for the SME driven sector: The approach provides sufficient capabilities for a lean information flow and the connectivity of network participants [21]. The sector of agricultural bulk logistic is dominated by SMEs which at the same time act as transport services. Under the assumption of various development stages of companies in the sector, no direct correlation between company size and the diffusion of the 4PL approach may be expected. Larger companies are likely to have more experienced internet users but have already appropriate software and services available. Smaller companies may use the internet less than larger ones but would appreciate the beneficial services of a 4PL.

H2.1 There is no significant relationship between the size of the company and the diffusion of the 4PL approach in the sector of agricultural bulk logistics.

The service portfolio of a logistics service provider influences its role in the network [37] in a way that diffusion factors for a 4PL can be affected. In the SME environment of the sector the question arises: what kind of services should be offered by a

4PL? Nevertheless, it is necessary to consider what services are of particular importance. This is because they often have an own service portfolio. Overlapping and similar services influence the diffusion of the 4PL approach [17]. Network actors with similar services may recognize the bundling of services as synergies so that 4PL is an option for them. With the following hypothesis we would like to proof whether or not there is a relationship between the number of services and the diffusion of the 4PL:

H2.2 A higher number of services offered by the network participants is not related to the diffusion of the 4PL approach in the sector of agricultural bulk logistics.

4.3 Environmental context

In the literature the environmental context is described in various forms: while Tornatzky and Fleischer [22] focus on government regulations and legislation, Hart et.al. [38] take into account the influence of factors such as willingness to use of e-commerce, competitive situations and situations of trust in the market. In this context the 4PL approach can be understood as a kind of a market where customers and transport providers act as participants. For this reason, the willingness to use IT and the willingness to invest in IT are central characteristics of the actors. This is of particular importance for the diffusion of the 4PL approach. The varying willingness of actors to outsource services on the one hand, and limited trust, which is apparent in an occasional analysis of the willingness of other actors to cooperate, on the other clearly indicate a competitive situation. The readiness to use IT is a factor for the introduction of new and innovative approaches. The decision to apply IT in companies can be seen as subject to industry-specific factors such as technological change or market volatility [39]. If manual information systems such as fax and phone are preferred within the industry, the implementation of a web-based 4PL approach can be difficult. To implement this, it is necessary to develop those technologies that are capable to encourage investments in the sector [13], and that rely on the participants' willingness to invest in appropriate information and communication technologies. For this reason, it is possible that companies support the 4PL approach without the required financial resources. They may not support the recent information and communication technologies but they support the 4PL approach notwithstanding. Hence, the readiness to support the 4PL approach does not depend on the level of willingness to invest in information technologies, which is expressed in the following hypothesis:

H3.1 There is no significant correlation between the willingness to invest in information and communication technologies and the diffusion of the 4PL approach in the sector of agricultural bulk logistics.

Another aspect within the environmental context is the variation in structures of a 4PL approach, taking into account the core competence approach of resources theory [40]. While a typical SME (2PL or 3PL) classifies occasional services such as transport or storage as core competences in the sector, a 4PL acts as a strategic service provider. It generates greater planning periods whereby resources can be used efficiently to achieve increased levels of data transparency [5] [41]. Therefore, it is necessary that network actors outsource services and acquire targeted services from providers within the network. The following hypothesis should examine this context:

H3.2 A higher focus on core competencies of the network participants is related to the willingness to outsource services to the 4PL approach.

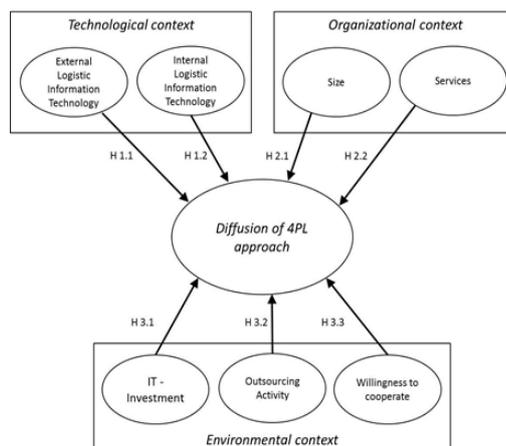
The division of labor in a network of agricultural bulk logistics as a diffusion factor of a 4PL approach requires the technical readiness of the involved actors and their willingness to cooperate. Studies have revealed that cooperation improves the innovation capability and performance of the cooperating companies [42]. However, readiness to cooperate, trust, resources and systematic management among the companies are required [43]. Willingness and confidence should be a premise for tasks and services, which could be provided to actors of the network that are more efficient. In view of actor behavior in the SME-driven sector trust and readiness to cooperate might be difficult to accomplish. This could hamper the emergence and transparency of information in the form of a 4PL platform. A transparent exchange of information is a central characteristics for the 4PL approach [21]. A 4PL provider is not a direct competitor, network actors might be more easily willing to exchange information than through a direct cooperation. Therefore, a direct relationship cannot be presumed.

H3.3 There is no significant relationship between the cooperative approach and the diffusion to support the 4PL approach.

The derived research model is displayed in Figure 1. The research objective is to identify the factors that will help to understand the diffusion factors of the 4PL approach in the sector of German agricultural bulk logistics.

The research model (Figure 1) includes seven factors, which are deduced from three different contexts of the TOE framework, and represented in form of seven hypotheses. In the technological context, the external LIT and internal LIT are central [32]. In the organizational context a distinction is made between company size and the number of services by the network participants [34]. As part of the environment context there is some differentiation between the participants' willingness to invest in IT, to outsource services to the 4PL and to cooperate [43]. In order to test the seven different hypotheses empirical data must be collected and analyzed. The methodology for the data collection is described in the following section 5.

Fig. 1. Research Model



5 Actor selection, data collection and empirical knowledge

The TOE concept including its three main elements provides a well structured conceptual framework for designing empirical research. This way the derived hypotheses can be tested, and the opportunities for the diffusion of the 4PL are indicated in detail. However, the survey population must be chosen carefully because of the high degree of specialization and the close relationship to the sector. For this reason stakeholder involvement and actor analysis is required prior to the actual survey. Data collection and enhancement for this study was accomplished in cooperation with a research partner (wholesale level) who is an actor in the field of agricultural bulk logistics. This partner identified the most relevant actors and experts in the field. As a first step semi-structured interviews were conducted. Those experts, two 2PL, two traders and two 3PL, were selected with the aim to provide various actor perspectives within this sector. The results of the expert interviews helped to identify the sample. The actors types 2PL and 3PL are most likely to make the transition to the 4PL approach. For this reason a high representation of these two actor types was envisaged. With the help of Limesurvey an online Survey was generated and provided to the selected actors. The survey design was evaluated by those experts of the sector who had worked for at least 8 years as dispatchers. Based upon the experience of these experts with actors of type 2PL and 3PL, they helped to find the appropriate terminology for the survey. The survey has the aim to detect the potential for the introduction of the 4PL approach in the sector. For this reason quantitative and qualitative questions were raised with the opportunity to comment and annotate. Two 2PL actors tested the revised draft of the survey in a pretest. This test resulted in the final version of the survey, which was sent to 146 2PL and 3PL between October 2012 and November 2012 (for the results, please, also refer to the appendix https://www.dropbox.com/s/lg14re5pmhwuyfk/WI15%20_Anhang.pdf).

6 Results

The data collected in our study were measured at different scale levels. The items in the questionnaire were scaled in a way that the analysis could be performed using non-parametric (distribution-free) tests. Given a sample size of 31 a gaussian distribution could not be assumed since companies have developed differently in terms of technology, organization and environment depending on the enterprise size. For the calculation of the difference hypothesis, the Wilcoxon-Mann-Whitney test and the Kruskal-Wallis test were used. The implementation of the function test was based upon the correlation coefficients (Spear man's rho). Mathematically, this approach does not result in deviation, since it uses the median [44]. The hypothesis tests were analyzed within groups (Kruskall-Wallis-Test) with the Mann-Whitney-U-Test and using a bivariate correlation. The groups depend on the factors turnover, employees and number of trucks of the participants. The result of the group building is the distribution of small businesses (32%) (Turnover < 0.5 Mio, Employees < 5, Trucks < 5), medium businesses (36%) (Turnover 0.5 – 2.5 Mio., Employees 6-20, Trucks 6-20)

and large companies (32%) (Turnover >2.5 Mio., > 21 Employees, Trucks > 21). All together 31 questionnaires were completed, which implies a response rate of 21.23%. Table 1 in the appendix displays the characteristics of the participants. Table 2 in the appendix shows the main characteristics of the companies of the survey.

The transport volume corresponds to approximately 12,400 transport units / company in the segment of full loads. Although the sample is comparatively small in terms of the available quantitative data, it is nonetheless a useful statistical outcome [45]. Various reports have demonstrated that feasible results can be achieved with small sample sizes such as ours (i.e. n = 20-40) (see Goodhue et al. [46]). Furthermore, it is worth mentioning that our sample represents approximately 24% of the Northern German agricultural bulk logistics sector. To classify the situation of the market the questionnaire asked for outsource activities and purchase activities of services (Appendix Fig. 1). If particular functions are outsourced, these are predominantly accounting and workshop (repairs) as well as for IT, truck and ship freight. Twenty of the companies who responded to the questionnaire would be willing to invest up to 5 % of their revenue (average 2.4%) for a possible 4PL service provider in a network. Furthermore, in our survey we asked about the services a company would desire from a 4PL. For this purpose, there was a choice of 39 different services. Figure 2 (Appendix) displays the most requested 10 services. Table 1 (Appendix Table 3) lists the evaluation results of hypotheses testing. The sample size, the correlation, the significance as well as the acceptance or rejection of the hypotheses is presented.

Table 1. Results of the hypotheses testing

Hypothesis	Sample	Testing of group differences			Testing of correlation		Perception
		Chi-square	df	asymptotic significance	Correlation	Significance	
<i>Technological context</i>							
H1.1	31	5.068	3	0.167	-0.277	0.132	Not supported
H1.2:	31	3.062	3	0.382	-0.050	0.788	Supported
<i>Organizational context</i>							
H2.1:	31	0.046	2	0.977	-0.033	0.861	Supported
H2.2:	31	0.769	3	0.857	-0.014	0.938	Supported
<i>Environmental context</i>							
H3.1	31	4.018	2	0.134	-0.302	0.098	Supported
H3.2	20	3.391	4	0.495	0.267	0.256	Not supported
H3.3	31	4.417	3	0.220	0.312	0.088	Supported

7 Hypotheses testing and Discussion

The goal of our research was a better understanding the diffusion factors of the 4PL approach in the sector of German agricultural bulk logistics. Based on the TOE framework, various factors have been worked out. The results reveal the current situation as well as a potential for further research activities. In the following paragraphs the individual factors are discussed in more detail.

7.1 Technological context

Information technology plays a significant role in the companies' success within the supply chain. An effective technological environment enables value-added services, such as transparency and tracking of products [18]. The means of IT involve logistical processes, sharing information and minimizing interfaces for the networking of companies [47]. These technologies are special for a 4PL as a possible provider for a sector to provide services for the supply chain participants. H1.1 suggests that supply chain participants are stronger linked to each other by help of external communication facilities, and they use newer technologies for information processing. Our survey demonstrates that the use of external LIT is rather low in the sector. The prevailing communication means are telephone and fax (96.7%) as well as email (87%). Information technology such as EDI, RFID and barcodes are only used occasionally. The analysis of the relationships resulted in a negative correlation (-0.277) and a significance level of 0.132, therefore hypothesis H1.1 cannot be confirmed. Little use of external LIT and the low level of awareness of the 4PL approach in the sector could be a cause for this result. Hypothesis H1.2 is confirmed with an underlying correlation -0.050 and a significance of 0.788. However, the analysis of the application of internal LIT reveals that only 30% of the respondents use ERP and other systems for internal communication and data processing. Respondents' quotes such as: "We use software to connect GPS and application systems (including route planning)" substantiate that. On the one hand, there is a possible potential of the sector, on the other hand some of the companies use their own existing internal LIT. For a diffusion of the 4PL approach the existing internal LIT has to be taken into consideration.

7.2 Organizational context

The size of a company is an important factor in the decision-making process for the introduction of innovative approaches [48]. The sector of agricultural 2PL and 3PL comprises mainly SME. When analyzing a possible introduction of a 4PL approach the size of the company is a criterion. Testing hypothesis 2.1 revealed that the size of a company does not correlate with the readiness to support the 4PL approach (-0.033). Therefore, the hypothesis H2.1 can be confirmed. Different development perspectives towards a 4PL approach could be a reason. Larger companies with lot of IT and other services may not have the need for a 4PL as they have the capability to develop those internally. Moreover, small companies might suffer from a synergy effect of an emerging 4PL within the network as they could result in a price deterioration among 2PL actors. Nevertheless, smaller companies recognize a potential for applying a 4PL, in spite of their existential fears. This was attested with statements such as "live and let live" or "fair play". The presumption of the H2.2 hypothesis was that network participants who offer a variety of services do not want to support a 4PL. A relation that confirms the hypothesis was not be indicated (correlation -0.014, significance 0.938). The negative correlation might be indicating that companies who offer many services are unwilling to support the 4PL. An average of two services per company is offered. This includes the transport of goods (90%) as well as logistical advice (3.5%)

and warehousing (2.6%). None of the respondents was offering IT services. This confirms the low implementation and use of information and communication technologies (ICT). Services predominantly consist of transport functions (90%) and a lack of services such as track and trace or dispatchers indicates a potential for a 4PL [7].

7.3 Environmental context

When introducing a 4PL, different environmental impacts have to be observed. Apart from the willingness to invest, an industry's readiness to outsource and its cooperativeness have to be examined. With regard to the willingness to invest it was not possible to determine a significant correlation between the willingness to invest in ICT and the diffusion of the 4PL approach (H3.1) (correlation -0.302, significance 0.098). Thus, the hypothesis was confirmed. However, in order to increase transportation sales actors are willing to invest in the exchange of equipment and new mobile technology. The majority of the participants acknowledged the 4PL as a potential cooperation partner for networking more than a partner for an improvement of the economic situation. Hypothesis H3.2 has to be discarded (correlation 0.267, significance 0.256). The survey demonstrated that 30% of the activities are outsourced. This relates predominantly to transport overhangs which could not be used due to capacitive restrictions. If a 4PL provides similar services, the majority of respondents would be willing to use the services. In Hypothesis H3.3 there is no significant relationship between cooperativeness and the diffusion to support the 4PL approach (correlation 0.312, significance 0.088). Although no correlation could be proven mathematically, 64% of participants would support cooperation in the wake of various functions of 4PL approaches. The possible functions of planning and control, the combination of services and the development of standards for the sector have been assessed as highly important. According to Xuefang [21] a 4PL approach requires transparency. From the perspective of the carriers stock overview are less important. Functions important for cooperation are: the introduction of new technologies, training, and consulting. The explanatory model for the diffusion of the 4PL approach in the German agricultural bulk logistics sector is depicted in Figure 4 in the appendix. In this chart all diffusion factors according to the TOE framework are quantified including the correlation and the significance.

8 Summary and Conclusions

8.1 Main Contributions

The 4PL approach is a novel concept and not yet widely applied. A central factor is the actors' acceptance of the introduction of a 4 PL approach in the considered sector. Moreover, the question arises whether there is a company with a strong market position to occupy the role of a 4PL actor. In a network structure with many small companies, different internal developments may be assumed. These are technological, organizational and environmental differences. The improvement of services and lowering of costs are in the focus of the developments. From a practical point of view one

of the main results is that the participants' expectations in a 4PL approach are the improvement of cooperation and networking rather than higher sales. 2PL and 3PL are willing to invest in an approach, where features and services are performed by a 4PL. However, this should not affect the core business (transport). This confirms the approach of asset freedom [7]. Based upon the survey there is a link between an increasing awareness and a willingness to work with a 4PL. There is undoubtedly a potential in this segment in comparison to other industries. The actors of the sector only have 1-2 core competencies (transport). A 4PL provider with a range of services could be a partner in the supply chain combining and implementing administrative activities. The analysis has shown that companies are willing to invest in new technology. Synergies for the carrier and for the 4PL are possible. From a scientific point of view, we provided a number of insights: Firstly, diffusion factors for a possible 4PL approach in German agricultural bulk logistics were detected. As a result we contribute to a better understanding of the non-critical considered 4PL approach in a continuously growing and increasingly connected working environment. The focus on the agricultural sector showed a potential for the 4PL. With the TOE framework, we analyzed the 4PL approach from various perspectives, and indicated a field of application in the logistical context.

8.2 Limitations

This study has several limitations which should be regarded in future research efforts. First, our study is based upon the sector of agricultural bulk logistics in Germany. Future research should also address the agricultural bulk logistics in other countries. Second, 2PL and 3PL participated in the survey because a 4PL is to the best of our knowledge not implemented yet. Future research should evaluate an industry where a 4PL is already successfully implemented and accepted by the supply network partners. A back casting of their relevant diffusion factors might deliver valuable insights for the agricultural bulk logistics. Third, the nature of the research and the available data result in uncertainties: a) the subjectivity of the respondents, because of their personal or company's perspectives and the different perception of the discussed TOE-factors. Moreover, the advanced average age of the respondents indicates a general reluctance to accept and apply recent ICT; b) the TOE framework has limitations in terms of its strict definitions of the contexts. Real world phenomena might have overlapping characteristics. However, the TOE framework applied to other industries provides a high degree of comparability. If future studies are carried out in an industry that specifies the 4PL approach in detail, yet available empirical methods such as questionnaires and surveys can be further developed, if resources are available.

8.3 Conclusions

Future research fields have been discovered based on the elements and features of the TOE framework. The virtue of a 4PL approach is that varieties of support services and tools can be developed which are capable of enhancing the entire process of a transport job in the sector. In future the use of techniques in route planning for the

sector as a service should be explored by the 4PL. This way early indicators for the operational and the strategic planning of the transport process can be incorporated. In respect of the retentiveness of several actors and the growing competition in the logistics business indicators need to be developed that show the performance of a 4PL. In this context, the 2PL and 3PL are given transparent information about their own functions but also in cooperation with a possible 4PL. Only by a high degree of cooperation the 4PL can implement the desired functions in the network.

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