Status quo und Entwicklungsperspektiven des Fourth Party Logistics Provider (4PL)-Ansatzes

– Eine Mixed-Methods-Untersuchung

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Vorwort

Die vorliegende Arbeit wurde im Rahmen einer kumulativen Dissertation am Fachgebiet „Unternehmensrechnung und Wirtschaftsinformatik“ des „Instituts für Informationsmanagement und Unternehmensführung“ der Universität Osnabrück von Mai 2012 bis Februar 2016 angefertigt. Die Betreuung der Arbeit erfolgte durch Prof. Dr. Frank Teuteberg. Die Übernahme des Koreferats erfolgte durch Prof. Dr. Piet Hausberg.

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Des Weiteren möchte ich mich bei Prof. Dr. Ingmar Ickerott, Benjamin Bütfering und Axel Jacob bedanken, welche mir an der Hochschule Osnabrück ein konstruktives und angenehmes Promotionsumfeld gegeben haben. In diesem Zusammenhang sind auch Dr. Jörg Krywkow und Marita Imhorst zu nennen, welche mich vor allem bei englischsprachigen Beiträgen mit vollem und bei Weitem nicht selbstverständlichem Engagement unterstützt haben.

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Herzlake, 18. März 2016 Dipl.-Wirt.-Ing. (FH) Jens Mehmann

Hinweise zum Aufbau des Dokuments

Die vorliegende Dissertation gliedert sich in zwei Teile: Teil A dient einem einleitenden Gesamtzusammenhang der enthaltenen Beiträge. Dies beinhaltet die Motivation, die Zielsetzung und den Aufbau der Arbeit. Neben einer Diskussion der angewandten Theorien und Methoden werden die Ergebnisse der jeweiligen Beiträge diskutiert. Im Anschluss werden die wesentlichen Implikationen für Wissenschaft und Praxis, Limitationen sowie Ansatzpunkte für zukünftige Forschung zusammengefasst. Teil A stellt folglich ein eigenständiges Dokument dar, welches die Verzeichnisse vorangestellt und ein nachgestelltes Literaturverzeichnis umfasst.

Teil B enthält die Forschungsbeiträge in der Reihenfolge des in Teil A vorgestellten Ordnungsrahmens. Die Formatierungen und Zitationsstile der Beiträge entsprechen jeweils den Vorgaben der Publikationsorgane, in denen die Beiträge veröffentlicht oder eingereicht wurden.

Hinweis zur Verwendung von geschlechtsneutralen Formulierungen

Die vorliegende Arbeit orientiert sich an den Empfehlungen der Redaktion des Dudens zur sprachlichen Gleichstellung von Frauen und Männern (Eickhoff 1999). Zur Verbesserung der Lesbarkeit und der Verständlichkeit wird auf die Verwendung von Doppelnennungen und Kurzformen verzichtet. Zur Gewährleistung der sprachlichen Gleichbehandlung von Frauen und Männern wird, sofern möglich, auf Partizipien oder Sachbezeichnungen anstelle von Personenbezeichnungen zurückgegriffen. Stellvertretend für beide Geschlechter und ohne Einschränkung der sprachlichen Gleichbehandlung von Frauen und Männern erfolgt die Verwendung der männlichen Form, sofern dies nach Ermessen des Autors der sprachlichen Ästhetik dient.

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Abkürzungsverzeichnis

4PL	Fourth Party Logistics Provider
AIsel	AIS Electronic Library
AQ	Annahmequote
CMM	Capability Maturity Model
FF	Forschungsfrage
IKT	Informations- und Kommunikationstechnologien
IS	Informationssystem
IT	Informationstechnologie
QDA	Qualitative Datenanalyse
SC	Supply Chain
SPICE	Software Process Improvement and Capability Determination
SJR	SCImago Journal Rank
TAMS	Transportauftragsmanagementsystem
TMS	Transportmanagementsystem
TOE	Technology-Organization-Environment
VHB	Verband der Hochschullehrer für Betriebswirtschaft e.V.
WKWI	Wissenschaftliche Kommission für Wirtschaftsinformatik

1. Einleitung

1.1. Motivation

Logistik ist für die Wirtschaftspraxis von zunehmender Bedeutung, wobei sich die Begriffsabgrenzung schwierig gestaltet (Delfmann et al. 2010). Bedingt ist dies durch die Vielfalt von logistischen Themenstellungen sowie die zukünftigen Herausforderungen der Logistik. Folgendes Grundverständnis wird in dieser Arbeit als Ausgangspunkt angeführt (Delfmann et al. 2010, S. 2).

„Logistik ist eine anwendungsorientierte Wissenschaftsdisziplin. Sie analysiert und modelliert arbeitsteilige Wirtschaftssysteme als Flüsse von Objekten (v.a. Güter und Personen) in Netzwerken durch Zeit und Raum und liefert Handlungsempfehlungen zu ihrer Gestaltung und Implementierung. Die primären wissenschaftlichen Fragestellungen der Logistik beziehen sich somit auf die Konfiguration, Organisation, Steuerung oder Regelung dieser Netzwerke und Flüsse mit dem Anspruch, dadurch Fortschritte in der ausgewogenen Erfüllung ökonomischer, ökologischer und sozialer Zielsetzungen zu ermöglichen.“

Die vorrangigen wissenschaftlichen Fragestellungen der Logistik, d.h. die Konfiguration, Organisation, Steuerung und/oder Regelung von Netzwerken und Flüssen, werden dabei durch Zukunftstrends beeinflusst. Zukunftstrends, welche die Logistik beeinflussen, beschreiben eine nachhaltige Ausrichtung, den technologischen Wandel, eine verstärkte Kooperation sowie die Veränderung von Geschäftsmodellen auf Basis der Zukunftstrends (Müller 2010). Eine nachhaltige Ausrichtung der Logistik beschreibt vor allem eine Reduzierung von CO_2-Emissionen, während der technologische Wandel durch die Einführung von neuen Informations- und Kommunikationstechnologien (IKT) sowie durch das Internet der Dinge geprägt ist (Xu 2011). Eine verstärkte Kooperation sowie die Veränderung der Geschäftsmodelle gehen mit den Entwicklungen einher. Als einen Entwicklungsschritt, welcher die Zukunftstrends betrifft, kann der Fourth Party Logistics Provider (4PL)-Ansatz angeführt werden.

Erste 4PL-Ansätze wurden durch Accenture im Jahr 1996 erwähnt (Kunkel et al. 2012) und durch Jensen (2010) und Olander und Norrman (2012) wie folgt beschrieben:

“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.”

Eine allgemeingültige Definition erfolgte durch Win (2008, S. 677) unter Berücksichtigung des Kriteriums der Asset-Freiheit und der operativen Perspektive.

“A 4PL is an independent, singularly accountable, non asset based integrator of a clients supply and demand chains. The 4PL’s role is to implement and manage a value creating business solution through control of time and place utilities and influence on form and possession utilities within the client organisation. Performance and success of the 4PL’s intervention is measured as a function of value creation within the client organization.”

Eine Abwandlung und Modifikation des Begriffs wurde von Mukhopadhyay und Setaputra (2006) angeführt, die den 4PL als einen strategischen Partner und einen Supply Chain (SC)-Integrator definieren, welcher die eigenen Ressourcen, Fähigkeiten und Technologien der eigenen Organisation und der komplementären Dienstleister bündelt, um eine umfassende SC-Lösung zu bieten.

In allen Definitionen wird der 4PL als Teil eines Netzwerkes beschrieben, wodurch die logistische Zielsetzung des Netzwerkes verbessert werden soll. Zur Aufgabenerfüllung soll der 4PL als ein SC-Visionär, SC-Planer und SC-Optimierer, SC-Reengineer, Projektmanager, Service-, System- und Informationsintegrator fungieren (Gattorna et al. 2004). Aufgrund der Aufgabenstellung des 4PL sind Parallelen zu den Trends der Logistik vorhanden. Dies beinhaltet eine Betrachtung der Nachhaltigkeit des 4PL-Ansatzes sowie die Betrachtung der technologischen und der kooperativen bzw. organisatorischen Anforderungen an den 4PL. Unter Berücksichtigung der Veränderung der Geschäftsmodelle kann der Ansatz des Crowd Logistics als Weiterentwicklung des 4PL-Ansatzes verstanden werden. Crowd Logistics basiert auf der Idee einer Sharing Economy (Bubner et al. 2014) und wurde aus den Entwicklungen des Crowdsourcings (Leimeister 2012; Howe 2006; Blohm et al. 2014) und des Crowdfunding (Kuti und Madarász 2014) abgeleitet. Crowd Logistics-Dienstleister wirken als Mediator, welche mittels einer Plattform potenzielle Dienstleister und Nachfrager einer logistischen Dienstleitung zusammenbringen. Da der Crowd Logistics-Dienstleister ähnlich wie ein 4PL nicht als Logistikdienstleister zur Ausführung des Transports oder des Transfers fungiert und somit über keinerlei Transportressourcen, d.h. Assets, verfügt, lassen sich Ähnlichkeiten erkennen.

Für beide Ansätze ist eine gemeinsame Informationsplattform entscheidend, welche den Informationsfluss unter den Netzwerkakteuren zur Erledigung der Aufgaben sicherstellt (Fu und Zhang 2011). Ebenso gibt es gemeinschaftliche Herausforderungen zur Umsetzung der eigenen Kompetenzen, der Anforderungen der Kunden und der Transportdienstleister hinsichtlich gewünschter Services, der technologischen Anbindung sowie der Motivation zur Zusammenarbeit im Netzwerk. Für beide Ansätze sind bisher lediglich vereinzelt quantitative und qualitative Forschungsarbeiten dokumentiert.

1.2. Zielsetzung der Arbeit

Die vorliegende Arbeit zur Logistik, verstanden als eine anwendungsorientierte Wissenschaftsdisziplin, verfolgt eine wissenschaftliche sowie praxisorientierte Zielsetzung. Als übergeordnetes Ziel ist die Feststellung des Status quo und der Entwicklungsperspektiven des 4PL-Ansatzes anzuführen. Durch die Verwendung von etablierten Forschungsmethoden wird die wissenschaftliche Rigorosität sichergestellt. Zur Erfüllung der praxisorientierten Zielsetzung wurden Fallstudien und Experteninterviews im Rahmen des Forschungsprozesses verwendet, um zum einen das Wissen aus der Praxis einzubinden und zum anderen eine Relevanz für die Praxis sicherzustellen. Für eine konsistente Praxis-Orientierung wurde die Branche der landwirtschaftlichen Schüttgutlogistik als exemplarisches Anwendungsfeld zur Untersuchung des 4PL-Ansatzes gewählt.

Die Schüttgutlogistik beschreibt das Bindeglied zwischen der Landwirtschaft, dem Handel und der Ernährungsindustrie und somit einen Teil eines Netzwerkes. Das Transportvolumen betrug im Jahr 2010 ca. 3,5 Mrd. t, wobei 76 % (2,7 Mrd. t) auf den Straßenverkehr entfielen (Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz 2010). In Anlehnung an die Trends der Logistik konnten gefestigte und klassische Strukturen vorgefunden werden, weshalb der 4PL-Ansatz als wahre Innovation untersucht werden konnte. Dies ist dadurch begründet, dass die Branche über genossenschaftliche Strukturen verfügt und neue technologische Trends eher zurückhaltend verfolgt. Dennoch sind die logistischen Herausforderungen wie die Reduzierung von Leerkilometern, die Optimierung der Frachtraumkapazitäten sowie die CO_2-Reduzierung laut den befragten Akteuren der Branche von hoher Bedeutung (Müller 2010).

Im Rahmen dieser Arbeit wurden daher Methoden, Modelle, Applikationen und Vorgehensweisen entwickelt, welche zur Beantwortung der folgenden übergeordneten Forschungsfragen herangezogen werden:

1. Was ist der Status quo des 4PL-Ansatzes sowie das Anforderungsprofil der landwirtschaftlichen Schüttgutlogistik an den 4PL?
2. Was sind die wichtigsten Diffusionsfaktoren des 4PL-Ansatzes in der deutschen landwirtschaftlichen Schüttgutlogistik?
3. Was sind die Potenziale innerhalb einer Branche durch Einführung eines 4PL?
4. Wie können eine Implementierung sowie die organisatorische Einordnung des 4PL-Ansatzes für eine Branche erfolgen?
5. Welche Trends der Zukunft zeigen Parallelen zum 4PL-Ansatz auf?

Die vorliegende kumulative Dissertation zeigt Potenziale für die Branche auf und trägt zum Verständnis einer zukünftigen Entwicklung des 4PL-Ansatzes bei. Zur Zielerreichung wird ein Mixed-Methods-Ansatz verfolgt. Dies bedeutet, dass unterschiedliche quantitative und qualitative Forschungsmethoden auf die genannten Fragestellungen angewendet werden, was einer Methodentriangulation auf die Problemstellung entspricht (Myers 2013).

1.3. Aufbau der Arbeit

Die vorliegende Arbeit unterteilt sich in fünf Kapitel. Während Kapitel 1 die kumulative Dissertation motiviert, beschreibt Kapitel 2 das Forschungsdesign mit der Auswahl der in die kumulative Dissertation eingegangenen Beiträge und die Darstellung eines Ordnungsrahmens. Der Ordnungsrahmen beschreibt den inhaltlichen Zusammenhang der Beiträge sowie die Darstellung der angewendeten Forschungsmethoden. Kapitel 3 erläutert die wesentlichen Erkenntnisse der Beiträge. Kapitel 4 stellt die Implikationen für die Praxis und die Wissenschaft dar. Außerdem werden Limitationen aufgezeigt und ein zukünftiger Forschungsbedarf abgeleitet. Teil A der Dissertation endet mit einem Fazit in Kapitel 5.

2. Forschungsdesign

2.1. Auswahl der Beiträge und Forschungsleistungen

Im Folgenden sind die für die vorliegende kumulative Dissertation ausgewählten Beiträge aufgeführt. Weitere Forschungsbeiträge wurden nicht aufgenommen, da sie entweder noch ein Reviewverfahren durchlaufen oder nicht im Fokus der dieser Arbeit zugrunde liegenden Forschungsfrage liegen. Insgesamt sind 14 Beiträge im Rahmen des Promotionszeitraums entstanden. Tabelle 1 beschreibt die ausgewählten Forschungsbeiträge. Jeder Beitrag ist durch den Titel, die Autoren, das Publikationsorgan sowie die Einordnung in ein Ranking beschrieben. Sofern eine konkrete Einordnung in ein Ranking möglich war, erfolgte diese. Auf folgende Rankings wurde dabei Bezug genommen:

- VHB-JOURQUAL3 des Verbands der Hochschullehrer für Betriebswirtschaft (VHB) (Verband der Hochschullehrer für Betriebswirtschaft e.V. 2011)
- WI-Orientierungsliste der Wissenschaftlichen Kommission Wirtschaftsinformatik (WKWI) (Heinzl et al. 2008)
- SCImago Journal Rank (SJR) indicator
- Annahmequote (AQ) der aufgeführten Konferenzen

Aufgrund der interdisziplinären Bearbeitung des Promotionsthemas konnte in landwirtschaftlichen, logistischen und wirtschaftsinformatischen Publikationsorganen publiziert werden. Während im Rahmen der Wirtschaftsinformatik eine Einordnung der Publikationsorgane in ein Ranking möglich war, konnten die eher landwirtschaftlich oder logistisch orientierten Publikationsorgane weniger einem Ranking zugeordnet werden.

Nr.	Titel	Autoren	Publikationsorgan	Ranking
1	Eine 4PL-Plattform zur Unterstützung der Nacherntelogistik − Eine Anforderungsanalyse	Mehmann, J.; Teuteberg, F.; Freye, D.	Clasen, M.; Kersebaum, K. C.; Meyer-Aurich, A. ; Theuvsen, B. (Hrsg.): Referate der 33. GIL-Jahrestagung in Potsdam 2013 - Massendatenmanagement in der Agrar- und Ernährungswirtschaft, Lecture Notes in Informatics, Potsdam, 2013, S. 199–202.	VHB: C
2	Adoption of Fourth Party Logistics in the Sector of German Agricultural Bulk Logistics - A Technology-Organization-Environment Framework Approach	Mehmann, J.,	Thomas. O., Teuteberg, F. (Hrsg.): Smart Enterprise Engineering; Proceedings der 12. Internationalen Tagung Wirtschaftsinformatik (WI 2015), Osnabrück, 2015, S.1498–1512	VHB D WKWI: A AQ 30 %
3	A Conceptual Framework of a Decision Support System for Operational Dispatching of Agricultural Bulk Goods – An Agent-Based Approach	Mehmann, J.; Teuteberg, F.	Müller, J.P. ; Weyrich, M.; Bazzan, A.L.C. (Eds.): MATES 2014, LNAI 8732, Springer, S. 121–137, 2014.	VHB: C WKWI: C AQ 50–55 %
4	A Fourth Party Logistics Provider within an Inter-Organizational Network: An explorative Study with the Example of the Agricultural Bulk Logistics Industry.	Mehmann, J., Teuteberg, F.	Proceedings of the 21th Americas Conference on Information Systems (AMCIS 2015), Puerto Rico, USA, 2015	VHB: D WKWI: B AQ 67%
5	Understanding the 4PL Approach within an Agricultural Supply Chain Using Matrix Model and Cross-Case Analysis.	Mehmann, J., Teuteberg, F.	International Journal of Logistics: Research and Applications (2015), S. 1–18.	VHB: C 24th out of 67 in the category of "Management Information Systems" SCImago Journal Rank (SJR Q2 – 0,469)
6	Process reengineering by using the 4PL approach – a case study on transportation processing in the agricultural bulk logistics sector	Mehmann, J., Teuteberg, F.	Business Process Management Journal (BPMJ)	VHB: C WKWI: B 51th out of 236 in the category of "Business Management and Accounting" SCImago Journal Rank (SJR Q1 – 0,585)
7	The Fourth-Party Logistics Service Provider Approach to support Sustainable Development Goals in Transportation − A Case Study of the German Agricultural Bulk Logistics Sector.	Mehmann, J., Teuteberg, F.	Journal of Cleaner Production	VHB: B 16th out of 253 in the category of "Environmental Science" SCImago Journal Rank (SJR Q1 – 1,588)
8	Crowd Logistics − A Literature Review and Maturity Model	Mehmann, J., Frehe, V., Teuteberg, F.	Kersten, W.; Blecker, T.; Ringle, CM. (Eds.): Innovations and Strategies for Logistics and Supply Chains; Proceedings of the 10th Hamburg International Conference of Logistics, Hamburg, 2015. S. 117–145.	

Tabelle 1: Übersicht der in die kumulative Dissertation aufgenommenen Beiträge

Die Autorenreihenfolge beschreibt den Beitrag der Autoren zu den Forschungsarbeiten. Der Verfasser der vorliegenden kumulativen Dissertation leistete einen wesentlichen Beitrag zu allen Arbeiten. Prof. Dr. Frank Teuteberg begleitete alle Publikationen durch eine kritische Reflexion sowie eine inhaltliche und methodische Ausrichtung. Johann Schütz, Kenneth Schwarz und Dennis Schünke unterstützten den Verfasser durch Vorarbeiten wie z. B. Literaturbeschaffung sowie durch Unterstützung bei der Vorbereitung von Interviews bzw. Umfragen. Zudem waren Marita Imhorst und Dr. Jörg Krywkow am Lektorat der englischsprachigen Beiträge beteiligt.

Beitrag 1 beschreibt ein systematisches Literaturreview und Experteninterview zur Erforschung des Status quo sowie der Anforderungen an einen 4PL und dessen Infrastruktur der Informationstechnologie (IT) im Kontext der Nacherntelogistik, welche Schüttgut transportiert. Auf Basis der ermittelten Anforderungen wurde eine 4PL-Plattform konzeptioniert und der Forschungsbedarf aufzeigt. Prof. Dr. Diethardt Freye wurde als Koautor aufgenommen.

Beitrag 2 gibt eine explorative Studie unter Berücksichtigung des Technology-Organization-Environment (TOE) Frameworks zur Eruierung von Diffusionsfaktoren und zur Annahme sowie zukünftigen Ausrichtung eines 4PL-Ansatzes im Untersuchungskontext wieder.

Beitrag 3 stellt ein konzeptionelles Framework eines Entscheidungsunterstützungssystems zur operativen Transportauftragsdisposition und Abwicklung auf Basis eines agentenbasierten Ansatzes dar. Die operative Transportauftragsdisposition wird als Basismerkmal des 4PL-Ansatzes im betrachteten Anwendungsfall identifiziert.

Beitrag 4 beschreibt eine explorative Studie zur Integration und Entwicklung eines 4PL-Ansatzes im interorganisationalen Netzwerk der landwirtschaftlichen Schüttgutlogistik.

Beitrag 5 veranschaulicht den 4PL-Ansatz in der landwirtschaftlichen SC unter Anwendung eines Matrix Models und einer Cross-Case Analyse. Mittels eines systematischen Literaturreviews unter Berücksichtigung des Work System Frameworks wurde eine Desktop Study durchgeführt.

Beitrag 6 erläutert einen Ansatz zum Prozessreengineering unter Berücksichtigung des 4PL-Ansatzes als Vorbereitung einer potenziellen Einführung in die Branche.

Beitrag 7 untersucht die Auswirkungen des 4PL-Ansatzes unter Berücksichtigung der Nachhaltigkeit in Folge eines simulationsbasierten Ansatzes in der landwirtschaftlichen Schüttgutlogistik.

Beitrag 8 gibt ein Literaturreview zum Crowd Logistics-Ansatz sowie die Entwicklung eines Reifegradmodells wieder. Volker Frehe als Koautor führte die qualitative Datenanalyse und Evaluation durch, wohingegen sich der Verfasser der Dissertation mit der Auswahl und Analyse der Unternehmen befasste. Die Entwicklung des Reifegradmodells erfolgte von beiden Autoren zu gleichen Anteilen.

2.2. Ordnungsrahmen der Beiträge

Der 4PL-Ansatz stellt für die landwirtschaftliche Schüttgutlogistik ein logistisches Konzept zur Abwicklung der Logistik dar. Auf Basis der in der Einleitung erläuterten Herausforderungen der Branche war es notwendig, das Themengebiet vielschichtig zu analysieren und aus unterschiedlichen Blickwinkeln zu betrachten. Teilbereiche eines möglichen 4PL-Ansatzes für die Branche wurden daher besonders hervorgehoben, wobei für eingehende Darstellungen auf die einzelnen Beiträge verwiesen wird. Dennoch beschreibt der Ordnungsrahmen (Abbildung 1) den Gesamtzusammenhang der vorliegenden kumulativen Dissertation auf Basis der zugrunde liegenden Beiträge.

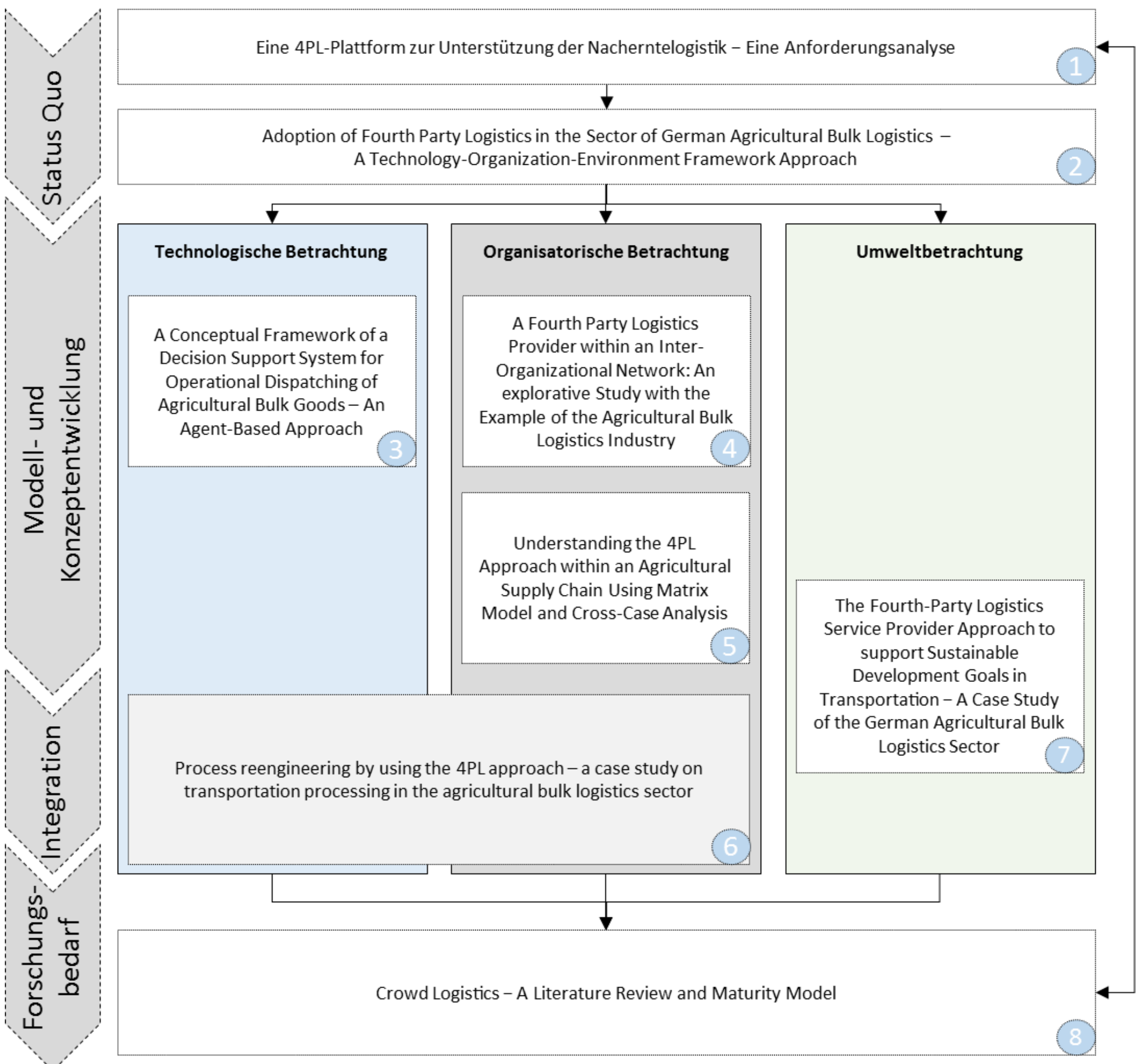

Abbildung 1: Ordnungsrahmen der Dissertation

Beitrag 1 (Mehmann et al. 2013) und Beitrag 2 (Mehmann 2015) definieren die Ausgangssituation der Forschung zum einen durch eine Analyse des wissenschaftlichen Status quo mittels eines Literaturreviews. Zum anderen definieren sie die Ausgangssituation der Forschung durch eine Analyse des praxisorientierten Status quo, indem mit Hilfe des TOE-Frameworks die Ausgangssituation der betrachteten Branche bestimmt werden konnte. In Anlehnung an das TOE-Framework (Tornatzky und Fleischer 1990) erfolgte eine Untergliederung der vielschichtigen Forschungsfragen in eine technologische Betrachtung, eine organisatorische Betrachtung sowie eine Betrachtung der Umwelt des 4PL-Ansatzes. Dies war notwendig, um die im 4PL-Ansatz vorhandenen Schnittstellen und Fragestellungen systematisch bearbeiten zu können. In Anlehnung an die Untergliederung konnten Modelle, Konzepte und Artefakte entwickelt werden, welche durch Beitrag 3 (Mehmann und Teuteberg 2014), Beitrag 4 (Mehmann und Teuteberg 2015a) und Beitrag 5 (Mehmann und Teuteberg 2015b) beschrieben sind. Zur anwendungsorientierten Forschung erfolgte durch Beitrag 6 (Mehmann und Teuteberg 2016) eine Simulation der Auswirkungen des 4PL-Ansatzes, welche die bereits erlangten Erkenntnisse sowie potenziellen Anwendererkenntnisse berücksichtigt. Die gewonnenen Erkenntnisse ermöglichten die Betrachtung der Umwelt in Form einer Untersuchung der Nachhaltigkeit des 4PL-Ansatzes für die Branche in Beitrag 7 (Mehmann und Teuteberg). Mit dem Ziel einer Implementierung des 4PL-Ansatzes in der betrachteten Branche und der Bewältigung vorhandener Herausforderung wie z. B. der Netzwerkbildung und Finanzierung wurden aktuelle Trends der Logistik analysiert und Schnittmengen untersucht. Im Zuge dessen konnten erste Forschungsarbeiten im Bereich Crowd Logistics identifiziert werden, welche eine Vielzahl von Schnittmengen zum 4PL-Ansatz haben. Beitrag 8 (Mehmann et al. 2015) befasst sich daher mit der Bestimmung eines Status quo sowie ein aus der Praxis eruiertes Reifegradmodell, was eine Reflexion auf die Ausgangssituation ermöglicht.

2.3. Spektrum angewandter Theorien und Forschungsmethoden

Zur Sicherstellung einer angemessenen Diskussion der Ergebnisse orientieren sich die Beiträge an verschiedenen Theorien, Frameworks und Ansätzen. Zudem werden unterschiedliche Theorien in den entwickelten Beiträgen berücksichtigt. Für eine ausführliche Betrachtung der Theorien, Frameworks und Ansätze wird auf die einzelnen Beiträge der Dissertation verwiesen. Tabelle 2 gibt einen Überblick über die berücksichtigten Theorien im Rahmen der Beiträge.

Theorien, Frameworks und Ansätze	**Beiträge**								**Referenzen**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Technology-Organization-Environment Framework		X							(Tornatzky und Fleischer 1990)
Transaction Costs Theory				X					(Powell 2003; Picot et al. 1996)
Grounded Theory				X					(Glaser und Strauss 2009)
Work System Theory					X				(Alter 2013; Alter 2006)
Contingency Theory					X				(Tsai et al. 2013)
Resource Advantage Theory					X				(Davis und Golicic 2010)
Triple Bottom Line Approach							X		(Elkington 1997)
Technology Acceptance Model								X	(Venkatesh und Bala 2008)

Tabelle 2: Berücksichtigte Theorien, Frameworks und Ansätze

Um eine nachvollziehbare Forschungsarbeit zu gewährleisten, basiert die vorliegende Dissertation auf unterschiedlichen Forschungsmethoden. Auf Basis des Mixed-Methods-Ansatzes werden quantitative und qualitative Forschungsmethoden zur Beantwortung der Forschungsfragen gewählt (Recker 2013; Venkatesh et al. 2013). Der Mixed-Methods-Ansatz stellt keine eigenständige Methode dar. Vielmehr integriert der Ansatz qualitative sowie quantitative Aspekte und Methoden im Rahmen der Methodentriangulation (Myers 2013). Zur Einbindung in die Praxis und Darstellung eines anwendungsorientierten Bezugs wurde qualitative Forschung eingesetzt. Mittels eines konstruktionsorientierten Forschungsansatzes konnte der Bezug zur Wirtschaftsinformatik hergestellt werden, da unterschiedliche Artefakte untersucht werden konnten. In Orientierung an Wilde und Hess (2007) ermöglicht die Wirtschaftsinformatik die Konstruktion und Evaluierung von Artefakten unter betriebswirtschaftlichen Gesichtspunkten. Ein Artefakt kann dabei ein Informationssystem darstellen, welches mittels Forschungsmethoden der Fallstudienforschung, der Modellierung, der Simulation sowie der prototypischen Implementierung untersucht werden kann

(Österle et al. 2010). Zum Ergebnis einer konstruktionsorientierten Forschung zählen Gestaltungsansätze und Innovationen durch die Beschreibung von Modellen, Referenzmodellen, Prototypen, Leitfäden und Geschäftsmodellen (Österle et al. 2010). Die vorliegende Arbeit adressiert derartige Ergebnisse im Rahmen des 4PL-Ansatzes.

Tabelle 3 führt die in dieser Arbeit verwendeten Forschungsmethoden auf, wobei für ausführliche Darstellungen auf die einzelnen Beiträge verwiesen wird. Grundlegende Erläuterungen zu den jeweiligen Forschungsmethoden sind in den Referenzen aufgeführt.

Angewandte Forschungsmethoden	**Beiträge**								**Referenzen**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Umfrage		X	X						(Raab-Steiner und Benesch 2010; Recker 2013; Myers 2013)
Simulation						X	X		(Wilde und Hess 2007; Myers 2013)
Fallstudienforschung				X	X	X		X	(Yin 2013; Myers 2013; Benbasat et al. 1987; Walsham 1995; Eisenhardt 1989; Ellram 1996)
Design Science (Prototyperstellung, Modellierung)	X		X					X	(Walsham 1995; Van der Aalst et al. 2003; Hevner et al. 2004)
Semi-strukturierte Experteninterviews	X		X	X			X	X	(Wilde und Hess 2007; Myers 2013; Walsham 1995)
Systematisches Literatur Review	X	X	X		X	X	X	X	(Webster und Watson 2002; Brocke et al. 2009; Fettke 2006; Recker 2013)
Weitere qualitative Analysen (z. B. Clusteranalyse)								X	(Backhaus et al. 2013; Myers 2013; Recker 2013; Wilde und Hess 2007)

Tabelle 3: Übersicht der verwendeten Forschungsmethoden

3. Zusammenfassung der Forschungsbeiträge

3.1. Anforderungsanalyse zum 4PL-Ansatz

Der Konferenzbeitrag „Eine 4PL-Plattform zur Unterstützung der Nacherntelogistik − Eine Anforderungsanalyse“ beschreibt die Darstellung der Anforderungen, welche wissenschaftlich aus der Literatur sowie aus der Praxis an den 4PL-Ansatz gestellt werden. Ziel war es, das Geschäftsmodell eines 4PL unter Berücksichtigung der spezifischen Anforderungen der Landwirtschaft in der Nacherntelogistik zu untersuchen. Anhand der Untersuchung konnte eine N-Tier Architektur einer 4PL-Plattform konzipiert werden, auf dessen Grundlage der zukünftige Forschungsbedarf beschrieben werden konnte.

Im ersten Schritt wurde hierzu ein systematisches Literaturreview durchgeführt, welches die Literatur in Fachzeitschriften, Büchern und Konferenzbeiträgen berücksichtigte. Zum einen wurde dadurch der Stand des Wissens ermittelt. Zum anderen konnten zukünftige Forschungsfragen aufgearbeitet werden (Fettke 2006). Zur Abgrenzung des Forschungsgebietes war eine standardisierte Analysestruktur zur Beurteilung der einzelnen Publikationen notwendig. Tabelle 4 zeigt den analytischen Rahmen.

Schritte	**Forschungsfrage**
1.Motivation (Warum?)	Warum ist der 4PL-Ansatz für Praxis und Wissenschaft von hoher Relevanz?
2.Methoden (Welche?)	Welche Forschungsmethoden werden im Rahmen des 4PL-Ansatzes eingesetzt?
3.Analyse (Was?)	Was sind die aktuellen Forschungsfragen und Services im Umfeld des 4PL?
4.Konzeption	Welche Anforderungen und Gestaltungsvorschläge haben Praxis und Wissenschaft zur Umsetzung des 4PL?
5.Implementierung und Validierung	Wie kann eine mögliche 4 PL Architektur umgesetzt und validiert werden?

Tabelle 4: Analysestruktur des Forschungsgebiets (Mehmann et al. 2013)

Im ersten Schritt wurde der 4PL-Ansatz für Praxis und Wissenschaft im Hinblick auf dessen Relevanz untersucht. Danach folgte im zweiten Schritt die Betrachtung der Forschungsmethoden, die in den analysierten Publikationen eingesetzt wurden. Diese Analyse verdeutlicht den bisherigen methodischen Ansatz der Wissenschaft im Kontext. Weiterführend wurden im dritten Schritt offene Forschungsfragen und Services eines 4PL identifiziert und definierten Kategorien zugeordnet. Diese umfassende Vorgehensweise und Analyse der Funktionen eines 4PL ermöglichten die Vorbereitung und Durchführung von Experteninterviews. Die Erkenntnisse aus dem Literaturreview und den Experteninterviews bildeten die Grundlage für die Konzeption einer 4PL-N-Tier-Architektur.

Schritt 1 orientierte sich zur systematischen Auswahl der wissenschaftlichen Literatur am Forschungsprozess von Brocke et al. (2009) sowie Webster und Watson (2002). Dieser unterteilt sich in Definition des

Forschungsbereichs, Konzeptualisierung, Literatursuche, -auswahl und -analyse sowie Implikationen. Die Definition und Abgrenzung des Forschungsbereichs umfasste die IT-Infrastruktur sowohl entlang der SC als auch jene, welche zur Abbildung der Services im Kontext des 4PL notwendig ist. Zur Konzeptualisierung wurden das Konzept des 4PL sowie die zu verwendende Erläuterung der IT-Infrastruktur erläutert.

Das Literaturreview bildete eine definierte Datengrundlage, wodurch die relevantesten Beiträge in einem bestimmten Zeitfenster systematisch untersucht wurden, um eine Analysierbarkeit zu gewährleisten. Im Rahmen der Vorwärtssuche wurde die Literatur im Zeitraum von 2000–2011 berücksichtigt, um den Stand der Forschung zu erfassen. Die Datengrundlage bildeten A, B und C gerankte Zeitschriften des Zeitschriftenrankings des Verbands der Hochschullehrer für Betriebswirtschaft e.V. (VHB) aus den Teilrankings der Logistik, der Wirtschaftsinformatik und des Informationsmanagements. Anhand definierter Schlagwörter (4PL, Transportation Management, IT-Infrastructure, Fourth Party, Transportmanagementsystem (TMS), Outsourcing, Lead Logistics Provider, Transportation Management System, 3PL) erfolgte die Durchführung der Recherche. Des Weiteren wurde die WI-Journalliste 2008 (Heinzl et al. 2008) beachtet (erarbeitet durch die Wissenschaftliche Kommission für Wirtschaftsinformatik (WKWI)). Ebenso wurden Beiträge des Anwendungsbereichs der Agrarlogistik zur Praxisorientierung mittels der wissenschaftlichen Datenbank AgEcon SEARCH beachtet. Zur weiteren Berücksichtigung der vorhandenen Literatur wurden die Datenbanken EBSCOhost (Business Source Premier Database), ScienceDirect, AISeL (AIS Electronic Library), ACM Digital Library und IEEE Xplore Digital Library mit den Schlagwörtern durchsucht. Somit wurden auch Konferenzbeiträge berücksichtigt. Insgesamt konnten 54 Artikel für den Untersuchungsbereich identifiziert werden. Mittels einer Rückwärtssuche konnten für die Analyse insgesamt 74 Artikel identifiziert werden.

Die Literaturanalyse erfolgte in Anlehnung an die PEST (STEP)-Analyse, wodurch die Beiträge definierten Kriterien zugeordnet wurden. Dieses waren politische (political change), ökonomische (economical), soziokulturelle (sociological) und technologische (technological) Kriterien. Mittels der PEST-Analyse konnten Änderungen und Entwicklungen zur Thematik aufgezeigt werden.

Zur Implikation wurden Experteninterviews auf Basis der Literaturanalyse vorbereitet und durchgeführt. Eine Auswertung der Interviews erfolgte mit Hilfe der Software MAXQDA, um Services, Begriffe und Anforderungen an und für den 4PL-Ansatz zu erarbeiten bzw. gewonnene Erkenntnisse aus dem Literaturreview zu bestätigen oder zu erweitern. Auf Grundlage der Erkenntnisse des Reviews und der Interviews wurde die in Abbildung 2 dargestellte 4PL-Plattform als N-Tier-Schichtenmodell konzeptioniert. Die N-Tier-Architektur zeigt Funktionen und Ausprägungen eines 4PL mit dem Verweis (Ziffern in Klammern) auf die im Rahmen des Literaturreviews analysierten Beiträge bzw. auf die Referenzen der Experten. Die Kürzel S, H und F beschreiben die jeweilige Bestätigung seitens der Spediteure (S1, S2), Händler (H1, H2) und Frachtführer (F1, F2). Die Funktionen eines 4PL-Ansatzes konnten in allgemeine Funktionen wie

SC Management, After Sales Service und Value Added Services, Beratungsdienstleistungen, Netzwerkdesign und -entwicklung sowie in Technologie-Support unterteilt werden.

Die N-Tier-Architektur wurde in Präsentationsschicht, Service-Schicht, Steuerungsschicht, Geschäftslogikschicht, Datenhaltungsschicht und Datenbereitstellungsschicht unterteilt. Besonderer Fokus der Entwicklung der N-Tier-Architektur lag auf der Symbiose zwischen der Darstellung der praxisrelevanten Anforderungen und der Darstellung der wissenschaftlichen Weiterentwicklung der Thematik.

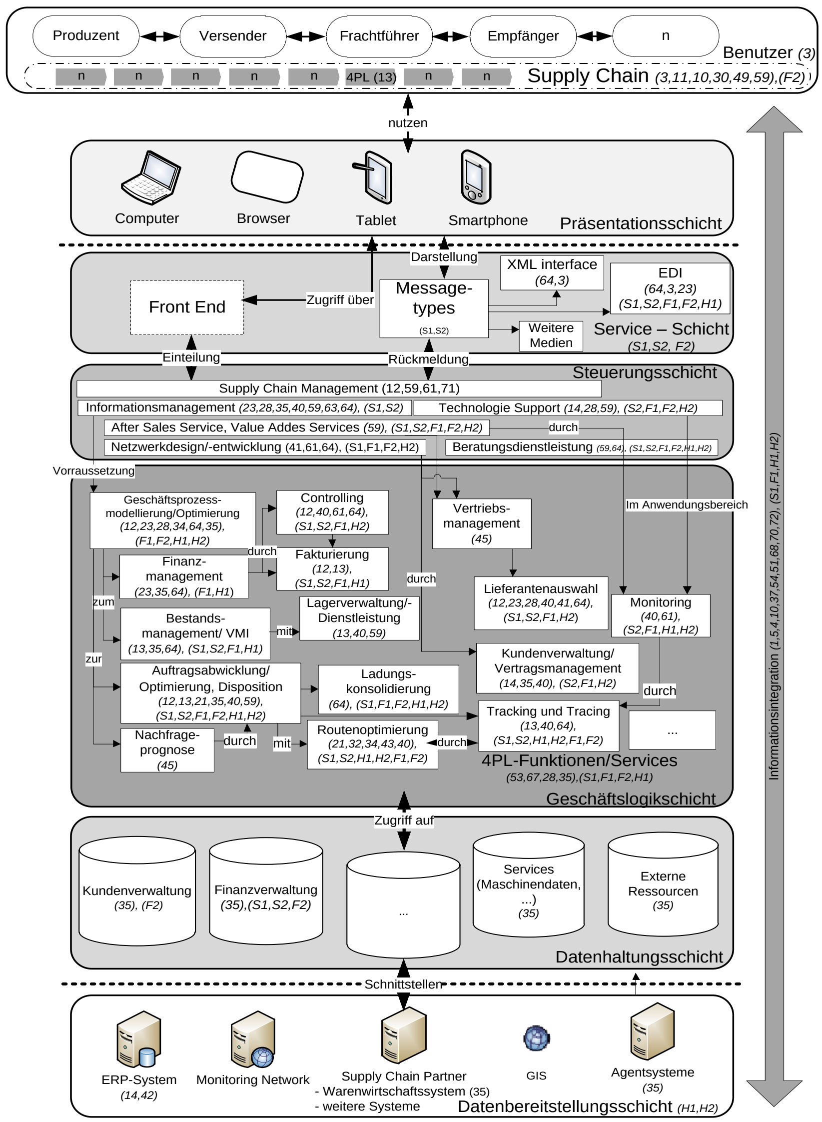

Abbildung 2: 4PL N-Tier-Architektur (Mehmann et al. 2013)

Die Ergebnisse des ersten Beitrags waren, dass der 4PL-Ansatz in der Literatur lediglich punktuell Erwähnung findet und dass dieser Ansatz bisher nicht systematisch aufgearbeitet wurde. Mögliche Architekturen und Referenzmodelle befanden sich noch am Anfang der Entwicklung. Es mangelte an wissenschaftlichen und praxisbezogenen Referenzmodellen und Lösungen, die alle Funktionen des 4PL-Ansatzes mit der Integration der Anforderungen der SC abbildeten. Die dargestellte Architektur sowie das ausführliche Literaturreview dokumentierten einen Ausgangspunkt zur weiteren Forschung. Des Weiteren konnten offene Fragestellungen zum 4PL-Ansatz erarbeitet und die Entwicklung einzelner Funktionsbausteine für den Anwendungsbereich begründet werden. Der Forschungspartner erkannte das Verbesserungspotenzial in der Nacherntelogistik durch den 4PL-Ansatz. Es fehlte jedoch an repräsentativen Schnittstellenanalysen unter den Akteuren. Auch waren keine Erkenntnisse über die strategischen, kooperativen und ökonomischen Auswirkungen eines 4PL-Ansatzes vorhanden. Die zahlreichen komplexen Schnittstellen des 4PL-Ansatzes konnten darstellt werden. Hinsichtlich einer wissenschaftlichen Diskussion konnten die Veröffentlichungszeiträume und offene Forschungsfragen aufgezeigt werden. Die Betrachtung der angewendeten Forschungsmethoden in Abstimmung des Forschungskontextes ermöglichte eine umfassende und strukturierte Planung der weiteren Forschungsschritte.

3.2. Spezifizierung der Anforderungen unter den Akteuren

Nach Eruierung der Anforderungen des 4PL-Ansatzes in der Nacherntelogistik in Beitrag 1 sowie der Darstellung der offenen Forschungsfragen folgte eine eingehende Betrachtung der Anforderungen an Dienstleistungslieferanten eines 4PL (Schnittstellenanalyse).

Folgende Forschungsfrage (FF) wurde damit beantwortet:

FF: Was sind die wichtigsten Diffusionsfaktoren des 4PL-Ansatzes in der deutschen landwirtschaftlichen Schüttgutlogistik?

Unter Berücksichtigung des Anwendungsfalls der landwirtschaftlichen Schüttgutlogistik wurden die in der Literatur aufgeführten Teilfragestellungen nach der Rolle eines 4PL in einem Transportnetzwerk unter Berücksichtigung der Akteure (Win 2008; Selviaridis und Spring 2007), der Voraussetzungen für ein SC Management (Evangelista und Sweeney 2006) sowie die Frage nach den Gründen zur Kooperation und zum Outsourcing von Transportaktivitäten in der Branche adressiert (Chen et al. 2010).

In Anlehnung an das von Tornatzky und Fleischer (1990) entwickelte TOE-Framework wurden die Anforderungen strukturiert analysiert. Die Grundstruktur unterteilte sich in drei Perspektiven (Technologie, Organisation und Umwelt). Mit dem Aspekt Technologie wurden Technologien beschrieben, die innerhalb eines Unternehmens (internal) und am Markt (external) verfügbar sind. Der Aspekt der Organisation berücksichtigte deskriptive Kenngrößen wie Firmengröße, Mitarbeiteranzahl und interne sowie externe Ressourcen. Der Aspekt Umwelt berücksichtigte die Bereitschaft, in IT zu investieren, Aktivitäten outzusourcen sowie eine Kooperation mit anderen Netzwerkteilnehmern einzugehen. Auf Basis des TOE-Frameworks wurden Hypothesen erarbeitet, welche durch eine empirische Untersuchung unter den Frachtführern der Agrarbranche analysiert wurden. Abbildung 3 zeigt das erarbeitete Forschungsmodell.

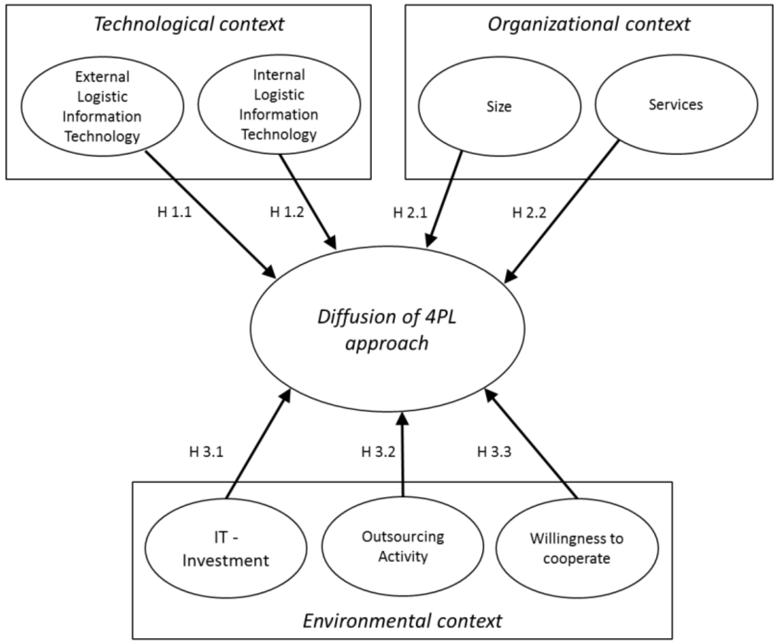

Abbildung 3: TOE-Forschungsmodell (Mehmann 2015)

Die Datengrundlage bildete ein Online-Fragebogen. Durch die Zusammenarbeit mit einem Forschungspartner (Sekundärgenossenschaft) wurden 148 Unternehmen zur Beantwortung des Fragebogens aufgefordert, wobei 31 Unternehmen den Fragebogen im Zeitraum von Oktober bis November 2012 vollständig ausfüllten.

Neben der Untersuchung der Diffusionsfaktoren konnten folgende Erkenntnisse erarbeitet werden. Zum einen wurde bestätigt, dass es sich bei dem 4PL-Ansatz um einen relativ unbekannten und noch nicht weitverbreiteten Ansatz in der Literatur sowie in der Praxis handelte. Es wurde zudem herausgefunden, dass mit steigender Bekanntheit die Bereitschaft tendenziell steigt, mit einem derartigen SC-Integrator oder SC-Mediator zusammenzuarbeiten. Die Branche zählt mit den Teilnehmer der Umfrage mit einem Durchschnittsalter von 43,5 Jahren, der eher kleinen Unternehmensstrukturen und den eingesetzten Kommunikationsmitteln vermutlich nicht zu den High-Tech-Clustern der Logistik. Dennoch waren die befragten Frachtführer bereit, in einen 4PL-Ansatz zu investieren, sofern Funktionen und Dienstleistungen von einem 4PL übernommen werden, welche nicht das Kerngeschäft, d.h. den Transport, beeinflussen. Dies bestätigte den in der Literatur beschriebene Ansatz der Asset-Freiheit (Win 2008). Mit dem TOE-Framework wurde versucht, den 4PL-Ansatz aus unterschiedlichen Perspektiven zu analysieren. Unter Betrachtung der Technologie konnten die von den Experten angekündigten Kommunikationsmedien der Branche (Telefon, Fax, E-Mail) bestätigt werden, sodass sich in diesem Segment im Vergleich zu anderen Branchen unerschlossene Potenziale aufzeigten. Organisatorisch verfügte die Branche der landwirtschaftlichen Frachtführer über sehr kleine Unternehmen, welche überwiegend Transportdienstleistungen anboten und lediglich 1–2 Kernkompetenzen besaßen. Ein 4PL-Dienstleister mit einem abgestimmten Dienstleistungsangebot könnte einen Partner in der SC darstellen, welcher administrative Aktivitäten bündelt und Aufgaben übernimmt. Die Analyse der Umwelteinflüsse zeigte, dass die Unternehmen bereit sind, in neue Technologien zu investieren sowie Kooperationsansätze zu fördern. Kritisch betrachtet wurden jegliche Veränderungen, welche zu einem Preisverfall führen würden.

Zur weiteren Forschung konnten auf Basis des TOE-Frameworks folgende Fragestellungen abgeleitet werden.

- Technologisch wurden entscheidungsunterstützende Hilfsmittel nachgefragt, welche die gesamte Abwicklung eines Transportauftrages in der Branche begleiten und die Leistungen eines 4PL für die Branche dokumentieren (Beitrag 3).
- Organisatorisch und umweltbezogen waren die Auswirkungen des 4PL-Ansatzes für die Branche zu untersuchen. Zudem waren Mechanismen zu erforschen, welche die Ängste einer Einführung des 4PL-Ansatzes hinsichtlich eines wachsenden Wettbewerbsdrucks in den Unternehmen minimieren sowie die Position des 4PL im Netzwerk definieren (Beitrag 4, Beitrag 5).

3.3. Technologische Betrachtung des 4PL-Ansatzes im Netzwerk

Auf Basis der spezifizierten Nachfrage aus den technologischen Anforderungen (Beitrag 2) beschreibt Beitrag 3 ein Entscheidungsunterstützungssystem zur operativen Disposition von landwirtschaftlichen Schüttgütern. Ausgangspunkt der Entwicklung definierten die Umfrageergebnisse sowie die vorliegenden Experteninterviews, wodurch die zentralen Einflussfaktoren der Disposition von landwirtschaftlichen Schüttgütern analysiert und die bisherigen Prozessschritte zur Abwicklung der Transportaufträge beschrieben werden konnten. Abbildung 4 zeigt die eruierten Einflussfaktoren.

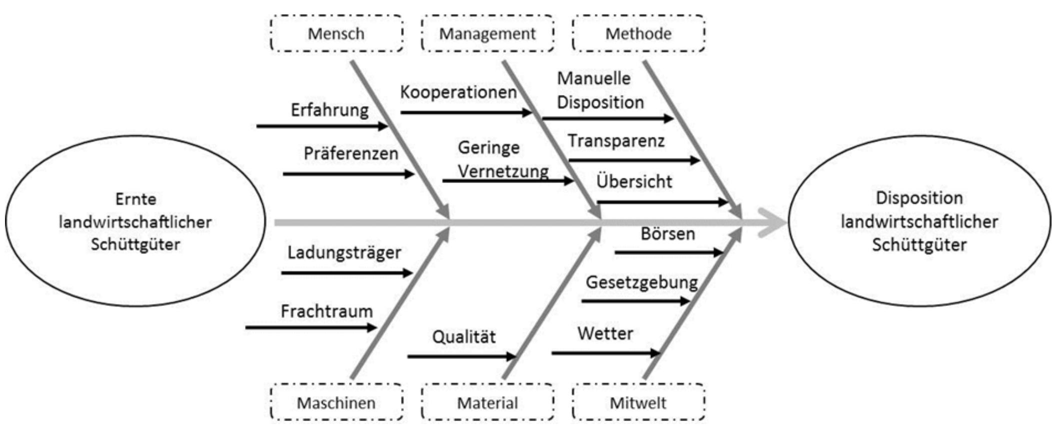

Abbildung 4: Zentrale Einflussfaktoren der Disposition der landwirtschaftlichen Schüttgüter (Mehmann und Teuteberg 2014)

Auf Basis der Umfrageergebnisse und der Experteninterviews wurde das Transportauftragsmanagementsystem (TAMS) entwickelt, wobei die Anforderungen der Netzwerkakteure berücksichtigt wurden. Abbildung 5 stellt das konzipierte TAMS dar.

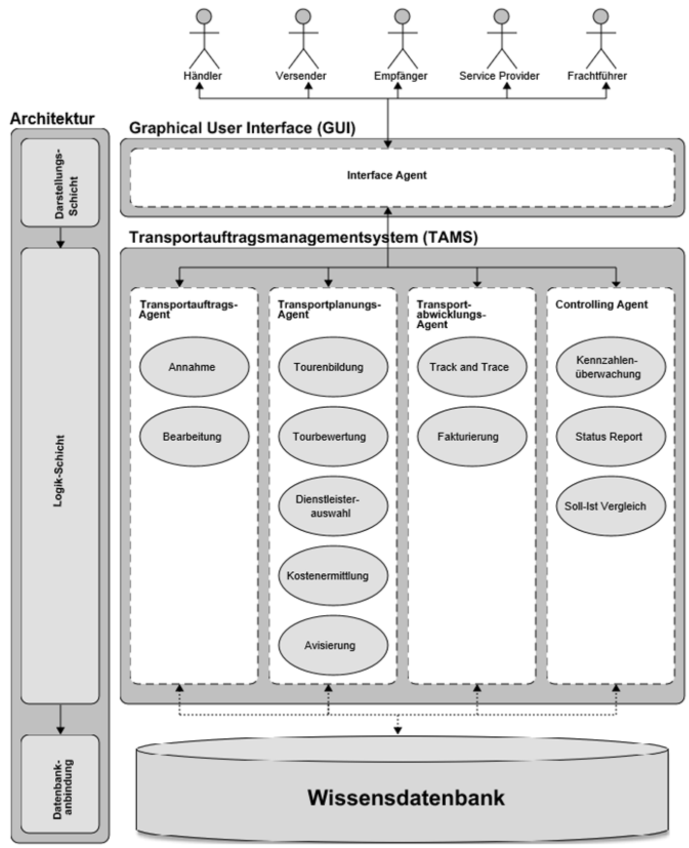

Abbildung 5: Konzept des Transportauftragsmanagementsystems (Mehmann und Teuteberg 2014)

Nach Entwicklung des TAMS folgte eine experimentelle Evaluierung des Transportplanungsagenten, da die Transportplanung aufgrund der Experteninterviews als Kernkompetenz eines 4PL-Ansatzes verstanden wurde. Auf Basis des Experiments konnte festgestellt werden, dass mittels eines Transportplanungsagenten zwischen 25–46 % an Leerkilometern aufgrund einer Routenbildung im Netzwerk eingespart werden können. Zudem wurde festgestellt, dass bei gezielten Informationsflüssen zum 4PL eine Minimierung von Schnittstellen möglich ist, was zu weiteren Einsparungen im Rahmen der Durchlaufzeit eines Auftrages führen könnte. Dies beinhaltete jedoch eine Überprüfung mittels einer Geschäftsprozesssimulation, welche im Beitrag 6 dargestellt wurde.

3.4. Organisatorische Betrachtung des 4PL-Ansatzes im Netzwerk

Die organisatorische Betrachtung des 4PL-Ansatzes im Netzwerk erfolgte aus zwei unterschiedlichen Perspektiven. Zum einen wurde der inter-organisationale Zusammenhang des 4PL-Ansatzes im Netzwerk unter Berücksichtigung der Transaktionskostentheorie betrachtet (Powell 2003; Picot et al. 1996).

Folgende Forschungsfragen wurden dabei adressiert (Beitrag 4):

- Wie kann ein aufzubauender 4PL in ein inter-organisationales Netzwerk und unter Berücksichtigung der drei Ansätze (Markt, Hierarchie und Kooperationsstrategie) integriert werden?
- Welche Erkenntnisse lassen sich aus dem beschriebenen Anwendungsfall ableiten, generalisieren und prüfen?

Zur Beantwortung der Forschungsfrage wurde die interpretative Fallstudienforschung angewandt (Walsham 1995). Die Erarbeitung der Datengrundlage und Interpretation erfolgten unter Berücksichtigung der Grounded Theory (Glaser und Strauss 2009). Unter Berücksichtigung der vorhandenen Literatur ermöglichte dieser Ansatz innerhalb des Kontextes Aussagen und Erkenntnisse praxisorientiert zu überprüfen und neue Ergebnisse zu generieren (Orlikowski 1993; Eisenhardt 1989).

Zum anderen wurden die organisatorischen, strategischen und technischen Attribute eines potenziellen 4PL in der SC durch die Entwicklung eines Meta-Modells näher analysiert (Beitrag 5). Die zugrunde liegende Forschungsfrage definierte sich wie folgt:

- Wie kann eine Methode zur Informationsbewältigung innerhalb einer SC zur Implementierung eines 4PL-Ansatzes unter Berücksichtigung von Gestaltungsebenen, Organisationen und eingesetzter Software- und IT-Lösungen aussehen?

Mit dem Ziel, die infrastrukturellen Gegebenheiten in der Branche theoretisch fundiert sowie allgemeingültig zu analysieren und den 4PL-Ansatz zu berücksichtigen, erfolgte eine Orientierung an der Work System Theory (Alter 2013). Damit konnten vielfältige Einflussfaktoren strukturiert für eine Analyse betrachtet werden. Insbesondere erfolgte eine Ausrichtung an das Work System Framework, welches ein beschreibendes und analysierendes Instrument darstellt, um IT-abhängige Arbeitssysteme durch neun Elemente strukturiert zu beschreiben (Alter 2006; Alter 2013). Die Datengrundlage bildeten Fallstudien (Yin 2013) der Branche sowie ein fundierter Literaturreview (Webster und Watson 2002). Die Datenaufnahme der Fallstudien erfolgte im Zeitraum von Februar bis Mai 2014. Nach einem telefonischen Erstkontakt mit den Befragten wurden alle notwendigen Informationen zur Vorbereitung per E-Mail versandt. Jeder Teilnehmer erhielt ein PDF-Dokument, welches aus einem Anschreiben, der Beschreibung des Forschungsvorhabens sowie dem Interviewleitfaden bestand. Nach einer Terminabsprache erfolgte die Durchführung von semi-strukturierten Interviews, um umfassende Eindrücke und Erkenntnisse in den Interviews zu erhalten. Zusätzlich zu den Interviews wurden Notizen gemacht. Alle Interviews wurden über den Zeitraum der Fragenbeantwortung zwischen 27–86 Minuten aufgezeichnet. Nach der Aufzeichnung folgte eine Transkription sowie Analyse und Auswertung mittels MAXQDA. Zum einen konnte damit das Rohmaterial von Interpretationen, Forschungsfragen und Rückschlüssen getrennt werden. Zum anderen konnte auf Basis der empirischen Untersuchung die Überprüfung des aus der Literatur abgeleiteten Metamodells erfolgen. Aus beiden Arbeiten des Autors dieser Dissertation lassen sich organisatorische Ergebnisse für den 4PL-Ansatz ableiten.

Die Ergebnisse des Beitrags 4 beschreiben die Herausforderung und Erfahrungen hinsichtlich der Entwicklung eines 4PL innerhalb der Branche der landwirtschaftlichen Schüttgutlogistik. Zudem konnte dargestellt werden, wie eine langfristige Implementierung des 4PL gelingen kann, welche Funktionen der 4PL gewährleisten sollte und wie der 4PL das Netzwerk beeinflussen würde. Zudem wurde eine relationale Perspektive eingenommen, damit jeder befragte Netzwerkakteur die Auswirkungen eines 4PL sowie die Potenziale eines 4PL versteht und auf seine Perspektive reflektieren kann. Als weiterer Forschungsbedarf konnte die Entwicklung eines Leitfadens zur Einführung bzw. zum Prozessreengineering definiert werden (Beitrag 6).

Als Ergebnis des Beitrags 5 ist das Metamodell anzuführen, welches ein umfassendes Analysewerkzeug zur Einführung eines 4PL-Ansatzes in einer SC darstellt und dabei eine Vielzahl von Elementen des Arbeitssystems berücksichtigt. Zudem wurden die Herausforderungen sowohl für die Branche als auch für die IT herausgearbeitet. Während Beitrag 4 eher die organisatorische bzw. hierarchische Einführung des 4PL-Ansatzes in der Branche darstellt, beschreibt Beitrag 5 die detaillierte Beschreibung des Arbeitssystems des 4PL-Ansatzes für die Branche.

3.5. Prozessreengineering unter Berücksichtigung des 4PL-Ansatzes

Beitrag 6 des Autors dieser Dissertation beschreibt einen anwendungsorientierten Beitrag zur Einführung des 4PL-Ansatzes in der Branche. Die im Forschungsprozess erarbeiteten Erkenntnisse der Beiträge 1–5 bilden die Ausgangssituation. Die beschriebene Methodik beschreibt den Reengineeringprozess durch Integration aller Akteure des Netzwerkes und Darstellung sowie Simulation der Prozesse mittels einer Geschäftsprozessmodellierung (Smith und Fingar 2003; Yu et al. 2011). Mittels einer Simulation konnten die organisatorischen sowie technischen Auswirkungen für die beteiligten Akteure dargestellt werden (Bae und Seo 2007). Ziel des Beitrags war die Beantwortung der Frage hinsichtlich der Vorteile, der Verantwortlichkeiten und des Mehrwertes eines 4PL (Stefansson und Lumsden 2008; Selviaridis und Spring 2007) (FF1). Anhand der Darstellung des Mehrwertes des 4PL sowie der Darstellung der Einsparungspotenziale sollten Ressourcen erhoben werden, welche eine Investition in IKT rechtfertigen (FF2).

Methodisch unterteilt sich der Beitrag in einen Bereich der Fallstudienforschung (Yin 2013) sowie einen konstruktionsorientierten Forschungsansatz (Wilde und Hess 2007). Die Methodik zum Prozessreengineering und zur Simulation des 4PL-Ansatzes ist im Beitrag beschrieben und durch die Fallstudie validiert. Abbildung 6 zeigt die im Beitrag vorgestellte Methodik.

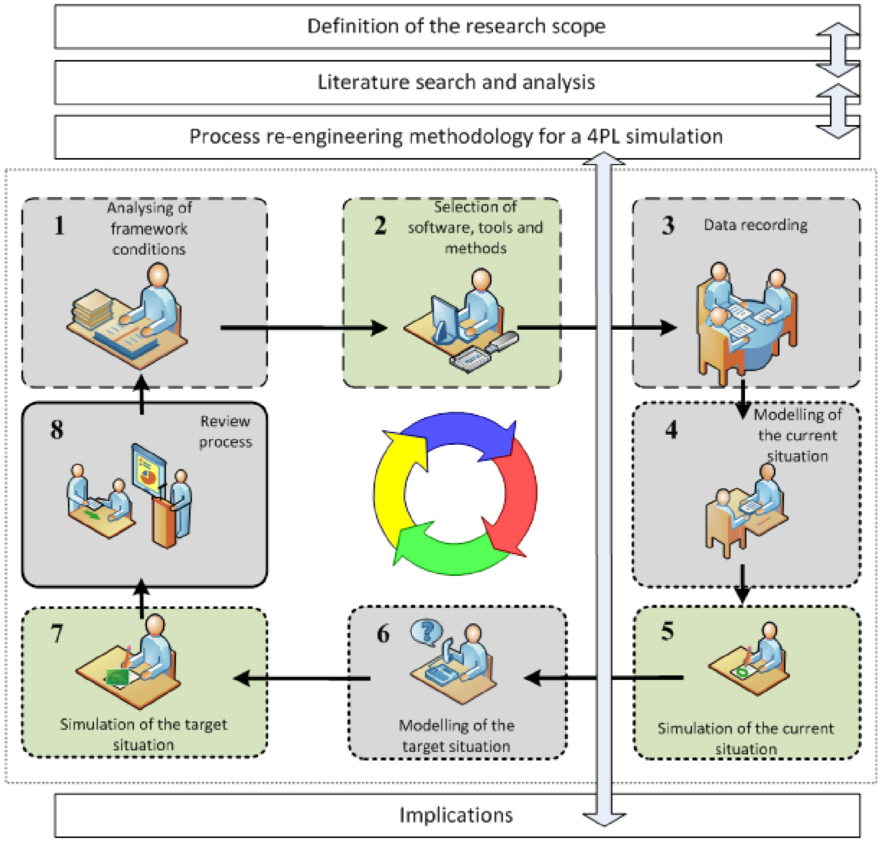

Abbildung 6: Prozessreengineeringmethodik zur 4PL-Simulation (Mehmann und Teuteberg 2016)

Unter Anwendung der entwickelten Prozessreengineeringmethodik zur 4PL-Simulation wurde mittels der Fallstudienforschung ein Vergleich zwischen den Ist-Prozessen des Netzwerkes und den Soll-Prozessen des Netzwerkes einschließlich eines 4PL-Akteurs vorgenommen. Jeder Prozessschritt wurde bewertet und analysiert.

Als Ergebnis des sechsten Beitrags ist der Mehrwert des 4PL für das Netzwerk beschrieben. Mittels einer zentralisierten Planung gelingt es einem 4PL-Akteur, im Netzwerk Durchlaufzeiten von Transportaufträgen zu minimieren sowie beeindruckende Kostenersparnisse durch eine Reduzierung von Leerkilometern zu erzeugen. Zudem würde ein 4PL die Transparenz hinsichtlich verfügbarer Frachtraumkapazitäten und Transportressourcen erhöhen, wodurch langfristig weitere Kosteneinsparungen zu erwarten wären.

Insgesamt konnte durch die Simulation dargestellt werden, dass der Aufbau eines 4PL für die Branche und die damit verbundenen Investitionen in IKT gerechtfertigt werden können, da entsprechende Einsparungen zu erwarten sind.

3.6. Nachhaltigkeitsuntersuchung des 4PL-Ansatzes

Zur Darstellung einer umfassenden Analyse des 4PL-Ansatzes erfolgt in Beitrag 7 eine Betrachtung der Nachhaltigkeit (Elkington 1997). Begründet ist dies zum einen durch die Forderung der Logistik, CO_2-

Einsparungen im Rahmen von Effizienzsteigerungsmaßnamen vorzunehmen. Zum anderen ergeben sich in einem Netzwerk durch die Einführung des 4PL-Ansatzes ökonomische, ökologische und soziale Anforderungen (Govindan et al. 2013; Nikolaou et al. 2013), welche zu untersuchen waren. Beitrag 7 betrachtet den 4PL-Ansatz daher aus einer weiteren Perspektive wodurch zwei weitere Forschungsfragen beantwortet werden konnten. Hierfür wurde der Transportplanungsprozess (Beitrag 3) in Form einer Geschäftsprozessmodellierung aufgegriffen und definiert (FF1), da der Transportplanungsprozess den größten Effekt zur Nachhaltigkeit vermuten lassen konnte. Zudem wird der zusätzliche Nutzen und der nachhaltige Wert des 4PL für die landwirtschaftlichen Schüttgutlogistik spezifiziert (FF2).

Zur Beantwortung der Forschungsfragen beschreibt der Beitrag eine inhaltliche Diskussion der Nachhaltigkeitsanforderungen. Zudem wird ein Model des 4PL-Transportplanungsprozesses im Beitrag vorgestellt.

Die Nachhaltigkeitsanforderungen wurden anhand der Prozessschritte des Transportplanungsprozesses untersucht. Die Datengrundlagen bildeten semi-strukturierte Interviews (I) und die durchgeführten Simulation (S) in Form der Geschäftsprozessanalyse sowie die Simulation der Transportplanung als Teilprozess des gesamten Transportplanungsprozesses. Tabelle 5 beschreibt die Datengrundlage in Form einer Matrix.

			4PL transportation planning process																
			Collection of transport orders	*Transportation concept planning*	*Planned transport orders*	*Request transport offer*	*Generate transport offer for customer*	*Order transport from carrier*	*Implement transport order in transportation planning*	*Transport date achieved*	*Generate final transportation route*	*Generate final transport contract for carrier*	*Inform shipper*	*Inform carrier*	*Inform processor*	*Transportation process*	*Accounting*	*Payment*	***4PL Approach***
Economic challenge	***Production costs***	EC 1		**S**							**S**					**S**			
	Order costs	EC 2		**S**	**I**						**S**					**S**			
	Logistics costs	EC 3		**S**	**I**	**I**					**S**	**S**				**S**			
	Lead time	EC 4		**S**			**I**				**S**	**I**				**I**	**I**	**I**	
	On time delivery	EC 5			**I**		**I**			**I**	**I**	**I**				**I**	**I**	**I**	
	Quality assurance	EC 6			**I**		**I**				**I**	**I**				**I**	**I**	**I**	
	Rejection ratio	EC 7	**I**								**I**					**I**			
	Technology level	EC 8	**I**	**I**			**I**	**I**	**I**	**I**	**I/S**	**I**	**I**	**I**	**I**	**I**	**I**	**I**	**I**
	Design of future services	EC 9				**I**	**I**												**I**
Ecologic challenge	***Pollution production/ reduction***	EO 1	**I**	**S**							**S**	**I**				**S**			
	Resource consumption	EO 2	**I**	**S**			**I**	**I**			**S**	**I**				**S**			
	Eco design	EO 3																	**I**
	Environmental management system	EO 4																	**I**
Social challenge	***Employment practices***	SC 1				**I**					**I**			**I**		**I**			
	Health and safety	SC 2				**I**					**I**			**I**		**I**			
	Influence of the sector	SC 3	**I**		**I**		**I**	**I**		**I**	**I**	**I**	**I**	**I**	**I**		**I**	**I**	
	Stakeholder influence	SC 4	**I**		**I**			**I**		**I**		**I**	**I**	**I**	**I**		**I**	**I**	

Tabelle 5: Nachhaltigkeitsanforderungen und Teilprozesse des 4PL-Transportplanungsprozesses (Mehmann und Teuteberg 2016)

Auf Basis der Nachhaltigkeitsanforderungen erfolgte eine fundierte Analyse, Bewertung und Beschreibung der Effekte, welche mit einem 4PL-Transportplanungsprozess einhergehen würden.

Die Ergebnisse des Beitrags können in anwendungsorientierte und wissenschaftliche Erkenntnisse unterteilt werden. Die anwendungsorientierten Erkenntnisse beschreiben eine signifikante Verbesserung der Transportplanung durch den 4PL-Ansatz, wodurch Kosteneinsparungen zu erwarten sind. Ökologisch bedeutet dies eine Verringerung des CO_2-Ausstoßes und weiterer Schadstoffe durch die Aktivitäten eines 4PL. Unter den sozialen Anforderungen sind die Existenzängste der Netzwerkakteure zu berücksichtigen. Die wissenschaftlichen Erkenntnisse verdeutlichen, dass sich die Anforderungen an ein nachhaltiges SC Management auf den 4PL-Ansatz anwenden lassen und dabei zahlreiche Schnittstellen berücksichtigt werden können. Zudem wurde das adaptierte Model (Nikolaou et al. 2013; Govindan et al. 2013) in einem Real-World-Szenario angewandt. Abschließend konnte der 4PL-Ansatz als Artefakt, basierend auf dem 4PL-Transportplanungsprozess, aufgearbeitet werden (Melville 2010; Watson et al. 2012).

3.7. Einflüsse und Trends zum 4PL-Ansatz

Die im Verlauf der Dissertation durchgeführten Literaturreviews konnten Trends in der Logistik im Rahmen der Digitalisierung sowie der Sharing Economy aufzeigen. Ein Trend, welcher dem untersuchten 4PL-Ansatz ähnelt, beschreibt der Crowd Logistics-Ansatz (Bubner et al. 2014). Für eine zukunftsorientierte Forschung wurde der Crowd Logistics-Ansatz näher betrachtet. In Beitrag 8 dieser Dissertation „Crowd Logistics − A Literature Review and Maturity Model" (Mehmann et al. 2015) wurde das Ergebnis einer Literaturrecherche (Fettke 2006) und einer Fallstudienrecherche (Myers 2013) für eine qualitative Datenanalyse (QDA) der Geschäftsmodelle genutzt. Das Ergebnis der Analyse wurde in ein Reifegradmodell überführt. Das entwickelte Reifegradmodell unterstützt Unternehmen bei der Aufdeckung von Verbesserungspotenzialen. Die durchgeführte QDA beinhaltete eine Clusteranalyse der Beiträge und Fallstudien auf Basis des Jaccard-Koeffizienten (Backhaus et al. 2013) (vgl. Abbildung 7 und Abbildung 8).

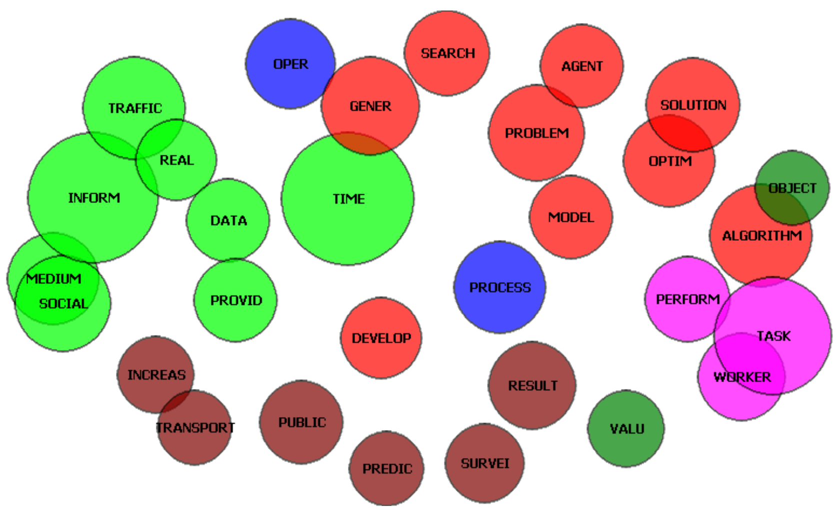

Abbildung 7: Ergebnisse der Clusteranalyse der wissenschaftlichen Zeitschriften (Mehmann et al. 2015)

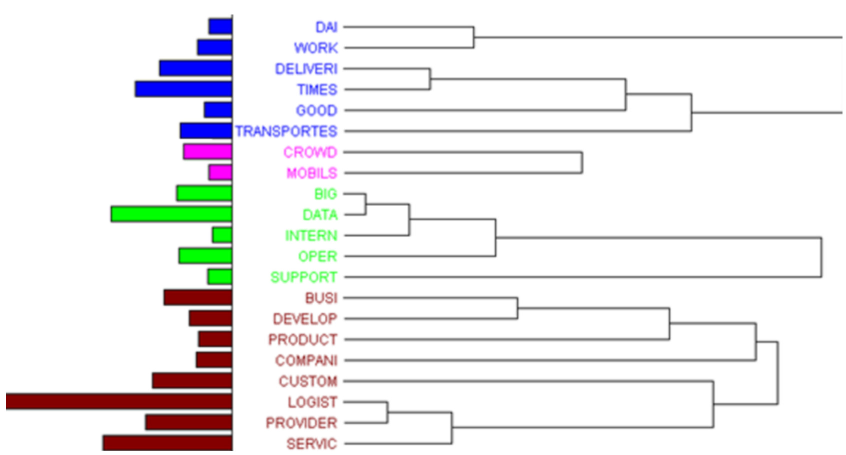

Abbildung 8: Dendrogramm der Clusteranalyse der Fallstudien (Mehmann et al. 2015)

Beide Analysen führen zu dem Ergebnis, dass die Transportabwicklung und -planung im Fokus der Crowd Logistics-Ansätze steht. Gleichwohl kann ein Crowd Logistics-Dienstleister als Service Provider verstanden werden, welcher moderne IKT einsetzt und Ansätze wie Big Data sowie die Möglichkeiten des Internets der Dinge verfolgt. Die Untersuchungen der Fallstudien thematisierten zudem direkte Verbindungen und Schnittstellen zum 4PL-Ansatz. Zur weiteren Aufbereitung der Thematik wurde ein Reifegradmodell entwickelt (Becker et al. 2009), welches in Anlehnung an bestehende Modelle wie das Capability Maturity Model (CMM) (Paulk et al. 1994) und das Software Process Improvement and Capability Determination (SPICE) (Emam et al. 1997) für die vier Bereiche Umwelt, Ökonomie, Kommunikation und Sicherheit zur Bewertung von Attributen mit unterschiedlichen Ausprägungen bereithält.

4. Diskussion der Ergebnisse

4.1. Implikationen

Aufgrund der anwendungsorientierten Forschung im Bereich der Logistik und insbesondere im Rahmen der Betrachtung des 4PL-Ansatzes konnten wissenschaftliche und praxisorientierte Implikationen erarbeitet werden.

4.1.1. Implikationen für die Wissenschaft

Beitrag 1 dieser Dissertation zeigte, dass Untersuchungen zum 4PL-Ansatzes in der Wissenschaft bisher unterrepräsentiert waren und eine systematische Aufarbeitung noch nicht erfolgt ist (Mehmann et al. 2013). Ein wichtiger Teil der systematischen Aufarbeitung wurde durch die Darstellung der N-Tier-Architektur geleistet, wodurch weiterführende Forschungsfragen adressiert und ein Ausgangspunkt zur weiteren Forschung definiert wurden. Mit Beitrag 2 (Mehmann 2015) ist es gelungen, erstmalig empirische Erkenntnisse über die Eigenschaften eines möglichen 4PL für eine Branche zu eruieren. Durch die Untersuchung konnten neue Forschungsfragen in den Bereichen Technologie, Organisation und Umwelt bzw. Kooperation für den nationalen Kontext erarbeitet werden.

Zur Beantwortung der technologischen Fragestellung liefert Beitrag 3 wichtige Erkenntnisse, indem eine Transportauftragsplanung unter Berücksichtigung einer Vielzahl von Akteuren umgesetzt wurde. Basierend auf dem Ansatz eines Multiagentensystems (Mehmann und Teuteberg 2014) erfolgte die Darstellung eines Transportauftragsmanagementsystems unter Berücksichtigung der Anforderungen eines 4PL-Ansatzes.

Durch Beitrag 4 (Mehmann und Teuteberg 2015a) und Beitrag 5 (Mehmann und Teuteberg 2015b) wurden die organisatorischen Fragestellungen zur Einführung eines 4PL-Ansatzes in eine Branche beschrieben. Beide Beiträge beschreiben, wie qualitative Daten, z. B. Erfahrungen und Wissen aus der Praxis, zur

Entwicklung von wissenschaftlichen Erkenntnissen beitragen können. Die praktischen Erkenntnisse sind hilfreich, um eine Einführung des 4PL-Ansatzes vorzubereiten, womit weitere wissenschaftliche Erkenntnisse gewonnen werden können. Zudem haben beide Beiträge den Forschungsbedarf in der Landwirtschaft adressiert, welcher für die IT- und Informationssystem (IS)-Forschung viele unterschiedliche Artefakte liefern kann. Die Landwirtschaft stellt unter Berücksichtigung einer wachsenden Weltbevölkerung und dem Aspekt einer begrenzten Anbaufläche von Nahrungsmitteln einen relevanten Forschungsgegenstand dar.

Beitrag 6 beschreibt einen Prozess zur Einführung und Validierung des 4PL-Ansatzes anhand einer Branche, was bisher in der Literatur noch nicht geschehen ist. Der multidisziplinäre Charakter der Forschungsarbeit, bestehend aus Fallstudien, einer Simulation und der Beteiligung der Akteure, unterstützt durch den Einsatz eines anwendungsorientierten Forschungsansatzes (Mehmann und Teuteberg 2016).

Erstmalig wurde durch Beitrag 7 (Mehmann und Teuteberg) der 4PL-Ansatz hinsichtlich Nachhaltigkeitsanforderungen untersucht und eine Vorgehensweise beschrieben, wie zukünftige logistische Ansätze einer Nachhaltigkeitsuntersuchung unter Berücksichtigung der Akteure erfolgen können. Einen weiteren Blick in die Zukunft wurde mit Beitrag 8 gewährt, welcher die Begrifflichkeit Crowd Logistics aus der Literatur herleitet und definiert (Mehmann et al. 2015).

4.1.2. Implikationen für die Praxis

Ähnlich wie die wissenschaftlichen Implikationen können aufgrund der anwendungsorientierten Forschung Implikationen für die Praxis und speziell für die landwirtschaftliche Schüttgutlogistik beschrieben werden. Teilweise sind 4PL-Ansätze in der Praxis beschrieben, wobei die landwirtschaftliche Schüttgutlogistik nach Kenntnis des Autors erstmalig mit diesem Ansatz untersucht wurde.

Ausgehend von Beitrag 2 (Mehmann 2015) erfolgt daher eine Darstellung der derzeitig eingesetzten Techniken, Verfahren und Arbeitsweisen in der Branche der landwirtschaftlichen Schüttgutlogistik, womit ein Entwicklungspotenzial aus der Perspektive der Logistik dargestellt wird. Beitrag 3 (Mehmann und Teuteberg 2014), Beitrag 4 (Mehmann und Teuteberg 2015a), Beitrag 5 (Mehmann und Teuteberg 2015b), Beitrag 6 (Mehmann und Teuteberg 2016) und Beitrag 7 (Mehmann und Teuteberg) beschreiben hinsichtlich des 4PL-Ansatzes im Netzwerk potenzielle Funktionen sowie eine Arbeitsteilung, welche mit dem 4PL-Ansatz einhergeht. Es konnte dargestellt werden, welche Funktionen ein 4PL für die Branche bereitstellen sollte, damit eine Win-Win-Situation für die Akteure und für den 4PL eintritt.

Zudem wird die Funktion der Transportauftragsplanung fundiert für den Anwendungsfall beschrieben, wodurch Kosteneinsparungen berechnet und Effizienzsteigerungen wie z. B. verkürzte Durchlaufzeiten dargestellt werden können. Neben der Betrachtung der Einsparungen wird der benötigte Investitionsbedarf in neu zu implementierende IKT dargestellt. Neu zu implementierende IKT würden vor allem Doppeleingaben und verzögerte Informationsflüsse minimieren, wodurch der 4PL mittels einer IT-Plattform die gewünschten Funktionen abbilden kann. Ein insgesamt verbesserter Informationsfluss für die Branche konnte dargestellt werden. Abschließend wurde für die Branche die Positionierung des 4PL im Netzwerk analysiert, damit eine fokale Steuerung im Netzwerk erfolgen kann. Dies beinhaltet die Analyse und Darstellung eines notwendigen Kooperationsansatzes im Netzwerk.

Beitrag 8 beschreibt die Parallelen des 4PL-Ansatze zum Crowd Logistics-Ansatz und stellt einen möglichen Entwicklungstrend für den 4PL-Ansatz dar. Der Markt um Crowd Logistics-Dienstleistungen folgt derzeit dem Trend, dass eine Vielzahl von Crowd Logistics-Dienstleistungen wie z. B. Uber oder Lieferando angeboten werden. Der 4PL-Ansatz sowie der Crowd Logistics-Ansatz unterliegen dabei der Restriktion, erst langfristig profitabel zu agieren, da das Lieferanten- und Nachfragernetzwerk neben der IT- und IKT-Infrastruktur zunächst aufzubauen sind. Im Regelfall werden Crowd Logistics-Dienstleister zur Überwindung der Anfangsphase durch Risikokapital gestützt, was eine Finanzierungsmöglichkeit zur Implementierung eines 4PL-Ansatzes in einem Netzwerk darstellen kann. Für die untersuchte Branche erscheint jedoch aufgrund der genossenschaftlichen Struktur eine Positionierung auf Ebene der Sekundärgenossenschaft der erfolgsversprechendste Ansatz.

4.2. Limitationen

Unter Berücksichtigung der Ergebnisse werden nachfolgend die Limitationen dieser Dissertation erläutert. Die aufgeführten Limitationen entsprechen dabei einer Zusammenfassung für die entwickelten Forschungsbeiträge. Die Literaturrecherchen erfolgten anhand definierter Suchbegriffe sowie einer Vorwärts- und Rückwärtssuche. Zudem wurden unterschiedliche Literaturquellen und Datenbanken im Rahmen der Recherchen berücksichtigt. Dennoch können möglicherweise weitere Quellen vorhanden sein, welche mittels anderer Suchbegriffe gefunden werden können. Die Analyse der Literatur sowie die daraus abgeleiteten Modelle wurden durch mindestens zwei Wissenschaftler durchgeführt, um Fehlinterpretationen zu vermeiden, welche dennoch nicht gänzlich ausgeschlossen werden können. Die durchgeführten Experteninterviews ermöglichen Interpretationsspielräume für die Befragten hinsichtlich des Verständnisses, der sprachlichen Barrieren und des Vertrauens zwischen Befragten und Fragenden. Neutrale Datenaufnahmen wurden durchgeführt, indem den Befragten die Hintergründe genau erläutert wurden. Dennoch kann die individuelle Perspektive der Befragten möglicherweise Ergebnisse liefern, welche aufgrund der Position des Unternehmens in der SC, der Position der Befragten im Unternehmen, der Erfahrungen und der Vorstellungskraft der Befragten die Generalisierbarkeit einschränken. Zudem muss die Generalisierbarkeit unter Berücksichtigung der Stichprobengröße der Interviews und der untersuchten Branche eingeschränkt werden, weshalb sowohl für andere Branchen als auch im internationalen Kontext weitere Forschungsarbeiten notwendig sind. Die untersuchten Prozesse der Branchen wurden detailliert in den Forschungsarbeiten berücksichtigt, um die Validität der Ergebnisse zu gewährleisten. Dennoch unterliegen die Prozesse und insbesondere die Prozessschritte einem Vereinfachungsgrad. Dieser Vereinfachungsgrad war mit den Experten abzustimmen und wird auch in anderen Branchen iterativ durchzuführen sein. Die Experten der Fallstudie haben Daten in Form von Prozessbeschreibungen, Dokumenten und Einschätzungen geliefert, welche Schwankungen des Marktes unterlagen.

5. Fazit

Der Forschungsgegenstand der vorliegenden Dissertation war, den Status quo und Entwicklungsperspektiven des 4PL-Ansatzes zu untersuchen. Dies erfolgte in den acht aufgenommenen Beiträgen. Zur Analyse wurde ein Mixed-Methods-Ansatz gewählt, wodurch sowohl qualitative und quantitative als auch Kombinationen unterschiedlicher Ansätze in Form eines Mixed-Methods-Ansatzes zur Ergebnisgenerierung beitrugen. Dadurch konnten vielfältige Forschungsfragen zum 4PL-Ansatz beantwortet sowie mögliche Entwicklungsperspektiven aufgezeigt werden.

Der in Abschnitt 2 dargestellt Ordnungsrahmen beschreibt die Vorgehensweise der durchgeführten Forschungsarbeit und beinhaltet strukturgebende Elemente zur Orientierung. Beitrag 1 (Mehmann et al. 2013) beschrieb den Status quo des 4PL-Ansatzes, wohingegen in Beitrag 2 (Mehmann 2015) die Strukturgebung der Arbeit in Anlehnung an das TOE-Framework erfolgte. Die Strukturgebung war notwendig, um die vielen unterschiedlichen Fragestellungen systematisch bearbeiten zu können, welche mit dem 4PL-Ansatz einhergehen. Die in den Beiträgen aufgeführten Implikationen für Wissenschaft und Praxis zeigten, dass der 4PL-Ansatz einen langfristigen und erfolgsversprechenden Ansatz für die Logistik darstellen kann und zu aktuellen Trends wie Crowd Logistics Parallelen aufweist. Dennoch ist anzumerken, dass viele Einflussfaktoren wie die Technologie, Organisation und Umwelt für eine erfolgreiche Umsetzung zu berücksichtigen sind. Nicht zuletzt wird die Gesellschaft in Form des gegenseitigen Vertrauens und der Fokussierung auf die Kernkompetenz des Einzelnen und in Anlehnung an einer Idee der Sharing Economy entscheiden, ob der 4PL-Ansatz in Zukunft die logistischen Funktionen unterstützt.

Das Ergebnis dieser Arbeit und insbesondere die einzelnen Beiträge beschreiben die Potenziale und notwendigen Veränderungen zur Einführung des 4PL-Ansatzes durch eine exemplarisch untersuchte Branche. Dennoch möchte der Autor mit dieser Arbeit zum Verständnis und zur Förderung der Idee des 4PL-Ansatzes beitragen und Forscher motivieren, weitere Beiträge zum 4PL sowie zum Themengebiet Crowd Logistics zu verfassen. Die Ergebnisse der Beträge sowie die der Dissertation können dabei als Grundlage dienen.

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Eidesstattliche Erklärung (Hilfsmittel)

Hiermit erkläre ich an Eides statt, dass ich diese Dissertation zur Erlangung des akademischen Grades eines Doktors der Wirtschaftswissenschaften des Fachbereichs Wirtschaftswissenschaften der Universität Osnabrück ohne unzulässige Hilfe Dritter angefertigt und die benutzten Hilfsmittel vollständig und deutlich angegeben habe.

Die jeweiligen Beiträge der Koautoren sind Abschnitt 2.1 zu entnehmen.

Jens Mehmann　　　　　　　　　　Lingen, 18.03.2016

Eidesstattliche Erklärung (entgeltliche Hilfe)

Hiermit erkläre ich, dass ich keine entgeltliche Hilfe von Vermittlungs- bzw. Beratungsdiensten (Promotionsberatern oder anderen Personen) in Anspruch genommen habe und niemand von mir geldwerte Leistungen für Arbeiten erhalten hat, die im Zusammenhang mit dem Inhalt der Dissertation stehen.

Jens Mehmann Lingen, 18.03.2016

Teil B – Einzelbeiträge

Beitrag 1: Eine 4PL-Plattform zur Unterstützung der Nacherntelogistik – Eine Anforderungsanalyse.

Autoren	Mehmann, Jens.; Teuteberg, Frank.; Freye, Diethardt
Jahr	2013
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Eine 4PL-Plattform zur Unterstützung der Nacherntelogistik – Eine Anforderungsanalyse.

Abstract:

Der Beitrag analysiert mittels eines systematischen Literaturreviews und Experteninterviews Anforderungen an einen Fourth Party Logistics Provider (4PL) und dessen IT-Infrastruktur im Kontext der Nacherntelogistik. Auf Basis der ermittelten Anforderungen wurde eine 4PL-Plattform konzeptioniert, welche zukünftigen Forschungsbedarf aufzeigt.

1 Einleitung

Jährlich werden ca. 55 Mio. t Getreide in Deutschland transportiert, wobei die größte Umschlagmenge (59%) durch den LKW-Transport abgewickelt wird [BME11]. Akteure in diesem Segment sind laut Brancheninformationen überwiegend Dienstleister in Form von klein- und mittelständischer Unternehmen, Landhandel oder Genossenschaften, welche zum Teil eine Handelsfunktion und eine Transportfunktion ausführen.

Ziel des Beitrages ist es, das Geschäftsmodell eines 4PL unter Berücksichtigung der spezifischen Anforderungen der Landwirtschaft in der Nacherntelogistik zu untersuchen. 4PL ist ein von „Accenture" im Jahr 1998 eingeführter Begriff und wird in diesem Kontext als ein „Wertschöpfungsnetzwerkmanager" beschrieben, der die Ressourcen, Kapazitäten und Technologien des 4PL und der Netzwerkpartner zusammenführt und steuert [Je10]. Die Aufgabe des 4PL ist es, die Material-, Informations- und Finanzflüsse der Supply-Chain-Teilnehmer zu integrieren, sodass ein effizienter Einsatz der Ressourcen entlang der Kette entsteht [Wi08]. Die Nacherntelogistik erstreckt sich dabei von der ersten Lagerung bis zum ersten Weiterverarbeitungsschritt des Gutes. Auf Basis eines systematischen Literaturreviews werden Anforderungen ermittelt, welche anhand von Experteninterviews validiert und ergänzt werden. Die Anforderungen spezifizieren dabei Aspekte des Informationsmanagements (Datenstruktur und Systeme) sowie organisatorische und institutionelle Eigenschaften [HHR04] eines möglichen 4PL-Ansatzes. Auf Grundlage der gewonnenen Erkenntnisse erfolgt die Konzeption einer 4PL-Plattform.

2 Forschungsmethodik und Vorgehensweise

Diese Forschungsarbeit basiert auf dem Forschungsprozess von vom Brocke et al. [Br09]; Webster und Watson [WW02]. Dieser gliedert sich in die Schritte Definition des Forschungsbereiches, Konzeptualisierung, Literatursuche und -auswahl, Literaturanalyse sowie Ableitung von Implikationen. Der Forschungsbereich umfasste Services und Infrastrukturen im Kontext eines 4PL. Zur Literatursuche wurde das Zeitfenster von 2000-2011 berücksichtigt. Datengrundlage bildeten Beiträge in A, B und C bewerteten Zeitschriften des Zeitschriftenranking des Verbands der Hochschullehrer für Betriebswirtschaft e.V. (VHB) aus dem Teilranking der Logistik und dem Teilranking Wirtschaftsinformatik und Informationsmanagement. Anhand definierter Schlagwörter (Link-Anhang - (Pos.2)) wurde die Recherche durchgeführt. Es folgte eine Voranalyse der Zusammenfassungen und eine Recherche in Datenbanken (Link-Anhang - (Pos.3)) zur Berücksichtigung der anwendungsorientierten Perspektive. In Summe konnten 74 Bei-träge für den Untersuchungsbereich definiert und untersucht werden (Link-Anhang - (Pos.4)). Die erarbeiteten Ergebnisse ermöglichten die Durchführung von Experteninterviews (Link-Anhang - (Pos.5)). Die generierten Daten konnten mit Hilfe der Software MAXQDA ausgewertet werden. Auf Grundlage der Erkenntnisse des Reviews und der Interviews (Link-Anhang - (Pos.7)) wurde eine mögliche 4PL-Plattform als N-Tier-Schichtenmodell konzeptioniert.

3 Ergebnisse

Im Zuge einer thematischen Analyse konnten die Veröffentlichungen ökonomischen, soziokulturellen, organisatorischen sowie technologischen Schwerpunkten zugeordnet werden. Verstärkte ökonomische Forschungsaktivitäten untersuchen die Fragestellung, inwiefern inter-organisationale Systeme die Supply Chain beeinflussen. Soziokulturell und organisatorisch betrachten die Forschungsarbeiten vor allem Entscheidungsfindungsprozesse eines 4PL. Technologische Forschungsfragen betrachten vor allem die Erforschung einer 4PL-Plattform mit unterschiedlichsten Funktionen. Eine Analyse der Forschungsmethoden zeigte, dass die argumentativ-deduktive Forschung und qualitative/quantitative Querschnittsanalysen die dominierenden Forschungsmethoden im Kontext des 4PL sind. Unter der Annahme, dass es sich dabei eher um „schwächere“ Methoden als beispielsweise mathematische/formale Modellierung, Simulationen etc. handelt, könnte dies auf die derzeitige Reife der 4PL Forschungsarbeiten hinweisen. Es deutet darauf hin, dass sich die Forschungsarbeit im Kontext des 4PL noch im vergleichsweisen frühen Stadium befindet. Diese Vermutung wird bei der Analyse der offenen Forschungsfragen bestärkt, da konkret in der Literatur nach möglichen Planungswerkzeugen und Simulationsmodellen im Zuge der IT gefragt wird (Link-Anhang - (Pos.4)). Zu-dem finden sich in der Literatur offene Fragestellungen nach Beteiligten und deren Funktion, nach Funktionen eines 4PL, nach Kooperationsmöglichkeiten und nach strategischen Herausforderungen. Aufgrund dieser vielfältigen Fragestellungen wurden Experteninterviews vorbereitet und in der Branche der Nacherntelogistik durchgeführt. Teilnehmer waren Spediteure (S), Frachtführer (F) und Händler (H) mit unterschiedlichsten Transport- und Handelsvolumen (Link-Anhang - (Pos.6)). Es wurde festgestellt, dass der 4PL-Ansatz mit einer entsprechenden Plattform bisher nicht in der Branche vorhanden ist bzw. war. Derzeitige logistische Aktivitäten der Nacherntelogistik werden mit Hilfe von Fax, Telefon und E-Mail durchgeführt. Als mögliche Services eines 4PL wurden ein Tracking und Tracing, eine

Auftragsabwicklung sowie eine Routenoptimierung von den Teilnehmern gefordert. Die Umsetzung des 4PL-Ansatz mittels einer 4PL-Plattform wurde als innovativer Ansatz in der Nacherntelogistik bekräftigt. Auf Basis der Erkenntnisse der Experteninterviews und der Ergebnisse des Reviews (Link-Anhang - (Pos.7)) wurde ein Konzept einer 4PL-Plattform, in Form einer N-Tier Architektur, für die Nacherntelogistik erstellt.

Abb. 1 stellt die N-Tier-Architektur dar, welche sich in unterschiedliche Schichten unter-teilt. Sofern möglich, sind die Bausteine und Funktionen mit den Referenzen aus der Literatur (Nummer) und den Ergebnissen aus den Experteninterviews (S,F,H) versehen. Die Steuerungsschicht zeigt übergeordnete Funktionen eines 4PL. Das Informationsmanagement wird durch die Geschäftslogikschicht näher beschrieben.

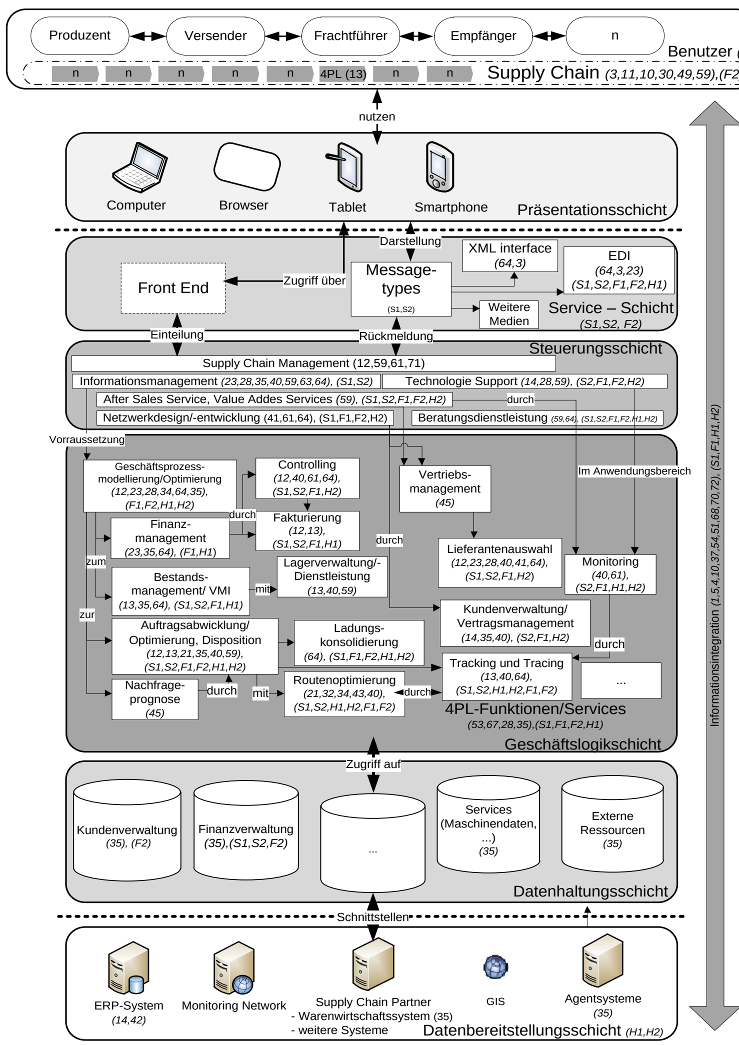

Abbildung 1: 4PL-Architektur

4 Fazit und Ausblick

Der 4PL-Ansatz findet in der Literatur punktuell Erwähnung, wurde jedoch bisher nicht weitergehend systematisch aufgearbeitet. Mögliche Architekturen und Referenzmodelle befinden sich derzeit noch am Anfang der Entwicklung. Die dargestellte Architektur kann als Orientierung und Ausgangspunkt für weitere Forschungsarbeiten dienen. Des Weiteren sind die Entwicklung einzelner Funktionsbausteine des 4PL sowie die Lösung der dargestellten offenen Fragestellungen (Link-Anhang - (Pos.4)) wünschenswert. Der allgemeine Tenor erkennt das Verbesserungspotenzial in der Nacherntelogistik. Es fehlen jedoch repräsentative Schnittstellenanalysen bzgl. der Frachtführer und Auftraggeber, die die strategischen, kooperativen und ökonomischen Aspekte berücksichtigen.

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Hinweis: Folgender Link führt zur Liste der analysierten Beiträge sowie zu den Verweisen. Im Falle einer Störung des Links, kontaktieren Sie die Autoren zur Bereitstellung des Anhangs. http://www.uwi.uni-osnabrueck.de/Anhang_4PL_Anforderungsanalyse_Nacherntelogistik.pdf

Beitrag 2: Adoption of Fourth Party Logistics in the Sector of German Agricultural Bulk Logistics - A Technology-Organization-Environment Framework Approach

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Adoption of Fourth Party Logistics in the Sector of German Agricultural Bulk Logistics - A Technology-Organization-Environment Framework Approach

Adoption of Fourth Party Logistics in the Sector of German Agricultural Bulk Logistics - A Technology-Organization-Environment Framework Approach

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 freightage 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 agricultural 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.

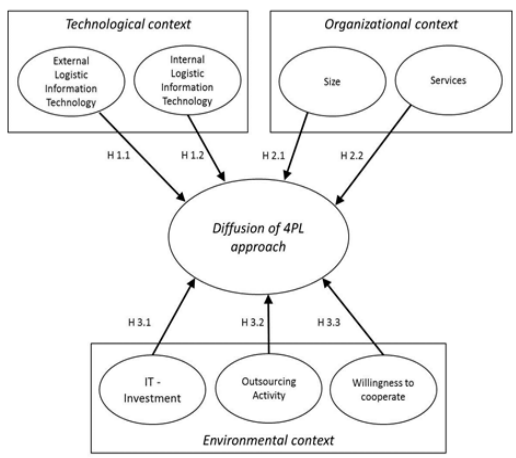
The division of labor in a network of agricultural bulk logistics as a diffusion factor of a 4PL approach requires the technical readiness of the involved actors and their willingness to cooperate. Studies have revealed that cooperation improves the innovation capability and performance of the cooperating 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 gausian 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***	
Technological context							
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
Organizational context							
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
Environmental context							
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 acknowledge 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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Beitrag 3: A Conceptual Framework of a Decision Support System for Operational Dispatching of Agricultural Bulk Goods – An Agent-Based Approach

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A Conceptual Framework of a Decision Support System for Operational Dispatching of Agricultural Bulk Goods – An Agent-Based Approach

Abstract:

Transportation planning may imply versatile and complex decision problems. The most distinctive feature of agricultural transportation planning is: a dynamic and rapid transaction of harvesting processes. During the harvesting process various actors such as farmers, contractors, agricultural traders, transportation companies and processing industries have to collaborate. This contribution presents a conceptual framework of a decision support approach for operational dispatching and its implementation based upon a multi-agent system (MAS). This agent-based approach enables users to conflate dispersed structure information, apply optimization techniques and provide a goal-oriented planning and transaction of transportation.

Keywords: Decision Support System, Multi-Agent System, Fourth Party Logistics (4PL), Agriculture

1 Introduction and motivation

Transportation volumes of the agricultural sector increase. This is a result of structural changes in the sector such as a steadily decreasing number of reception points and the emergence of major processing industries. In addition, an increasing commodity trading on the stock market as well as the current trend towards more energy supply through biomass indicate a change within the agricultural sector [1], [2]. As a result an increasing demand in transportation has to be met with available capacities, which are presently at their limits.

The transportation volume of the agricultural sector in Germany is at about 3.595.373.000t per year, of which 76% (2.734.098.000t) are commercial road traffic [3]. About 90% of this is inland traffic [3]. Other means of transportation are railroad cargo traffic, inland navigation and sea cargo handling, which serve as cross-boarder transport through import and export of agricultural goods. The value of the harvests of agricultural goods significantly impacts the transportation volumes and thus the dispatch of transports. The main influencing factors of dispatch are: people, management, method, machines, material and the environment. For example, within the factor 'environment' weather determines the harvest period and for the harvest volumes stock markets determine price development and trading activities. At the same time legislation influences the dispatch of transportation depending on the use and processing of the goods with foodstuffs directives. Those directives impose quality criteria on the transportation means (Global Manufacturing Practice (GMP)) [4]. The quality of the harvested crop influences its utilization and thus the type of processing of the good (material) either for foodstuff or feeding stuff. Furthermore, the dispatch of transportation depends on the supply of cargo space and machinery. The latter is important because many harvested crops require specific means of transportation. Currently, people are the main factor for transportation dispatch. According to an online survey of 148 carriers in the sector, conducted in October and November 2012, transportation commissions are assigned based upon experience and individual preferences of the cargo loaders. The factor 'management' of this sector is characterized by little interconnectedness and few approaches of cooperation. In terms of the methodology, dispatching is accomplished mainly via phone and fax as well as sporadically via email. Presently, this may be characterized as 'ad hoc workflow' of transportation transaction. As a result transparency and oversight of transportation activities for the dispatch of agricultural bulk goods are slight. Figure 1 provides an overview of the main influencing factors [5].

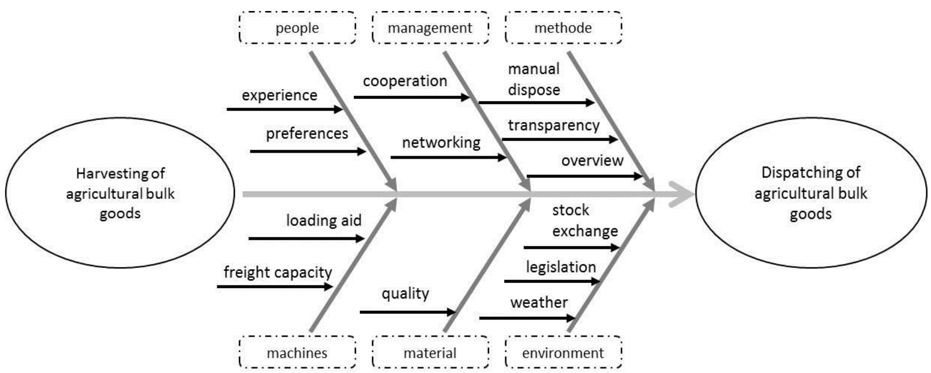

Fig. 2. Main influencing factors of dispatching agricultural bulk goods

In order to introduce market transparency as well as to pool the aforementioned key actors the authors examined the Fourth Party Logistic Provider (4PL) approach. With this approach requirements of a Transport Order Management System (TOMS) can be identified. The main challenge of a TOMS is to master the transition from the previous ad hoc workflow, in which each actor tries to optimize individual target criteria locally, to a global optimization of work flow with network-oriented target criteria and standardized information flow. The main part of a TOMS is the transaction of shipping orders.

The following paragraphs describe the conceptual framework as well as design considerations of a decision support system (DSS) for the transaction of shipping orders in the agricultural sector. This sector is characterized by loosely linked actors which create a transportation network of Germany. Furthermore, the transportation network is subject to dynamic alterations dependent upon varying harvest periods as they affect trading and transportation activities as well as the routes of transportation. From the point of view of a 4PL structural information is decentralized in the hands of the actors of the transportation network. For this reason a multi-agent architecture was selected, which represents actors as software agents integrated in a DSS. These actors may be endorsed with diverse manifestations and functions. In the first instance, a transportation planning agent (TPA) is developed. This agent is endowed with the capability to operatively dispatch agricultural bulk goods. The agent's activities are integrated in a conceptual framework of a TOMS.

These research activities are part of the third party funded research project KOMOBAR, which examines decision and communication strategies of cooperating mobile agricultural work machines. The following section provides terms and definitions. Section 3 sketches the state of the art of Transport Management Systems (TMS) and MAS. Section 4 elaborates on the functions of a TOMS based upon an implemented requirements analysis within the sector in combination with a validation of the MAS and taking into account practical values of the involved actors. The last section 5 discusses potential future research and benefits of the TOMS, for the 4PL approach and for the sector.

2 Background and terminological foundation

The 4PL approach introduces a neutral actor to a network who plans, implements and controls the requirements of customers. This actor is equipped with the capacity of the suppliers [6], [7]. The pooling of available information is supposed to create synergies among customers and suppliers. Practice-oriented approaches describe a successful implementation of 4PL in retailing [8] as well as automobile production [9]. These results encouraged the authors to review an adaption of the 4PL approach within the agricultural sector. Similar to the aforementioned branches, customers within the agricultural sector should be enabled to acquire traded goods safely and transparently. Moreover, transportation services suppliers may expect an efficient resource utilization. In order to implement the 4PL approach sufficiently a thorough analysis of the previous ad hoc workflow for the transaction of transportation including its applied methods, mechanisms and processes of the sector.

A typical ad hoc workflow is characterized by a non-standardized process, which can not always attain optimal results. Furthermore the ad hoc workflow is mainly determined by individual experience. However, an administratively supporting workflow follows well-defined procedures, apart from occasional exceptions [10]. Internal and cross-company business processes that are operated and controlled by IT support have key functions for the workflow management as well as the 4PL approach [11]. An increased process transparency, an improved integration of actors, an accelerated information flow and this way an improved efficiency result in an increased additional value of the workflow. A cross-company workflow is significant for a transportation management that controls the transportation of goods and includes all actors of the sector (traders, transportation providers, service providers, recipients and senders). This results from the timing process among the various actors. The literature [12] distinguishes central, decentral and hybrid transportation planning approaches that provide guidance for handling the complexity within those supply chains. This may also be relevant for the application in the agricultural sector.

Central transportation approaches plan and regulate the transportation network by help of a software instance. This includes the recognition of a transportation request message (TRM), transaction and controlling. The integration of various actor parameters which includes processing large data sets is a challenge. These data sets may alter permanently, but have to be processed instantly [13]. In addition, only local planning expertise is available for processing relevant information within a centralized planning system [14].

In case of a decentralized transportation planning approach network actors decide autonomously. Each of the actors may apply own specific target criteria, and individually decide either for acceptance, forwarding or rejection of a commission. In this case local knowledge is applied [14]. Yet, available local actor systems are linked due to software agents as well as predefined interfaces and protocols. This system landscape facilitates a data and information exchange beyond local scale.

Hybrid planning systems merge both centralized and decentralized planning approaches, whereby a centrally designed plan is being provided for autonomous units. In case of a deviation of the plan agents flag feedback, which may achieve control function on demand [13].

According to Wooldridge and Jennings [15] a software agent is a hardware or software-based computer system which operates without the direct intervention of humans or others. Software agents have some kind of control over their actions and internal state (autonomy). In addition, agents may have social capabilities in order to interact with other software agents or users. Moreover, agents are reactive and even proactive, and this way have the capability to interact with the environment (entities that are not agents nor users) [15]. Once single software agents are linked and start interacting, a multi-agent system (MAS) emerges. These MAS may generate and represent complex systems with various functions [16]. Agent-based approaches including MAS emerged from a number of scientific disciplines such as artificial intelligence, robotics or system science when object-oriented programming methods were applied and human interfaces have been examined [17]. The application of agent-based approaches is manifold and reaches from product developments to supply chain management (SCM) [18]. The following section discusses related agent-based approaches as well as previous knowledge and experience of the agricultural sector as well as the 4PL approach.

3 Related research and survey results

In order to study possible applications of MAS within logistics the databases 'EBSCO', `Web of Science and Wiley Online Library were employed to browse for the keywords: MAS, agent, supply chain and logistic. This resulted in various descriptions of applications in the field of logistics in scientific journals and conference proceedings. For instance, Mishra et al [19] describe the MAS-based logistic management of a recycling process that supports the enterprise in the implementation of 'green' supply chains. Kaihara und Fujii [20] demonstrate an example of a gaming approach for the management of industrial collaboration with an MAS. Sheremetov und Rocha-Mier [21] demonstrate another example of a supply chain optimization with an MAS. The focus is here on dynamic structure and information alteration within a decision making process in a supply chain. Gerber and Klusch [22] describe the use of agents for mobile planning services in the agricultural sector for the harvesting process. The intended transport process takes place down-stream of the harvesting process. These examples examine possible applications of MAS upon various issues. However, the literature does not provide applied MAS in transportation planning with logistic service providers in the agricultural sector [23]. Effects of collaborative planning are discussed [24], however, only sporadic functions and issues suitable for the application of MAS are presented [25].

There are several approaches for agent endowment. For example, supply chain actors may be represented as software agents (e.g. Supplier Agent, Producer Agent, Distribution Agent, Warehouse, Purchasing) [21] [26], if the number of actors/agents is manageable, and the specific roles are different. Alternatively, agents may represent various planning functions [16], [27]. Lima [16] introduces an agent-based model that employs three different principle agents (client, order management and resource agent) for production planning and control. In contrast, Yee und Cheng-Wei [27] model a procurement process of a supply chain with a MAS. A number of practice-oriented approaches demonstrate partial solutions, where an MAS only contributes to a single problem, but cannot provide the entire solution [28]. For example, an MAS was employed to simulate an entire supply chain in order to calculate the lowest possible total logistic costs. This is achieved by an inventory management among agents [29].

Lee and Kim [18] demonstrate that especially those MAS should be employed which are capable of handling the dynamic and rational behavior for strategic commercial decisions. This is the case of applied transportation planning. On the one hand due to harvesting and trade activities agricultural transportation planning must be dynamic. On the other hand each of the involved actors behaves entrepreneurial with rational target criteria. For this reason transportation transaction must be implemented in a way that various sub processes can be clearly distinguished and represented by help of a MAS. Every agent is designed to control a sub process with the aim to keep the complexity low – especially for potential users. Decentralization is supposed to enable the integration of communication and information systems with the aim to minimize barriers at an early point of time within the process.

In the agricultural bulk sector different factors influence the dispatching. These are the temporal coordination (fast flow of information, flexibility), the sector specific factors (especially transportation requirements), low cooperation and competition of the actors. The quest for an appropriate method to implement a service provider (4PL) in the dispatching process resulted in an agent-based approach. This way each actor is represented within the dispatch of agricultural bulk transportation through the TOMS according to his access permissions and his specific requirements. Due to the competition among actors a transparent, neutral and anonymous dispatch is required. In addition, each actor wants to act anonymously. The added value of the 4PL is the coordination of transportation based upon the capabilities of the TOMS and the emerging cooperation of all involved actors. Through the TOMS each actor is expected to benefit from the added values. In addition to saving transaction costs the greatest potential are expected by the improved resources.The aforementioned requirements analysis [30], supported the idea to develop a TOMS which was integrated in a DSS for operative dispatch. Participants of this analysis requested order administration (acceptance, processing), a cross-network planning (a combination of freight orders, tour optimization and assessment, selection of service providers, choice of loading and unloading points, pricing, tracking and tracing) as well as transportation order controlling (parameters of the cost-benefit analysis and comparison of the planning and implementation parameter, documentation of the traceability).

Due to sector-specific impact factors derived from management of the sector as well as from the yet available methods how agricultural goods are dispatched, a test is required for the analysis to what extent a neutral 4PL employing an MAS-based and networked TOMS can contribute to an efficient dispatch of bulk goods in the agricultural sector.

Apart from modeling the entire TOMS the design of the agents for transportation planning was condensed, since synergies may be expected due to the application-oriented design of the agents. On the network scale the 4PL applies the travelling sales man problem (TSP) approach for the long-term planning over a period of one to six weeks. However once the transportation service provider is engaged the 4PL has to consider the Vehicle Routing Problem with the special case of the Pickup and Delivery Problem (PDP) on the short term. Hence, the design of a conceptual model including an implementation and validation of the transport planning agent are the first goals for this research.

4 A conceptual framework for an agent-based TOMS

TOMS are distinguished in the analysis of transport order demand, transport order planning, transport order transaction and transport order controlling [31]. The latter activity follows the transport order via the actors of a transportation chain. Various characteristics may be derived from the different sub ranges of transport order management (see table 1).

Table 2. Elicited characteristics of a TOMS

Analysis of transport order demand	**Transport order controlling**
• Entry of transport order • Feedback to sender	• Monitoring of business ratio • Provision of status reports • Controlling of deviations between target and performance
Transport order planning	**Transport order transaction**
• Compilation of supply routes • Evaluation of routes • Selection of service providers • Identification of alternative means of transportation • Costs assessment • Order of services, compilation and sending of transport orders (nominal value) • Sending of transportation information to the involved actors	• Provision of the goods by sender • provision means of transportation by transportation service provider • Informing the recipient • Track and trace of transportation activities • Invoicing of the transport order/service

In order to describe the conceptual framework of a TOMS a description of the involved agricultural actors is required. Actors of a network who use such a system may resume several roles at the same time. For instance, a trader may also be a recipient as well as a transportation provider as long as he holds transportation capacity. However, a 4PL service provider can only play the role of a service provider. In addition the actors have specific properties and have to consider sector specific characteristics.

Traders: the aim of a trader is to efficiently (in terms of transportation costs and emission volumes) transport goods from the sender to the recipient in a well defined time slot as economically as possible. This way commercial transactions generate transportation demand. Once generated the transportation demand order is endowed with criteria such as recipient's and sender's address, transport volume and the preferred transportation provider. In addition, the trader wants to monitor the transportation status. Furthermore the trader sells the goods including logistic costs and has to guarantee that the transportation provider is certified (GMP). This includes also a complete documentation of the origin and the quality of the goods.

Sender: the aim of a sender is to send goods in a well-defined time slot in order to finalize the commission with the trader accordingly. From a logistics point of view the sender wants to be informed in time about the transportation status, in order to consistently provide loading points with resources. Depending on the transport vehicle an appropriate equipment is to be provided. Transport vehicles can be a dump truck, tanker or walking floor. A dump truck or walking floor can be loaded by conveyor belts. The loading of a tanker is usually through a top opening. Based on the vehicle information and the information of the defined time slot preparations can be performed that minimize the downtime of the transportation provider.

Recipient: the aim of the recipient is to receive goods purchased from a trader in a well-defined time slot. From a logistics point of view the recipient requires precise information about the scheduled unload of the transportation provider, in order to provide the required resources. The use of the resources to discharge corresponds analogously to the restrictions of the loading. Furthermore, monitoring of the transportation status is desired.

Service provider: the aim of a services provider is to employ available resources in a network efficiently. The transportation planning is a complex planning task because of the agricultural factors (good, vehicle, equipment loading point, equipment unloading point, quality of goods, certification of the transportation provider). The TOMS supports the bundling of information flow as well as the conflation of various transportation demands for transport order planning. Considering the sector specific characteristic that all actors are loosely connected and decide by themselves which information to share. Based upon the transport order planning, transportation providers are selected, transportation costs requested and transmitted to the trader. Once confirmed, transport orders and loading information are sent to the transportation provider. Sender and recipient receive advise, and the transportation status is monitored by track and trace. Finally, the transport order controlling for routing the entire network and invoicing of transportation. One task of the service provider in the sector is the representation of the added value for all actors through a controlling.

Transportation provider: the aim of the transportation provider is to utilize the available resources (vehicle fleet). This can be accomplished by simulating transportation during the planning phase in order to minimize empty trips as well as CO2 emission. In the agricultural sector the available resources are especially in the harvest very limited so that the shift of transports or orders is the only possibility. In addition the selection of the vehicle is influenced by the freight as well as the load and unload resources.

During previous interactions of the actors mainly direct trade of goods is applied. This enables all trading partners (sender, recipients and traders) to both employing their own vehicle fleets as well as engaging transportation providers. Because of the solitary character of transport orders and the segmented transportation control an agent-based transportation planning should be implemented by a single service provider.

Figure 2 depicts the conceptual framework of a TOMS including its actors and the respective agents.

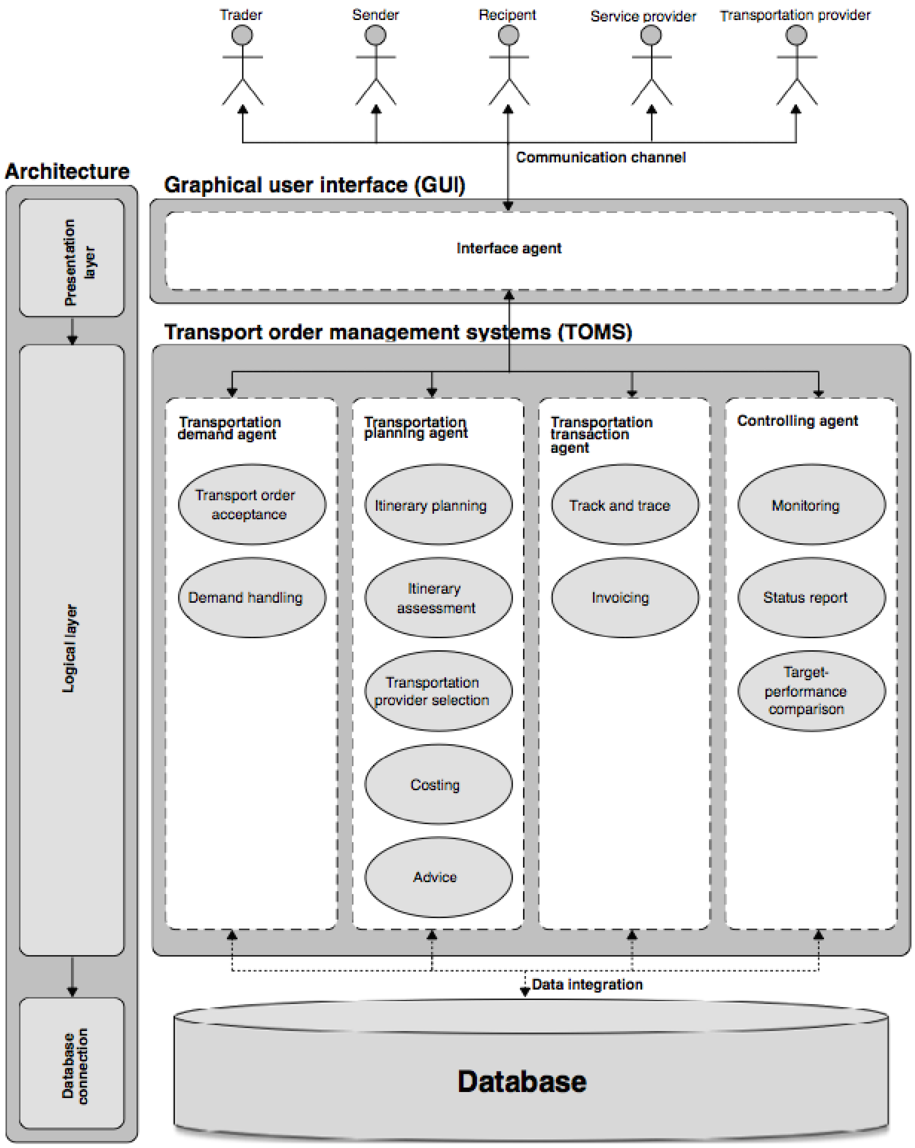

Fig. 3. Conceptual framework of a TOMS

The model architecture is partitioned in three different layers: 1) the presentation layer, 2) the logical layer and 3) the database connection. The presentation layer holds the interface agent who assigns permissions to various actors. The logical layer contains the TOMS which is partitioned in the transportation demand agent (TDA), the transportation planning agent (TPA), the transportation transaction agent (TTA) and the controlling agent (CA). Each of the agents has particular functions. The database is a mySQL relational database.

The TDA decides whether the TRM can be dispatched based upon his own parameters and specific properties of the TRM. Furthermore, an instant feedback indicates missing parameters of the TRM. In addition, an instant feedback informs the actor whether the service provider accepts the TRM or the usual ad hoc procedure should be applied.

The TPA performs an automated dispatch including an improved employment of resources. To this end the TRM is subdivided in TO. Moreover, various TRM are linked and a transportation providers are selected automatically. In contrast to an ad hoc process the TPA is capable of reducing the complexity of dispatch by bundling all TO.

The TTA provides a target-matching procedure, which is demand-oriented based upon the information from other agents in the system. To date target adjustment is only done selectively.

The controlling agent collects all generated data for the stakeholders. The TOMS enables actors to benefit from the added value of the 4PL including a planning and cooperation. Apart from saving transaction costs the improved use of resources has the highest potential for economisation.

Based upon the demand for itinerary planning from the sector the TPA was developed as the first prototype. The agent was programmed in Java, and linked to the mySQL database. In addition to the existing itinerary planning a complete lookup procedure, a tabu search (TS) and a simulated annealing (SA) were implemented. The application of an array of algorithms and heuristics supported the examination of the most suitable procedures. The dependent parameters hereby were: TRM, computing time and cost savings. At the same time planning periods can be selected, and other parameters such as cruising speeds for transportation vehicles and computing time can be configured. Figure 3 depicts the graphical user interface (GUI) of a dispatching device for itinerary planning. The various TRM as received from the traders, senders and recipients is compiled by the TDA. The TPA is able to access these data and process them according to his functionality and additional information's. Moreover, the TRM contains information such as time window for delivery, loading and unloading address and characteristics, tonnage, as well as vehicle specifications. The TPA pools the registered TRM and assigns the complete transportation request to single vehicles. This process generates new transport orders (TO) which takes into account a delivery tour for the transportation provider. Furthermore the database facilitates a data set of transportation services and transport capacity. The TPA is initiated based upon TO in a way that itinerary planning including its restrictions (loading aid, time slots, driving times, maximum tour distance) is generated. The results of such a TPA activity are generated delivery tours consisting of various TO and various TRM, and at the same time considering the transport capacity. This way the transportation transaction agent (TTA) is capable of providing the dispatched deliverance tour to a transportation provider. Once the TO is confirmed the transportation provider can be assigned, which results in the removal of the respective TO's out of the itinerary planning pool. If the assignment is refused, the TO's remain in the pool. In the case of a successful assignment, the involved actors such as senders, traders and recipients are informed.

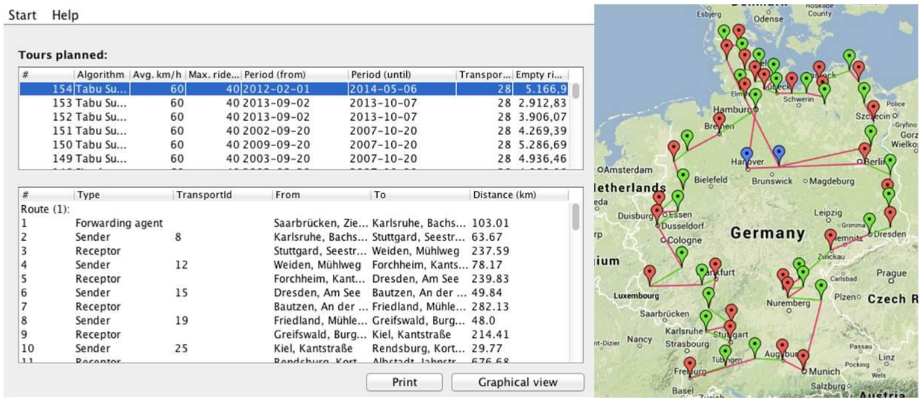

Fig. 4. GUI for route planning

In view of communication capacity and fault management the TTA is not yet entirely implemented. In the conceptual framework this agent receives those data in XML data format, and transmits status information to other agents. This way TO are registered, (the order starts: loading) and logged off (the order stops: unloading). Furthermore, track and trace data of the transportation status, possible faults (downtime for loading and unloading, traffic jam, breakdown) should be communicated. All together, this should enable the agent to automatically react upon those signals. As soon as the transportation provider signals the accomplishment of the TO, invoicing as well as crediting of the transportation service will be disposed. During the entire order process the trader should be enabled to track the order status with his own GUI for the TPA. In addition, this agent compiles the TRM. The Sender and recipients have GUI for transport order tracking, where the notification function of the TPA provides an overview of incoming and outgoing transports.

The controlling agent is supposed to collect all generated data of the transport order process and compiles them for the use of the respective actors. This way relevant parameters are supplied for transportation providers, traders, senders and recipients. Based upon those parameters a number of evaluation criteria are generated for guiding each of the involved actors and to demonstrate development perspectives of the TOMS and the involved actors.

On the basis of TOMS the information flow is accelerated in contrast to the previous adhoc process. Thereby time can be saved which allows a transportation planning for a more efficient use of resources. In addition, the TOMS enables a transparent flow of information between the actors.

Figure 4 describes the interaction protocol of the described agents. All current research activities focused on the implementation of the TPA. The reason to start with this agent is that especially the agricultural specific challenges and characteristics have to be considered in this agent. Furthermore the functions of the transportation demand agent is implemented so that the TPA can perform the functions. The delivery tours are currently available in XML format for the TTA.

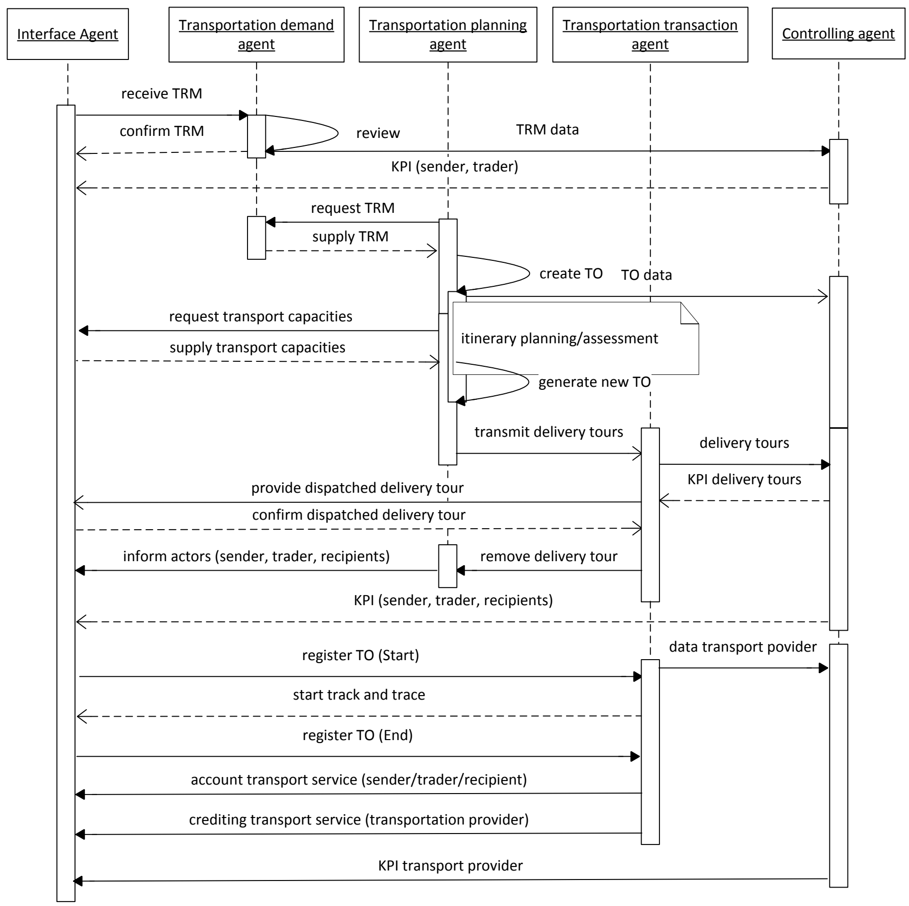

Fig. 5. Interaction protocol of a TOMS

In the following the experimental evaluation of the TPA is demonstrated, because of its strategic significance as first prototype. The TPA allows an improved transportation planning via Algorithms. Based on the Algorithms' more restrictions of the agricultural transport planning can be considered against to the manual adhoc process. In addition the dispatching based on the TPA allows a transportation planning in smaller time intervals.

5 Experimental evaluation

In order to validate the transportation planning agent an experiment was conducted. About 150,000 TO transacted within a period of two to three years (2010-2012) and about 200 transportation providers including their geographical data serve as input variables. Those data were provided by a research partner who is himself a wholesale trader within the agricultural sector. These are real-world data from past activities, which have the capacity to represent real-world actors under sector-specific conditions. Each of the TO has a loading and unloading position as well as a time slot for transportation transactions. Other parameters such as quantities, price as well as loading and unloading times were neglected. For the itinerary planning the methods tabu search (TS) and simulated annealing (SA) were employed.

Key parameter of the Tabu Search is the length of the tabu list. A too short tabu list < 3 can result in cycles. Cycles should be avoided because these calculate same solutions. In the described experiment the authors apply a tabu list length of 32.

Key parameter for the Simulated Annealing are the temperature and the cooling down rate. The temperature represents the duration of the experimental runtime in seconds/1000. For example, an experiment with an 8h runtime complies with a temperature of 28800/1000. T and r were divided by 1000 in the experiment because the procedure needs small numbers to work with the probability of the Boltzmann's theorem. Usually these parameters are given and are not calculated. Based on the practical time-based approach the calculation was necessary.

The complete lookup procedure is only suitable for dispatching a maximum of 11 TO because more TO would result in unacceptably long runtimes. However, this method can be applied for tour optimization at a later model stage. For this reason a number of restrictions have been specified: a maximum of 40 weekly hours, the transportation provider has to return to his origin by the end of the week. The aim is minimization of empty trips. A computer with the following features has accomplished all calculations:

- Processor: Intel® Core ™ i5-3550CPU@3,30GHz;
- Memory: 8,00 GB;
- Windows 7 Enterprise-Service Pack 1,
- System:64 Bit OS.

The Computation times of one, two or eight hours determined termination conditions of the respective procedure, which is derived from real practice-oriented everyday work. A calculation time of one hour represents a rearrangement procedure in the case of failure. A calculation time of two hours describes the required dispatch during forenoon or afternoon of any working day. The dispatch of eight hours describes the available computation power during inactive work periods. The TO sample set also describes practice-oriented periods. Exactly 20 TO describe a dispatch effort of one hour and 100 TO describe the dispatch effort of half a day. Hence, 2000 TO correlate with the dispatch effort of two weeks. The reduction of empty trips in kilometer served as measurand, since this way efficiency enhancement can be delineated. In addition, possible costs savings can be derived.

Each experiment was carried out by selecting the number of the TO and the planning method and the runtime (1h, 2h, 8h). For the number of TO a randomly selected period was chosen from the data. Due to the graduation of the runtime we did 12 experiments with 1h, 12 experiments with 2h and 12 experiments with 8h. The empty kilometers calculated by the TPA were set in relation to the empty kilometers of the adhoc process. Table 2 presents the experimental results.

Table 3. Generated experimental results of the transportation planning agent

TO	Methods	Empty trip in km			Empty trip (adhoc) in km	Saving in km			Saving in %		
		1h	2h	8h	-	1h	2h	8h	1h	2h	8h
20	TS	3316	3316	3316	5404	2088	2088	2088	39	39	39
	SA	3288	3287	3287		2117	2117	2117	39	39	39
50	TS	11774	11453	11229	15695	3921	4242	4467	25	27	28
	SA	11585	11186	11055		4110	4510	4640	26	29	30
100	TS	19151	19151	18741	29591	10440	10440	10850	35	35	37
	SA	18965	18902	18387		10625	10689	11204	36	36	38
200	TS	34841	34829	33889	52944	18103	18116	19055	34	34	36
	SA	33968	30279	28504		18976	22665	24440	36	43	46
1000	TS	153406	150057	150051	224429	71022	74371	74377	32	33	33
	SA	147775	142080	141237		76653	82349	83192	34	37	37
2000	TS	311329	295081	285974	440493	129164	145412	154519	29	33	35
	SA	289829	287303	273750		150664	153190	164581	34	35	37
					Average saving tabu search				32	34	35
					Average saving simulated annealing				34	36	38

The experiment demonstrates that calculating with the TS method results in less empty trips than the SA method. Essentially, the application of a transportation planning agent can save 25 – 46% of empty trips due to route generation. Depending on the quantity of automatically dispatched TO the reduction of empty trips can vary between 2,000 and 164,000 km, which corresponds to a dispatch time frame of one to two weeks. In addition, there is more potential in terms of dispatch effort since every itinerary route has an average of 9 TO, which may entail a decreasing dispatch effort by a factor of 9.

The transportation planning agent selected service providers automatically based upon the vicinity of the provider to the loading point. If transportation providers receive specific request for particular routes, the TTA of a transportation provider is addressed.

6 Summary and outlook

In summary, this effort describes the design and development of a DSS for operative dispatching of agricultural bulk goods by means of an MAS including a 4PL approach for this sector. The collected research results can be clustered in the decision for an MAS, in the decision for 4PL service provider and the findings for the agricultural supply chain.

The decision for an MAS resulted from the complex and dynamic planning requirements of that sector. For this reason a requirements analysis of the sector was conducted in order to determine relevant functions. The conceptual framework of the TOMS integrates all relevant actors including their specific functions and characteristics of the sector. Due to the distinctive autonomy of the different actors the model is based upon autonomously acting agents. These agents are capable of handling the associated requirements of the real-world actors. On the one hand the individual autonomy of each actor/agent is preserved, on the other hand an optimal itinerary planning can only be achieved due to the network character of the overall model. Based on Lee and Kim [18] we presented a practice orientated approach where the transport planning has a very flexible time dimension in a network. To the best of our knowledge this is the first approach which combines MAS and the 4PL approach in the agricultural sector.

The 4PL service provider has the main responsibility for the planning procedure. He pools information, and receives this way a more comprehensive basis for planning in comparison to the other actors. In addition, due to concerted communication the number of interfaces can be minimized. The committed supply of status information for each of the involved actors minimizes queries and accelerates information flow since prompt decisions are yet possible. The planning activities of the 4PL service provider applying the transportation planning agent depends upon the number of incoming TRM as well as the supply of transportation provider capacity. Both parameters fluctuate depending on harvesting periods and general trade activities. The 4PL approach is described in a variety of branches but the authors are not aware of any approaches in the agricultural bulk logistics.

The agricultural bulk logistics has a high potential in terms of coordination the TO and cooperation of the actors considering the dynamic characteristics of the sector. Each actor can maintain his autonomous choice in the presented TOMS. Nevertheless, the existing adhoc process can be supported by the implemented agents. In the long term, the TOMS can replace the existing adhoc process completely. This would be a leap innovation for the sector. For this purpose more convince in the rather conservative-driven industry is required. A first contribution should make the evaluated experiment.

The evaluation experiments indicate that higher quantities of TO in the planning correlate with a higher reduction of empty mileage. Hence, there is an increased chance of financial savings. At one hour computation time the saving potential is about 32-34%. At an increased run time additional savings of merely 2-4% have been achieved. Thereby, SA excels the TS method. This may be due to the faster methodological approach: in contrary to TS, SA calculates multiple routes within the same time slot.

The experiment is limited by the initial parameters as well as the structure of the conceptual framework of the TOMS. Initial parameters in form of sector-specific information describe discrete relationships as well as recurrent transport volumes in a data set. Moreover, the experiment was calculated with a regular PC.

Specialized data processing centers may compute different results because more calculations can be done per given time slot. However, employing a PC underlines the applicability in practice. Within the conceptual framework of the TOMS currently a maximum of 2,000 TO were calculated, which correlates with a TO influx of two weeks. The implementation of the TPA supports a minimization of the present ad hoc work flow and fosters the assignment of itinerary tours. For future developments the presented agents will be finalized. Those agents carry standardized information flows and interfaces. In addition, the overall systems performance and the user friendliness of the various agents will be improved with the help of the relevant real world actors. Moreover, criteria for the evaluation of actors by the controlling agent will be further specified. Finally, the TPA will be tested with additional heuristics including the implementation of forecasting data.

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Beitrag 4: A Fourth Party Logistics Provider within an Inter-Organizational Network: An explorative Study with the Example of the Agricultural Bulk Logistics Industry

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A Fourth Party Logistics Provider within an Inter-Organizational Network: An explorative Study with the Example of the Agricultural Bulk Logistics Industry

Abstract

This exploratory study provides an understanding of how the Fourth Party Logistics Provider (4PL) approach affects the development of inter-organizational networks within the agricultural sector. A research within the German agricultural bulk logistics industry discovered that the 4PL approach coincides with the ongoing technical development of the industry and enables them to provide crucial functions for these networks. Moreover, the functions of a 4PL may induce an efficiency-enhancing effect for a network. The greatest identified potentials are: (1) Information and communication technologies (ICT) support a more efficient transportation planning as well as more transparency, and enhance the degree of cooperation within the network and its inter-organizational dynamic; (2) If the 4PL approach adapts to inter-organizational forms of coordination, than new experiences for the development of the 4PL (increased commitment, cooperation strategies) may be expected; (3) If the 4PL claims technological leadership within the industry, this may result in a long-term competitive advantage.

Keywords: 4PL, inter-organizational network, relation view, logistics, ICT

Introduction

Supply chain management is a set of various approaches for the integration of actors such as suppliers, manufacturers, distributors, and clients in order to transport and distribute goods within the required time, to the right location, at the correct quality, and the correct volumes. The functionality of supply chain management defines itself as an inter-organizational network (González-Benito et al. 2013; Sydow and Frenkel 2013). This network comprises a variety of functions depending on the requirements of the clients; for example, transportation, handling, and the distribution of goods. As a consequence, a specialization of the actors involved (division of labor) is required in order to achieve an efficient use of available resources. The development of ICT enabled an increasing labor share and encouraged a more efficient use of resources within a network. The literature provides several definitions of Fourth Party Logistics Provider (4PL) (Mukhopadhyay and Setaputra 2006; Win 2008). In summary and for the present research approach we define 4PL as a neutral intermediary implementing supply chain management and using the resources of actors efficiently. Order fulfillment is accomplished with an IT infrastructure that provides network functions (Nissen 2001). The 4PL does not operate with own equipment (non-asset based approach). Furthermore, surplus value for a focal enterprise as well as for the clients is generated by a supervisory management function (Win 2008).

A number of industries such as automotive (Liu et al. 2010), food (Prümper and Butz 2004) and chemical (Bertschi 2011), have realized the potential of a higher-level planning instance in the form of a 4PL. However, the implementation of this approach was rather prolonged. In this article, the 4PL approach is viewed as a supporting actor within the agricultural supply chain assigned the task of handling bulk good transportation. Furthermore, the present research describes a comprehensive re-organization of current processes including the outsourcing of entire planning and management functions such as dispatch, controlling, and handling of bulk goods.

Based upon its definition and functionality, a 4PL will have a significant impact on inter-organizational networks. One reason for this is the implementation of a supervisory actor within the existing supply chain. However, the question of how the integration as well as the management of inter-organizational relationships can be implemented still has to be resolved. Based upon the current real-world situation, new approaches have to be found for introducing the 4PL to the agricultural bulk logistics industry in a way that will secure the collaboration of all actors involved. More specifically, this effort focuses on the identification of trans-organizational requirements that foster or hamper the effects of the 4PL. According to the theory of transaction costs, to Powell (Powell 1990), and to Picot et al. (Picot et al. 1996), three approaches for inter-organizational relationships can be described:

- *Market approach*: a number of companies show interest in a collaboration with a 4PL with a focus on resource efficiency rather than a collaboration per se. In this case, logistic resources are provided, which become part of the 4PL's planning effort. Yet, this network actor may achieve an economic value-added with the opportunity to withdraw from his commitment. Furthermore, providing logistic resources may be implemented either on a short-term or long-term basis.
- *Hierarchical approach*: this approach may be applied if the functions of the 4PL are of a long-term character and of profound content. This may be achieved by a complete integration (insourcing) of the 4PL within a focal enterprise as well as the foundation of a joint venture among network actors.
- *Cooperative network approach*: this strategy will be effective if all actors are certain to possess important and irreplaceable resources. That may result in a long-term, strategic value-added. The implementation of such an approach is characterized by informal regulations such as trust, reputation, reciprocity, cooperation, and adaptive behavior of all actors involved.

Based upon these three approaches, various processes, responsibilities, behavior patterns, and perspectives may emerge resulting in different management styles. Moreover, all actors have to comply with permanent changes in the contemporary economy, which influences inter-organizational relationships (Ibbott and O'Keefe 2004; Rodrigues et al. 2013). At best, borderlines are blurred when integrating the 4PL in a network so that actors collaborate smoothly (Vasiliauskas and Jakubauskas 2007). This results in a direct relation between the implementation of a 4PL and the inter-organizational network.

According to Win (2008) the 4PL should have a distinct expertise within the sector as well as consulting capacities and outsourcing experience. Coyle et al. (2003) reasons that ICT has a particular relevance to shape and tighten supply chain relationships. Outsourcing is substantiated by the transaction cost theory which expects a value-added in comparison to an actor network without 4PL (Bretzke 2010; Gattorna 1998; Ji 2008). However, the decision for or against outsourcing (make or buy) of particular transactions to the 4PL remains difficult for network partners. The classic conflict here is between the market and co-operation approach (Koch and Schultze 2011). The implementation of transactions according to the market approach is price-determined, while administrative control remains low and a legal-rules contract law regime should be established. In contrast, the cooperative approach enables transactions through the actor network. However, this requires a mutual agreement, and may entail higher administrative effort (Williamson 1979; Williamson 1985).

Recent publications on the 4PL development within ICT prefer the transaction cost approach and demonstrate how the application of new technologies supports cost reduction, efficient transaction handling and risk reduction due to an improved transparency and information flows (Evangelista and Sweeney 2006; Hong et al. 2010; dos Santos et al. 2013).

Consequently, the application of a 4PL results in various benefits such as (Nissen and Bothe 2002):

- integration of ICT within a platform as well as the integration of network actors (e.g., service providers and customers);
- responding to customer demand by introducing industrial expertise;
- handling process and cooperation management while taking the dynamics of the networks into account;
- generating logistic concept information of services that a single actor cannot provide;
- provision of consulting competencies and strategies with regard to outsourcing, business process optimization, and modification of the network actors.

With respect to the aspects mentioned above, a 4PL can only be beneficial if communication and information systems enable a transparent delineation of transaction costs and a clear definition of all core competencies within the network. For this reason, a transition to the 'make to buy' principle or, in other words, from the hierarchical approach to a market approach logically follows if ICT supports the inter-organizational network (Malone et al. 1987).

At the same time, the inter-organizational network together with the 4PL must comply with specific customer requirements. Hereby, the development of network competency for the implication and compliance of transactions is a special necessity of the 4PL with its ICT.

Apart from the decision of network actors to carry out transactions or not, source-them-further criteria are relevant within inter-organizational networks: trust, reputation, and a minimum degree of altruism are endowments for collaboration with a 4PL and, thus, for the emergence of an independent network. This is demonstrated when a network actor recognizes that a transaction is more efficiently processed by a 4PL than autonomously. Inevitably, in this case, a 4PL would commission another network actor for processing this transaction (Chong et al. 2013; Zaheer et al. 2010).

The emergence of a 4PL, including the introduction of ICT, affects both the inter-organizational network as well as the clients' behavior. Yet, the network is capable of providing new services through the 4PL which a single actor cannot. This is due to the limited resources of a single actor and a high network complexity. Hereby, ICT has a supporting role and the emergence of the 4PL results in a hierarchical approach. If the transaction costs approach is neglected, the increase in service quality remains a significant factor. In addition, clients now have a competent point of contact for addressing their inquiries. Based upon this, the 4PL selects the relevant network actors for processing an order (Feng et al. 2011). This is another indicator of a hierarchical approach.

While the 4PL approach is scarcely in use in Europe, in the USA it is already well-established (Wagner et al. 2014). For this reason it is important to examine relevant differences between the two economic territories. Furthermore, it might be interesting to know why the aforementioned potential of the approach is only barely recognized nor implemented in Europe. However, there is no supporting theory and 4PL can comprise various organizational entities. For instance, a 4PL may be part of a hierarchical system if a focal enterprise defines requirements accordingly (Papadopoulou 2012). In other examples, the market approach is applied as an inter-organizational strategy for a 4PL (Salleh et al. 2009). Both the market and cooperation approach describe different positions of a 4PL and thus different functions. There are no theories on why different forms and approaches are implemented. Moreover, there are no exemplifying descriptions of different networks and industries (Riemer and Vehring 2012).

Based upon the aforementioned initial situation, this research was conducted in order to get an understanding of the missing theories. In order to be able to derive concepts for tangible use cases, an exploratory approach was chosen. Results in the form of proposals and concepts are presented in the conclusions. The following research questions (RQs) are the basis for this research:

- *RQ1*: How can a 4PL be newly introduced to and integrated in an inter-organizational network while factoring in the three different approaches of market, hierarchy, and cooperation?
- *RQ2*: Which insights can be derived, generalized, and examined from the described use case?

Research methodology

In order to conduct an exploratory case study that supports theory-building and is application-oriented, a suitable industry has to be identified that is relevant from a logistics point of view but has not yet been confronted with the implementation of an 4PL approach. Furthermore, unbiased results should be generated that enable users to apply them without preconceptions and experiences. For this reason, actors are presented with a possible implementation of a 4PL are then able to reply with their perceptions, apprehensions, and critical judgments in a transparent way. Based upon previous experiences, an industry was selected that has a minimum transport capacity and, thus, enables a 4PL to possibly generate a surplus value. Furthermore, the industry should have at least one actor that has the capacity to play the role of a focal enterprise and at the same time integrate a 4PL. In addition, this focal enterprise must be willing to provide information about the integration of the 4PL. Another assumption is that the potential for the development of management and ICT within the industry is made explicit to all actors involved. Finally, network structures must be available within the industry with the capacity to sufficiently represent the market, hierarchical, and the cooperation approach for transport handling. According to the definition of a supply chain management, all actors of the chain must be involved.

For a subsequent exploration of this research effort, a research assumption must be defined that supports the transfer of generally formulated themes, questions and concepts into specific research questions and results (Eisenhardt 1989). In order to fulfill that assumption, the research topic must be relevant for a real world application and future development prospects should be made explicit. For this reason, a number of industries were examined with the result that agricultural bulk logistics provided sufficient fulfillment of all assumptions. The agricultural sector appears to be especially relevant since logistics are a vital part of activities from harvest to the further processing of goods. In addition, agricultural and foodstuff directives require accurate documentation, which conveniently supports such a research. However, contrary to the logistics industries, the agricultural sector is known as conservative and rather skeptical about the adoption of new technologies.

With respect to the research focus, an inter-organizational network should be found within the industry that will serve as a use case confronted with a 4PL approach. The use case should provide information in the form of documents, data, and evidence that permits some degree of interpretation. For this reason, Walsham's method of interpretative case studies was applied (Walsham 1995). In doing so, data collection and interpretation was realized according to grounded theory (Glaser and Strauss 2009). According to Orlikowski, this combination is a suitable and effective approach for the research goal (Orlikowski 1993). Based upon the available literature, this approach enabled us to verify previously collected statements and insights within the given context as well as to generate new knowledge (Eisenhardt 1989).

Category	Wholsesale level		Wholesale level	Pirmary cooperative		Processor	Carrier	Ware-housemen	Contractor	Farmer	
Function	trade of goods		Processing of transports	Intermediaries of goods		Production of feed	Transporting of goods	Storage of goods	Harvest service provider of the goods	Production of bulk goods	
Employee	approximately 5000			300	450	22	3-4	2-5	105 - 205	2	2
Turnover (€)	ca. 7.5 bil.			ca. 400 mil.	ca. 350 mil.	ca. 70 mil.	ca. 185 thou.	ca. 200 thou.	ca. 14 mil.	ca. 1.2 mil.	ca. 1.25 mil.
Experts	2		1	1	1	1	1	1	1	1	1
First source	3 - Expert interviews			2 - Expert interviews		1 - Expert interviews	1 - Expert interviews	1 - Expert interviews	1 - Expert interviews	1 - Expert interviews	1 - Expert interviews
Second source	Annual report, org chart, IT architecture, process documentation			Annual Report, process Desciption		Internal process description	Internal documents	Internal documents	-	Internal documents	Process description
Informant	Head of project execution/ Disposition	Head of Trading	Head of Logistics	Head of Logistics	Head of Disposition	Manager	Manager/ Owner	Manager/ Owner	Manager/ Owner	Owner	Owner
Sector experience	35 years	27 years	7 years	25 years	21 years	44 years	25 years	20 years	21 years	10 years	13 years

Table 4: Categories and information on the experts

The required data have been collected in cooperation with the wholesale market level in Northern Germany. This way, all actors of the supply chain have been factored in according to the material flow. Documents, press articles, business reports, and semi-structured expert interviews are the available sources of information, whereas the expert interviews are the primary data source (Walsham 1995). Based upon the collaboration with the representatives of the wholesale level for each group of actors, a priority list was generated. This list determined the sequence of contacts to be established. Furthermore, the definition of priorities was based upon transport orders processed between 2010 and 2012. Following a descending sequence, relevant actors have been contacted in such a way that at least one or two actors from each category were interviewed. The categories as well as additional information concerning the experts are shown in Table 1.

The analysis of documents and the given supply chain resulted in the identification of relationships representing all three theoretical approaches (market, hierarchical, and cooperative) of transportation handling. As a consequence, the sampling was enhanced in order to represent all approaches alike.

The collaboration between scientists and actors of this industry started in 2012. Between February and May 2014, eleven semi-structured interviews were conducted (for the results, please, also refer to the Link semi-structured interviews in the appendix). The willingness among experts to cooperate differed because of ongoing competition and contracts among each other. Despite this fact all interviewees evaluated the role of logistics for transportation handling as crucial and confirmed the potential for improvement. The 4PL approach was explained during the interviews based on the definitions by Mukhopadhyay and Setaputra (2006) and Win (2008), whereby our definition was described as mentioned in the introduction. Thereby, the 4PL approach is recognized as providing an added value to all involved actors. All interviews were recorded for the data analysis with an iPad and the software AudioNote5. The audio file was converted to an mp3 file with a bit rate of 96 bits / s by the software XMediaRecode7. Thereafter, the transcription was carried out, followed by the content analysis with the software MAXQDA6. Figure 1 depicts a flow chart of the applied research process based on the ideas by Eisenhardt (1989) and Yin (2014).

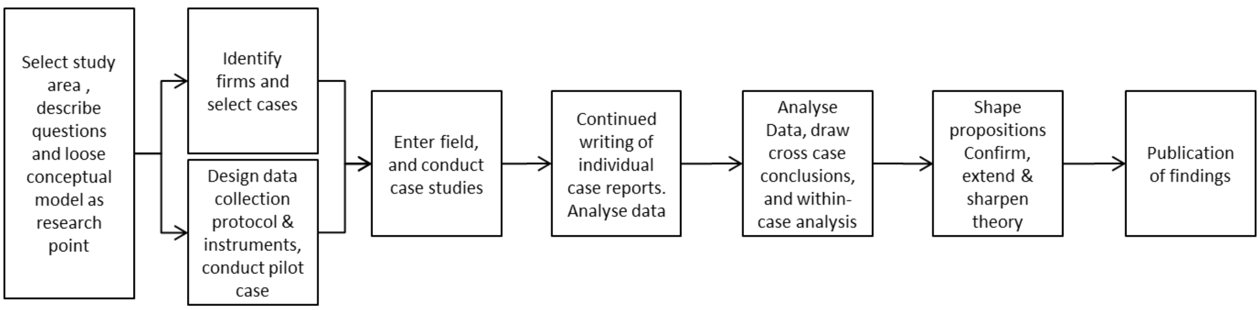

Figure 1: Workflow of the research process

The 4PL approach within an inter-organizational network

The present research effort provides exemplified structures within the supply chain with regard to the 4PL approach rather than a detailed representation of particular actors. Based upon this, a synthesis may be derived that delineates possible effects of a 4PL on the industry. Our synthesis is structured according to the material flow, from the origin of goods to their processing, in order to evince development perspectives in a systematic manner. For each process stage the potential as well as implications and results of a 4PL application are described.

The **first process stage** of the supply chain comprises the transport handling of bulk goods from the fields to the first warehousing stage, all within the time frame of the harvesting period. The actors involved are primary co-operations, contractors, and farmers. Usually, the contractor harvests the bulk good from the farmer's field and is responsible for the first transportation. Primary co-operations or warehousemen take over the harvested goods and store them for subsequent processing steps. The primary co-operation is a regional business unit which imbibes the harvested volume. It is the first warehousing stage. Generally, cooperative network relationships are detected among these actors. This relationship has been growing for a long lasting period of time. Sporadically, a market approach was chosen for handling the harvesting process. However, this depends on regional interdependencies during the harvesting period.

Only contractors, including their transportation efforts, were affected by the 4PL approach due to their function as a superordinated coordination and processing instance. Farmers usually outsource logistic functions (“We outsource harvesting and logistic to contractors.”) and are responsive to a 4PL approach if efficiency can be increased. Contractors are willing to apply the 4PL as a market approach in a way that innovations can be developed for the industry, information is accessible, consulting material is provided, and resources are planned in an automated manner. Given the incessant increase in costs, an efficient use of resources is desirable.

The results of the expert interviews reveal the responsiveness of all actors to implementing the 4PL with the prospect of future ICT development. Moreover, the interviewees emphasized an increased need for uniform data formats and interfaces, real-time communication as well as an improved interconnectedness. Common goals of all experts are the reduction of administrative work and the minimizing of transaction costs. All actors interviewed have a high willingness to invest in innovations. Furthermore, they assume that a higher transparency of information will foster an improved use of the available resources. However, there is also a risk in terms of an increased effort for communication in general and the implementation of a 4PL in particular. One of the interviewees stated that ”farmers are hard to accept ICT innovations and the introduction of new concepts in general”.

The **second process stage** describes transportation from the first warehousing stage to the first processing stage. Prior to transportation handling, a commercial transaction is carried out, which has in turn an impact on the transportation process. The main actors are primary co-operations, warehousemen, carrier, processors, and the wholesale level. The latter is also responsible for the import and export operations of the agricultural sector. Furthermore, they trade a significant share of goods within the sector in order to provide inputs for the first processing stage. In doing so, actors of the wholesale level use goods from their own warehouses or purchase them from primary co-operations or warehousemen of the first warehousing stage. Furthermore, the wholesale level dispatches transportation by employing carriers. This way, the security of supply for the processors is guaranteed. Similar transactions are carried out directly between primary co-operations or warehousemen and processors. In this case, the actors involved use their own transport fleet. All those actors assign high priority to logistics, since trading businesses inevitably entails transport demands. The following statements underpin the important role of logistics: “logistics is increasingly important since growth generates cargo”, “logistics play a central role”, and “logistics is of growing importance”.

During the past decades, logistics industries have experienced a significant transition due to changing inter-organizational relationships. From the perspective of the wholesale level and according to the market approach, logistics were an external service that was available at a well-defined price. During an insourcing process based on the hierarchical approach, a focal enterprise established an internal 4PL for transportation handling. Transport volumes were planned, bundled, and ordered in order to create potentials for synergies and to introduce a labor share between trade and logistics. In 2009, a strategic partnership with wholesale levels of other industries was initiated in order to develop a strategic partnership and a cooperative network. In spite of acting as one unit for a year and a half, this partnership finally failed because of a lack of trust, the sparse use of information as well as communication facilities, and an ambiguous labor share of the actors involved. To date, the hierarchical approach is applied because the wholesale level recognizes the long-term relevance of logistics as well as its inherent competencies. Based upon this, a consolidation of 4PL services for the industry is conceivable and even envisaged in the long run ("We see ourselves as internal service providers, while an extension of tasks by dispatching external orders and resources is thinkable. Especially, the potential for a further development of ICT is present.").

Assuming the current hierarchical approach, actors see the 4PL as having a high potential for the modernization of ICT within the industry. This includes a further networking of the actors by standardized interfaces, the introduction of cloud solutions, the design of a centered platform, and the development of apps for transport handling within the inter-organizational network.

Actors describe the current function of the 4PL as an economical, reliable and high-quality planning tool for transportation handling by the focal enterprise. This is because of the existence of an internal infrastructure. Furthermore, network actors such as carriers identify an automated route planning as main function of the 4PL with the aim to reduce empty mileage. All actors state that an increase in information transparency improves the quality of logistics in general. Under the assumption of an increase in efficiency, all actors indicate a willingness to invest and to change. The integration of a 4PL within a focal enterprise while applying the hierarchical approach is promising from the point of view of all network actors. This is because such an enterprise handles the highest transport volumes and has the capability as well as financial resources to drive the ICT development. In order to further develop a 4PL, the network actors prefer a market approach in order to prepare a long-term implementation. However, as a long-term development prospect, a cooperative approach is the preferred method of achieving the highest possible added value in form of an increased efficiency. Table 1 in the Appendix displays selected actor statements from which the aforementioned insights have been derived.

Results

This research effort has generated both scientific as well as industry-oriented insights. In terms of implications for practice, the following statements have been generated:

1. The 4PL approach is an interesting, strategic approach for actors in an inter-organizational network. The role of the 4PL exceeds that of a mere mediating position. Under the assumption of a general increase in

efficiency, all actors show a willingness to accept relevant new leadership and cooperation strategies. In addition, the actors request an improved coordination and management of the logistics within a dynamic network. This network must be enabled and supported by ICT.

2. The technological development, adaptation, and implementation of ICT are significant functions of the 4PL. This may also add value in terms of reduced transaction costs and an increase in resource efficiency. The focus here is on efficient transport planning and handling. Without the aforementioned development, a relational scale effect, in the form of both an increase in efficiency and a higher transparency of information, is difficult to achieve.

3. Actual ICT development fosters the currently preferred hierarchical approach. The focal enterprise's willingness to invest minimizes the risk for other network actors. However, among them there is also a willingness to invest. As a barrier it should be noted that there is currently no solution implemented for the industry. A fear with regard to complex end-user solutions is present. A collaborative development towards the improvement of individual requirements of the actors is possible. At the same time, a collaborative approach is a future option.

4. The technological leadership of 4PL within the industry generates both a competitive advantage and a direct knowledge gain for the network. This is especially obvious when compared to the standalone solutions of individual actors.

5. If a collaborative ICT development entails an increased division of labor within the network, an efficient deployment of actors' resources may be expected. This way, ancillary operation can be minimized and each actor is enabled to focus on core activities. That is, network and market development may result in a win-win situation and may at the same time increase the inter-organizational dynamic of the network.

Additionally, scientific implications are summarized in the following:

1. When applying the aforementioned research method, relevant qualitative data such as perspectives and experience may be collected. All interviewees were able to make comments on risks, misgivings, individual requirements and desires in relation to the 4PL approach.

2. The practical insights (see above) have a particular value-added since these enable scientists to provide scientific support during the introductory phase of an innovative approach. Hence, scientists are also able to accompany a situation from the pre-innovation phase to its successful implementation. These insights help to shape role models for the introduction and implementation of a 4PL approach.

3. Although agricultural bulk logistics are neither typical for mainstream computer science nor for logistics research, insights of this specific case study may contribute to both research topics. In addition, due to a growing world population on the one hand and limited farmland on the other, the agricultural sector will be increasingly foregrounded in these research areas.

4. Based upon our research results there is much potential for following research in the agricultural sector in conjunction with both ICT and information systems (IS). Especially, the development of platform-based apps indicates this potential. An application-oriented research should accompany the development process.

Conclusion and outlook

This exploratory research approach describes which experiences and challenges are existent in terms of the development and introduction of a 4PL within the agricultural bulk logistics industry. Furthermore, this research demonstrates how a long-term implementation of a 4PL can be accomplished, which functions a 4PL is able to perform and how the 4PL affects a network of actors. The research was conducted according to a relational perspective so that all actors involved had a chance to comprehend both the potential and the implications of a 4PL and, at the same time, reflect on this from their own perspective. With respect to transportation handling in an inter-organizational network, this was of pivotal importance since network actors are all interconnected. Another relevant outcome is the fact that all companies within the network recognized the potential of a 4PL and, at the same time, requested specific 4PL functions which cannot be provided by a single actor.

However, the presented research results need to be seen in the light of limitations, regarding both the chosen research approach and the specific characteristics of the industry. First, the research approach dictated that research was applied to a variety of databases. Second, based upon the interpreted case study, expert interviews have been carried out. These interviews resulted in a variety of valuable actor perspectives. However, divergences due to different interpretations of the questions, linguistic variabilities, and an episodic lack of trust must be taken into account. Other restrictions emerge due to the dependencies among various actors, although the scientific purpose and the anonymous responses have been made explicit. Finally, personal motivations might have eventually biased answers even though the purpose and background of the questions had been made explicit in the form of explanations and freely available documentation.

Further research should focus on the development of a reference model for the introduction of a 4PL as well as an application-oriented development of the required ICT functions. The different management approaches for the integration of the 4PL have to be incorporated along with the related dependencies and implications. This research demonstrates various possible developments, which may be tested for implementation. In addition, an actor analysis should be conducted by developing a capability maturity model. This fosters the development of specific ICT solutions including the implementation of functions by particular actors. Furthermore, the allocation of the economic added value for the integration of all actors involved remains a research topic to be further pursued. In this respect, various hypotheses, the evaluation of theories and the delineation of new insights for the industry are of distinct relevance for future development. The latter is especially important for the long-term implementation envisaged for a cooperative management approach within the inter-organizational network.

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APPENDIX

Actor	4PL				Statements (selection)
	Management-approach	Function	ICT	Goals	
Farmers	-				“Farmers are less affected by service providers. Our logistics is outsourced anyway.”
		X			“If our efficiency is going to be increased, we would handle more transports via the 4PL.” “We have outsourced both harvesting and transportation to contractors.”
			X		“Enhanced ICT applications are useful and effective for the further development of our industry.” “Apps are used in subareas of the industry. However, they are scarcely used because they are not adapted to the our requirements” “Some prerequisites such as Wi-Fi are already available”
				X	“A reduction of administrative activities is of pivotal importance” “We keep on investing in new technologies”
Contractors	X				“If we were able to purchase well defined services, this would be advantageous”
		X			“Support for our administrative tasks is more than welcome and would be utilised within service management, information management, business process management and consulting”
			X		“We need unified interfaces and data formats as well as an on-time communication” “Currently, only our internal IT systems are interlinked” “We prefer among us a digitisation and processing of communication via tablet and smart phone. Unfortunately, this is not possible externally (to date communication is paper-based).” “E-Mail, hard copies and fax are the main communication media”
				X	“There is a general willingness to invest in ICT. More information results in more transparency.” “Automated data generation enables an improved controlling, and this way decreases process costs and decreases costs for documentation.” “In the long run we can plan our resources much better.” “The agricultural sector is hard on changes and improvements.”
Primary cooperative	X				“A super ordinated planning instance should be developed.”
		X			“Currently, route planning is accomplished manually, which has a significant potential for improvement.”
			X		“Currently, there are no external interfaces (for IT).” “Information flow is prevailingly generated on paper.” “Currently, lack of information transparency as well as high empty mileage are the most common problems.” “(Redundant) interfaces should be removed.”
				X	“Strong volatilities of the clients have a direct effect on our logistics.” “Logistics is the core (of our business) which should permanently be optimised.” “Willingness for change is generally present, if an increase of efficiency may be expected.” “We are investment-happy.”
Carrier	X				“The organisation (of the inter-organisational network) should be improved. If this can be accomplished with a 4PL, it would be a conceivable way.” “In fact the implementation (of a 4PL) should be initiated by traders.”
		X			“Improved dispatch, transport planning, loading and unloading, and in general the entire transportation handling (should be improved).”
			X		“We prefer a greater use of IT.” “We have a demand for technological optimisation, especially automated planning, optimised interfaces and documentation of transports.” “An increased information transparency would contribute to an increase in efficiency.” “Exchange of information is very important.” “It is a challenge to reduce empty mileage, which we are not able to accomplish that to date.” “An increase in transparency should be accomplished with smart phones and apps.”
				X	“Our own decision making ability should be retained.” “The willingness for change is definitely present.” “Once transportation is better planned, we can handle more transports, and I do not need to care about side issues.”

Internal transport service provider	X				"Currently we play the role of an internal service provider. We plan commercial transports." "The expansion of our tasks by planning external resources is conceivable, and should be envisaged in the long run." "An establishment (of the 4PL) on the market, and this way a gradual convergence, is a conceivable approach for the industry."
		X			"We see the 4PL functions especially in an efficient supply chain planning, process and product development, business process optimisation, contract management, control of supply chain, shipment tracking, return management, document management, quality management, training and services " "The development of a platform for handling (transports) is conceivable and useful. However, towards this end a lot has to happen."
			X		"ICT has enormous development potential." "Currently, there are no interfaces available." "The prevailing forms of communication are telephone, fax and print outs." "Currently, the information flow is very slow and rarely transparent."
				X	"Our goal is a high quality, reliable and cost-efficient handling of transports, which complies with the goals of a 4PL." "I don't see a problem with investments in ICT for the purpose of an increase in transparency as long as investments are economically sensible in the long term."
Processor	X				"The development should be slow and confidence-building." "In principle we support a cooperative approach." "The actor with most transports should take over transportation handling."
		X			"The deliveries of our goods should be guaranteed."
			X		"We have a significant potential for the development of technology and ICT." "Partially, we transpose to standardised interfaces. However, this happens rather slowly within the industry." "External information flows are paper-based and manually processed. This is prone to disturbances." "We appreciate and support the introduction of ICT. Here are the highest potentials (for improvement)." "An interlinkage with other actors is preferable, if the cooperation approach is applied."
				X	"The increase in cooperation is a special goal." "We partly coordinate the deliveries by ourselves in order to handle this with the available resources."
Wholesale level	X				"Logistics plays an important role. We pursue the hierarchical approach for (transportation) handling." "We welcome investments in IT, if they are beneficial."
		X			"Our clients need security of supply by logistics."
			X		"An interlinkage of systems is conceivable if there is a mutual trust." "In any case ICT, has an enormous potential, and there is a willingness to invest." "Cloud solutions are conceivable in the long run."
				X	"Logistics must be cost-efficient and reliable." "There is a willingness to invest"

Table 5: Selected actor statements

Link semi-structured interviews http://tinyurl.com/AMCIS2015

Beitrag 5: Understanding the 4PL Approach within an Agricultural Supply Chain Using Matrix Model and Cross-Case Analysis

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Understanding the 4PL Approach within an Agricultural Supply Chain Using Matrix Model and Cross-Case Analysis

Abstract:

This article presents a study that aims to examine and describe the long-term implementation of the fourth-party logistics provider approach (4PL) for logistics management within the agricultural bulk logistics sector. Based on a review of the 4PL literature, attributes are defined and clustered according to the elements of the Work System Theory (WST). The result is a matrix model validated with seven case studies involving 11 experts and a cross-case analysis. Key findings describing the usage, the benefit and the organizational structure of the 4PL approach are identified. These should be considered in the preparation of (multidisciplinary) conceptual and (semi-) formal description models with the introduction of a 4PL. The matrix model based on WST provides a significant value added for the development of a 4PL in the context of agricultural supply chain management. The WST was helpful for achieving a structured analysis of the complex 4PL approach.

Keywords: Fourth Party Logistics (4PL), Work System Theory (WST), Cross-Case Analysis, Agriculture, Bulk Logistics

Introduction

Supply chain management is of growing importance. However, the use as well as the meaning of this term depends on the sector. The distinctiveness of the agricultural supply chain derives from to the requirements resulting from an increasing globalisation. More specifically, various factors such as cost reduction within the agricultural delivery chain and costs of integration and implementation of alterations due to changing consumer behaviour are seen as the main challenges (Bhagat and Dhar 2011). In order to deal with these challenges, the implementation of new business models and increased integration of information technologies (Vinay et al. 2009) are promising.

Within supply chain management of the agricultural sector a fourth party logistics provider (4PL) can introduce a business model that supports overall transportation handling including a multitude of related services (Baumgarten et al. 2004; Partsch 2011). Thereby, the 4PL is responsible for the transportation planning of the actors within a supply chain. In this case the 4PL provider has a neutral position with the sub task of pooling transportation demand while factoring in the available transportation resources (Win 2008). The main goal is an efficient implementation of transport as well as the efficient use of available resources within a supply chain. In this way the performance of the supply chain should be improved. The authors of the paper at hand conducted a survey within the agricultural bulk logistics sector in Northern Germany in October and November 2012 as well as between February and May 2014. According to the analysis of these data no integrated supply chain management was applied. Within the German agricultural sector, transportation volume was about 3.7 billion tonnes in 2012, of which 76% (about 2.8 billion tonnes) were road-based (Transport of agricultural goods, 2012). Agricultural bulk transportation is prevailingly full-truck load. Moreover, the sector is exposed to volatile market fluctuations due to variable harvest volumes and trade activities especially in the stock market. Hitherto, transportation planning is an ad hoc activity planned, dispatched and implemented by its main actors (traders, forwarding agents, carriers, shipper and recipients). According to the sector information services coordination only took place at a basic level.

Yet, the role of the 4PL approach is heterogeneously described in the literature. Vinay et al. (2009) describe a potential for improvement if a contract logistics provider (3PL) does not serve his customers satisfactorily within the relevant logistics processes. Furthermore, Mukhopadhyay and Setaputra (2006) describe win-win situations resulting from 4PL benefits. For instance, the 4PL approach fosters outsourcing as well as pooling of particular activities by applying IT services for a network of logistics actors. In this way, the overall planning is improved and results in better utilization of the available (physical) resources. This does not only include the dispatch but also all 4PL-related services for customers (Win 2008). The idea to introduce the 4PL approach in the agricultural bulk transportation sector is underpinned by examples from various sectors within the food industry (Prümper and Butz 2004) (Vivaldini and Pires 2013), the automotive industry (Schmitt 2006) as well as other industries (Krakovics et al. 2008). These examples demonstrate how cooperative planning can potentially increase the efficiency of resource use (Lambert et al. 2004). In these examples, collaborative planning is implemented by a focal business. Based upon the trade structure within the agricultural sector (primary level or regional cooperatives, and wholesale or secondary level) these focal businesses are already established. Within this structure the secondary level pools the harvested goods and the primary level operates as regional receiving docks. At both levels a commercial transaction is followed by transportation activities, where the secondary level transports multiple quantities in comparison to the primary level.

However, the literature does not yet provide examples of the application of the 4PL approach, whereas the parameters, 'seasonal harvest' and 'the involvement of various actors' have been incorporated in the field of agricultural bulk good logistics.

In order to implement the 4PL approach, business processes, technologies and process management among the involved actors must be applied (Mukhopadhyay and Setaputra 2006). Business processes describe the processes and activities the 4PL can support as well which products and services the 4PL should deliver to the actors. On the one hand, technologies are very important for information flow in the 4PL approach. On the other hand, technologies already implemented by actors have to be incorporated in the implementing the 4PL approach. The process management describes the design, documentation, implementation, control and improvement of these processes. In particular, organizational and strategic aspects, as well as the involvement of the participants are taken into account. A special challenge for the application of 4PL in agricultural bulk logistics is the generation of a value that is accepted by all actors of a supply chain (Win 2008). This value can be quantified by the carrier's improved utilization of the vehicle fleet. Furthermore, the recipient receives the product ordered, at the correct location, in timely way, with the required quality, the correct quantity and at the lowest possible price (Jünemann and Daum 1989). In order to generate this value, infrastructural conditions for the supply chain and key actors determining the working system of each actor must be incorporated. For this study, the work system theory (WST) was applied as a theoretical framework (Alter 2013). This framework incorporates the relevant elements of a working system within a supply chain. In addition, the attributes of a 4PL approach are included. The actors of the agricultural bulk logistics sector have been examined in a case study.

The underlying research question is: what is the appropriate method for information processing within a given agricultural bulk logistics supply chain including the implementation of the 4PL approach and factoring in the given working system/design process as well as the available hardware and software?

For answering the research question we built upon a desktop study in combination with the WST. Furthermore, a matrix was developed, and based upon this matrix and the elicited industry-specific knowledge the main attributes of a 4PL approach were identified.

This article begins with an introduction to the concept of the 4PL approach as well as the WSF in section 2. Furthermore, in the same section, the matrix which is derived from literature studies is described. The methodology applied is presented in the following section 3. Section 4 introduces the case studies including a cross-case analysis. The presentation of the results, the answers to the research question and a discussion of the results follow in section 5. The final section 6 provides the summary and an outlook to further research.

Theoretical background

The 4PL approach – open research questions and functions

The 4PL approach refers to a neutral actor in the supply chain who is responsible for the management of logistic processes without participating in the physical transport of bulk goods with their own equipment (see section 1). This function requires competences and knowledge of the transport sector, related supply chain management as well as information technology (Coyle et al. 2003). In this respect, the information flow is of eminent importance.

Based upon these facts, this article pursues the following research question: which methodological framework is appropriate for mastering the information flow within a given supply chain with regard to the design process, the organization form, the available software and IT integration. In particular, the communication technologies applied (fax, email) as well as the possible knowledge gain of the involved actors is of importance for the employment of a 4PL approach (Mammitzsch and Franczyk 2012).

As a result of the superordinated management function and the involvement of the actors of a supply chain, the periphery of the 4PL is complex. This entails an intricate integration of those attributes which are described in the literature (see Table 4). The arrangement of those attributes may vary due to diverse actors in a supply chain. For this reason the WSF is employed for the analysis of a supply chain (Alter 2013).

The work system framework (WSF)

In considering various infrastructural conditions within the agricultural bulk transport sector as well as the incorporation of the 4PL approach a variety of theoretical frameworks was examined. To that end, contingency theory (Tsai et al. 2013), the works system theory (WST) (Alter 2013) as well as resource-advantage theory (Davis and Golicic 2010) have been studied with respect to the research question. Ultimately, WST with emphasis on Alter's work was selected (Alter 2013) since it can best represent a supply management system which requires the incorporation of various influencing factors such as people, machinery or information technology. The 4PL approach requires the consideration of technical, computational and organizational artefacts among supply chain actors. This is possible due to the application of WSF (Alter 2013).

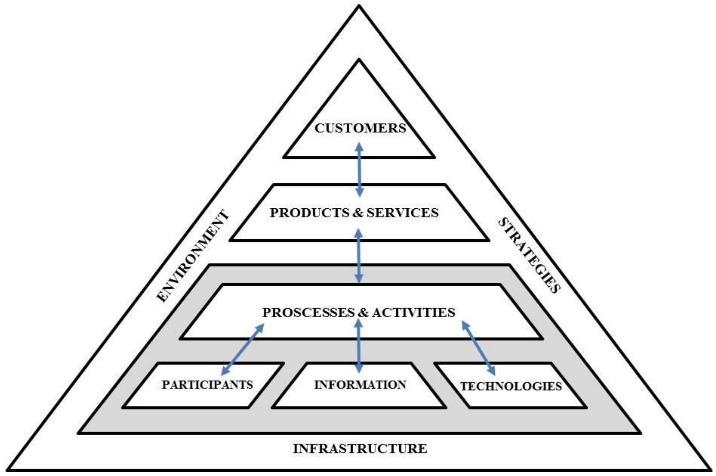
The WST comprises an explanatory part (type 2) and an analytical part (type 1). Moreover, each part can be applied independently (Alter 2013). Type 2 describes a work system life cycle model which is capable of analysing dynamic alterations of the work system. In our research, type 1 is applied because it examines the concept of a work system (4PL) which is central for this research. Alter's definition of a work system in which human actors or machines employ technologies and resources in order to generate a product of a service for the benefit of internal or external customers serves as basis for this research (Alter 2013). A work system may be analyzed within an organization or beyond its boundaries (inter-organizational). For instance, information systems are described as systems (Alter 2008), whereas a supply chain is seen as an inter-organizational work system.

The WST is both a descriptive as well as an analytical instrument to provide a structured description of an IT-based work system. This framework consists of nine elements. The elements are categorized as elements within the working system (Process and activities, Participants, Information, Technology), elements within and outside a work system (Products and Services, Customer) and elements which are outside the work system (Environment, Infrastructure, Strategy). Table 1 describes the elements in their context in detail. The objective is to acquire a comprehensive understanding of the supply chain in or to profile the given work system including its functions, external factors, not yet explicitly described business transactions as well as IT functions. Figure 1 depicts the WSF according to Alter (Alter 2013, 2006).

Table 1: The nine elements of a WSF

Category	Element	Description
Within the working system	Process and activities	The work system should possess at least one process or activity. These processes and activities may be not fully identified. Furthermore, these can be implemented based upon specific individual knowledge of an actor (Hall and Johnson, M. Eric, 2009). The main focus of this element is the question: “How can work currently be carried out?”
	Participants	The work system has participants (actors) who operate the system. To this and the actors utilise available technology. The main focus of this element is the question: “Which individuals work in this system?”
	Information	The work system processes information by various means (utilise, design, send, store, renew, manipulate, display, output, delete, etc.). Typical information processing instances are: ordering, invoicing, tenders, lists, descriptions, etc. Apart from data storage, information is generated and retained through communication. Information is indispensable to implement working processes and activities. The focus of this element is the question: “What information is being processed within the system?”.
	Technology	The works system provides technologies for processing the work flow. Technology can be divided into manual and automated applications. Technologies employed have been analysed in respect to user demand. Automated technologies are divided into hardware and software components which supports the requirements for future development. The focus of this element is the question: “Which technologies are used within a given system?”.
Within and outside a work system	Products and Services	The work system has a product or service which a user generates for the benefit of a customer. If information and physical resources are joined within a system, this benefit is generated. The focus of this element is the question: “What is the benefit of a work system?”
	Customer	The work system generates products and services that are purchased and used by a customer. For this reason it is important to acquire precise knowledge about the user demand. A customer may be both an internal or an external actor. External customers reside outside a company, whereas internal customers may be employees or departments within an enterprise. Each actor may adopt dual roles both as customer as well as participant who offers services. The focus of this element is the question: “What are the characteristics of a customer inside and outside a work system?”
Outside the work system	Environment	The environment of a work system comprises organisational, cultural, competing, adjusting (technological) and demographic factors, which are included when the system operates. In this way both effectiveness and efficiency of operations can be controlled. The environmental impact has a direct influence upon the performance of a work system. If this element is not factored in, the likelihood of a system failure is increasing. The focus of this element is the question: “What are the characteristics of the environment of a work system?”
	Infrastructure	The infrastructure of a work system is characterised by its actors and its technical and IT resources. However, these resources are not always parts of a work system exclusively, but have to be shared with other work systems. The focus of this element is the question: “What are the characteristics of the infrastructure of a work system?”
	Strategy	The strategy of a work system is divided into the corporate strategy, department strategy and the work system strategy. All three strategies should be implemented in unison. The focus of this element analyses the question: "Which strategy is pursued in the work system?"

Figure 1: Work System Framework (Alter 2013, 2006)



Within the chart the arrows represent connections among the elements. Participants, information and technology influence process activities directly. The latter, on the other hand, influence products and services. Ultimately, the result in the form of a product or a service has an impact on the customer. All internal activities depend upon the environment, strategy and infrastructure of a work system.

One intention to apply such a WSF is a broad analysis of the targeted system prior to the development of a IT system for this application (Lee 2010). According to Lee (2010) a system comprises technical artefacts, configured hardware as well as software that are intended to be used by all involved actors. For this reason Denis et al. (2009) propose an array of questions that have to be addressed during the analysis phase:

- Which actors use the system?
- What is the benefit of the system?
- Where will the system be applied?
- When can the system be applied?

During the subsequent design phase hardware, software and processes between the supply chain actors will be defined. However, this phase is not examined in this article. Because of the specific WSF-based analysis of the 4PL approach a number of challenges based on the literature are examined with a matrix. This is described in the following section.

Derivation of a Matrix by WSF characteristic

A systematic literature review consistent with the work of Webster and Watson (2002) provided the basis for our case study research (Yin 2012) for this scientific effort. The systematic literature review is based upon a selection of key words within the research presented in the journals and databases listed below.

After the identification of the relevant literature a reverse search based upon all identified citations has been performed in order to obtain a selection of relevant articles. On the one hand, open research questions were identified and the described functions of the 4PL approach examined. On the other hand, the literature review formed a basis for the development of a matrix in compliance with the WSF, which supports the analysis of the agricultural bulk supply sector. In the context of the forward search, literature published between 2000 and 2014 was examined. The concept of 4PL was first coined in 1997 by Anderson Consulting. Scientific literature on this concept published prior to 2000 cannot be found. However, in recent years the term '4PL' was increasingly used in the context of services and logistics.

The journal ranking of the German association of academics in the field of business management (VHB) provided the requisite data for this research. Thereby, journals ranked A, B and C form the sub ranking business informatics and information management, as well as the WI journal list (2008) (WKWI, 2008) were employed in order to comply with a high scientific standard. The selected 152 journals have been browsed for the keywords “4PL, Logistics and Fourth Party Logistics Provider”. Furthermore, the same keywords have been employed to browse the databases EBSCOhost (Business Source Premier Database), Science Direct, AISel (AIS Electronic Library), ACM Digital Library, Emerald and IEEE Xplore Digital Library. As a result 24 articles have been classified as relevant after examining 56 contributions. An article was relevant, if it described the 4PL approach directly. However, articles have been taken into account, which provide IT services for a supply chain. Each of the 24 articles was studied and evaluated with the criteria: focus (function and research questions) and context (4PL, and logistics). As a result a matrix was designed by assigning the described attributes of the 4PL approach to the elements of the WSF (Table 3). Subsequent to the assignment of the 4PL attributes the selection of WSF elements was carried out with consideration to the requirements of the 4PL. The result is the assignment of each of the articles to one or more attributes of the WSF. This is indicated by the reference number in table 2. Based upon this assignment the matrix describes functions of a 4PL drawn from the literature. Table 2 provides a complete overview of the selected 24 articles.

Table 2: Literature selected for the design of a matrix

Reference	Source/Article
(1)	Nissen, V. and Bothe, M. 2002. “Fourth Party Logistics - Ein Überblick”. *Logistik Management* 4 (1): 16-26.
(2)	Kunkel, R., Klinkmüller, C., Ludwig, A. and Franczyk, B. (2012). “Modellgetriebene Integration von Logistik-Informationssystemen in die LSEM-Plattform“. In Mattfeld, D.C., Robra-Bissantz (Hrsg.).2012. *Tagungsband der MKWI 2012*.
(3)	(Mammitzsch and Franczyk 2012).
(4)	Roth, M. (2013). „Monitoring von Prozessinstanzen in logistischen Netzwerken“. In Ruhland, J., Wenige, L. (Hrsg.): Beiträge zum 17. Interuniversitären Doktorandenseminar Wirtschaftsinformatik (IDS 2013).
(5)	Edwards, P., Peters, M. and Sharman, G. (2001). “The Effectiveness of Information Systems in supporting the extended Supply Chain”. *Journal of Business Logistics* 22 (1): 1-27.
(6)	Althoff, K. and Schulcz, J. (2009). “Fourth Party Logistics (4PL). - Vermeidung von Zielkonflikten durch unabhängige Anbieter”. In 4flow-Newsletter

(7)	Erturgut, R. (2012). "The Future of Supply Chain and Logistics Management in the Strategic Organizations: Contractor Companies and New Generation Suppliers". *Procedia - Social and Behavioral Sciences* 46: 4221–4225.
(8)	Evangelista, P., McKinnon, A. and Sweeney, E. (2013)."Technology adoption in small and medium-sized logistics providers". *Industrial Management & Data Systems* 113 (7): 967–989.
(9)	Stefansson, G. and Russell, D. M. (2008). "Supply Chain Interfaces: Defining Attributes and Attribute Values For Collaborative Logistics Management". *Journal of Business Logistics* 29 (1): 347–359.
(10)	Thiell, M. and Hernandez, S. (2010). "Logistics Services in the 21st Century: supply chain integration and service architecture". *Service Science and Logistics Informatic:* 359–378, Business Science Reference, Hershey
(11)	Robu, V., Noot, H., La Poutré, H. and van Schijndel, W-J. (2011). "A multi-agent platform for auction-based allocation of loads in transportation logistics". *Expert Systems with Applications* 38 (4): 3483–3491
(12)	Zacharia, Z.G. Sanders, N.R. and Nix, N.W. (2011). "The Emerging Role of the Third-Party Logistics Provider (3PL) as an Orchestrator". *Journal of Business Logistics* 32 (1): 40-54.
(13)	(Win 2008)
(14)	(Agnetis et al. 2006)
(15)	Selvaridis, K. and Spring, M. (2007). "Third party logistics: a literature review and research agenda". *The International Journal of Logistics Management* 18 (1): 125-150.
(16)	Steffansson, G. and Lumsden, K. (2008). "Performance issues of Smart Transportation Management systems". *Journal of Productivity and Performance Management* 58 (1): 55–70.
(17)	Steffansson, G. (2006). "Collaborative logistics management and the role of third-party service providers". *International Journal of Physical Distribution & Logistics Management* 36 (2): 76-92.
(18)	Salleh, N.A.M., Mukhtar, M. and Ashaari, N. (2009). "Logistic E-Marketplace for Agro-Based Industries in Malaysia", I*n: International Conference in Electrical Engeneering and Informatics:* 339-342.
(19)	Ojala, L., Andersson, D. and Naula, T. (2006). "The definition and market size of Third Party Logistics Services". In Ojala, L., Jamsa, P. (Hrsg.): Third Party Logistics – A Nordic Research Approach, Series A-4: 44-70.
(20)	Li, X., Liu, W., Lei, L., Zhao, Y. and Ren,S. (2003). "The Design and Realization of Four Party Logistics". *IEEE International Conference on Systems, Man and Cybernetics* 1: 838-842.
(21)	Hingley, M., Lindgreen, A., Grant, D. B. and Kane, C. (2011). "Using fourth-party logistics management to improve horizontal collaboration among grocery retailers". *Supply Chain Management: An International Journal* 16 (5): 316-327.
(22)	Kunkel, R., Kerkhoff, H., Augenstein, C., and Franczyk, B. (2013). "Generierte Mensch-Maschine-Schnittstellen zur Ad-hoc-Integration von Logistikketten". *HMD Praxis der Wirtschaftsinformatik* 50 (6): 76–86.
(23)	Huemer, L. (2012). "Unchained from the chain: Supply management from a logistics service provider perspective". *Journal of Business Research* 65 (2): 258–264.
(24)	Prockl, G., Pflaum, A. and Kotzab, H. (2012). "3PL factories or lernstatts? Value-creation models for 3PL service providers". *International journal of physical distribution & logistics management* 42 (6): 544-561.

Table 3: WSF – 4PL matrix model

WSF element	4PL Attributes	Literature																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	∑
Process and activities	*Service Management*			X	X		X		X		X	X	X		X	X	X	X		X	X					13
	Service provider selection	X		X			X		X				X	X	X	X	X	X	X	X				X		13
	Information Management		X	X			X				X		X			X			X		X			X		9
	Business Process Management	X			X		X	X						X							X		X			7
	Controlling	X			X								X										X			4
	Consulting																				X			X		2
Participants	*Suppliers*	X	X	X	X				X	X	X		X	X				X	X	X	X	X	X			15
	Trading partners					X				X	X		X								X	X				6
	Producer	X																	X		X	X				4
	IT service provider	X							X					X												3
	Management consultant								X					X												2
	Financial services provider	X							X																	2
	Employee							X																		1
	Exchanges											X														1
Information	*Transportation resources*	X	X	X		X			X		X					X	X	X	X		X	X				12
	Transportation orders	X	X	X		X			X	X	X					X	X	X	X							11
	Status overview		X						X								X		X		X	X	X			7
	Transport documents	X					X											X								3
	Stock Overview			X		X																				2
	Sector information	X																						X		2
	Order and sell orders											X														1
	Loading and unloarding resources			X																						1
	Risk assessment										X															1
Technologies	*Used Technologies*																									
	Online platform	X	X	X		X					X	X					X	X	X		X	X	X			12
	Internet		X			X			X	X							X		X		X		X			8
	RFID				X				X								X					X				4
	Phone								X	X																2
	E-Mail								X	X																2
	Fax								X	X																2
	Barcode								X																	1
	Mobile phone									X																1
	Paper									X																1
	Automated Technologies																									
	ERP System	X			X				X	X							X						X			6
	EDI									X							X				X	X	X			5
	CRM								X														X			2
	GPS								X								X									2
	Decision Support System					X																				1
Products & services	*Efficient supply chain planning*	X	X	X			X					X		X			X	X	X		X					10
	Process and poduct development	X					X						X						X							4
	Market analysis	X														X		X							X	4
	Business Prozess Optimization	X																		X	X					3
	Contract Management	X																						X		2
	Control of supply chain	X	X				X	X	X			X			X		X			X	X			X		11
	Inventory management	X	X	X					X		X	X	X	X			X			X	X					11
	Shipment tracking								X								X	X	X							4
	Return management	X							X											X						3
	Document management	X															X									2
	Quality management	X																								1
	Supply chain controlling	X					X							X			X		X				X			6
	IT-Consulting	X											X							X				X		4
	Financial implementation and Insurance								X									X								2
	Training and Services	X																							X	2
Customer	*Transport requirements*	X		X			X		X		X	X	X	X	X			X		X	X					12
	Increase outsourcing								X					X	X			X		X	X					6
	Increase efficiency						X						X													2
	Informations & Technology			X																						1
Environment	*Sector knowledge*	X					X							X												3
	Cooperation													X										X		2
	Applied ICT								X																	1
	Products and Services										X															1
	Resources													X												1
Infrastructure	*Data transparency*				X					X							X				X					4
	Data quality				X					X							X				X					4
	Data integrity				X					X							X				X					4
	Willingness to invest																X				X					2
	Open systems		X																							1
	Technical standards and interfaces								X																	1
	Knowledge management	X																								1
Strate-gies	*WSF strategy cooperation*	X		X				X					X									X		X		6
	WSF strategy efficiency improvement								X					X					X	X						4
	∑	30	11	14	9	7	12	4	28	14	11	8	12	14	5	6	21	13	14	11	22	9	10	9	2	

As an intermediate result of the literature reviewed a remarkable variety of services can be assigned to the 4PL approach. Taking into account the WSF elements "Process and activities" a service management is often mentioned. In addition, the service provider selection is described in the literature as an important process. Considering the “participants” the suppliers of a 4PL are especially highlighted in the literature. The most important “information” consist of transportation resources and transportation orders. As “technologies” to be used are especially online platforms along with the Internet described. The aim is to ensure a instant and transparent flow of information. “Products” as a 4PL are especially described as efficient supply chain planning and functions which are connected to the controlling and inventory management of a supply chain. From the perspective of the customer it is important to meet the transport requirements.

Methodology

Research method

This research makes use of three main research methods: (1) a systematic desktop study, (2) a matrix for the WSF and (3) case study research to assess practical relevance. For this reason 11 case studies have been examined among actors in the agricultural bulk logistics sector. A case study is an examination of a topical inquiry within a real-world context. Furthermore, the boundary between the research object and the context is not evident (Yin 2012; Ellram 1996) Case study research is applied to answer the why and how questions (Yin 2012). In this study the issues addressed are: of 'why' can a 4PL approach generate added value, and ‘how’ can the implementation of the 4PL approach within the agricultural bulk sector be designed? As aforementioned, for this reason, the attributes of the 4PL approach have been analyzed based upon the indicators of the matrix.

Identification and selection of case studies

The analysis of the infrastructure required for the 4PL approach provides a framework for the selection of particular cases. A multiple case approach was chosen in order to increase (1) the significance, (2) the validity and (3) the reproducibility of results (Yin 2012; Eisenhardt 1989). After the identification of supply chain process (Beamon 1998) main actors and functions which are relevant for the 4PL approach have been identified. Each actor of the model represents one person within the supply chain. A function represents the task of a person within the supply chain. Based upon the literature review and the focus on the work system, the specific characteristics of the sector are factored in. Concurrently with the material flow of the supply chain possible actors in the supply chain have been chosen depending on the firm size.

In collaboration with representatives of the agricultural wholesale marketing industry a list of relevant actors within the agricultural bulk logistics sector in the northern German region was compiled. This list includes farmers, contractors, agricultural traders, carriers, shippers, and recipients of agricultural goods. The list was filtered and sorted according to the priorities function, experience and spatial distance. As a first step the function was filtered and then the experience and spatial distance were filtered. The spatial distance between loading stations was incorporated because of the location within northern Germany. In this way a context was provided that applied for all actors that were interviewed. That context is also illustrated in the supply chain. The survey was designed in a way that the actor with the highest priority for a main function was approached first. If no response was received within two weeks the next actor in the priority list was approached and so forth. This approach was implemented on a rolling basis until each function was assigned an actor. In particular, within the 'secondary stage' function the variability of actors from various departments was high due to the size of the firm and the high geographic relevance of northern Germany.

Data capture and further processing

Data capture has been conducted between February 2014 and May 2014. After initial telephone contact with the respondent all required information was emailed in order to prepare the interview. Each of the respondents received a PDF document consisting of a cover letter, a description of the research effort, as well as an interview guideline. In order to increase the validity and appropriateness of the study the principles according to Yin (2012) have been applied. Essentially those are: (1) the use of several sources of evidence, (2) the generation of a case study data base and (3) the selection of a tool for the presentation of evidence. In compliance with the first point as well as for the sake of increasing the robustness of this research, various sources have been tapped for the presentation of evidence. Table 4 lists these various sources in relationship to the each of the case studies in an anonymous form. Moreover, semi-structured interviews were applied in order to capture additional insights and enrich the findings in addition to the standard questions. Furthermore, notes have been taken during the interviews. Interviews had a length of between 27 and 86 minutes and all were recorded. All recordings were transcribed and received a unique consecutive number.

In compliance with Yin's second and third principles a case study data base based on MAXQDA was set up. On the one hand, mere observations and raw data could clearly be separated from interpretations, research questions and conclusions. On the other hand, empirical data served as verification for the matrix model which was derived from the literature.

Table 4: Sources of the case studies

Case	F1			F2		F3	F4	F5	F6	F7	
Participant	Secondary cooperative			Pirmary cooperative		Processor	Carrier	Storage company	Contractor	Farmer	
Sector	Trade			Trade/Logistic		Production	Logistic	Logistic	Logistic	Production	
Main functions	Pooling of harvest goods and trade of goods			Recieving harvest amounts, Distirbution of goods to the regional agriculture		Production of feed	Transport of bulk goods	Storage of bulk goods	Transport-ation of bulk goods	Production of bulk goods, Consumption of feed	
Employee	approximately 5000			300	450	22	3-4	2-5	105 - 205	2	2
Turnover	ca. 7.5 bil.			ca. 400 mil.	ca. 350 mil.	ca. 70 mil.	ca. 185 thou.	ca. 200 thou.	ca. 14 mil.	ca. 1.2 mil.	ca. 1.25 mil.
Expert	1	2	3	4	5	6	7	8	9	10	11
First source	3 - Expert interviews			2 - Expert interviews		1 - Expert interviews	1 - Expert interviews	1 - Expert interviews	1 - Expert interviews	1 - Expert interviews	1 - Expert interviews
Second source	Annual report, org chart, IT architecture, process documentation			Annual Report, process Desciption		Internal process description	Internal documents	Internal documents	-	Internal documents	Process description
Informant	Head of project execution/ Disposition	Head of Trading	Head of Logistics	Head of Logistics	Head of Disposition	Manager	Manager/ Owner	Manager/ Owner	Manager/ Owner	Owner	Owner
sector experience	35 years	27 years	7 years	25 years	21 years	44 years	25 years	20 years	21 years	10 years	13 years

Analysis of the case studies

Case study descriptions

The following case study descriptions provide examples for the scope of development that a 4PL can take on, if implemented. In particular, expert knowledge highlights cornerstones for the potential implementation of the 4PL approach. Selected quotes of interviewees are provided between double quotes:

- Case study F1 describes a secondary cooperative that acts at the level of a wholesale business, and has significant influence on the entire sector. Following the supply chain process experts in the fields of trade, processing and transport handling have been interviewed. Interviewees pointed out that the success of these businesses involved depends significantly upon logistics: “We can buy and sell but at the end goods have to be transported somewhere”. For this reason logistics are of eminent relevance. All three interviewees attest to the potential for improvement in the current information flow;
- Case study F2 focuses on primary cooperatives, which receive, store and trade harvest quantities. As a result transportation demand is generated, which takes on the central role for logistics. An improvement of the information flow in the form of a (centralized) IT platform through the introduction of a 4PL is conceivable and desirable. “4PL has the potential to reduce empty runs”;
- Case study F3 describes companies who process agricultural bulk goods, especially, for the production of feed. Furthermore, the feed produced must be transported to the nearby farms. “Stock

and consumption data determine the demand for supply logistics", "In our sector nothing functions without logistics. Information flow is of special importance". Currently, 80% of the orders are online.

- Case study F4 describes a carrier within this sector. For this actor transport is of vital importance. An improvement of information flow due to an intensified implementation of new information technology such as email, online platforms or apps are welcomed.
- Case study F5 describes a storage company that offers services such as warehousing and externalizing agricultural bulk goods as well as the dispatch and implementation of occasional transportation. Here, logistics is of vital importance. Operators assume that increased transparency in information management will result in better business activities, since a savings potential for empty mileage is assumed. "In many cases we have 200 km return mileage".
- Case study F6 describes a contractor involved in the harvesting process as well as bulk logistics. "logistics yields more than 40% of the turnover". There is significant potential for improvement within the information flow in terms of the introduction of unified interfaces as well as performance figures.
- Case study F7 describes farmers who produce, based upon their annual harvest, products that are shipped as bulk goods. Furthermore, the farmers require feed stuff produced by other farmers and transported to them as bulk goods. Logistics, however, plays a subordinate role. More importantly for the interviewees is a transparent information flow which they believe helps to save costs, avoids mistakes, and increases the quality of order processing. "A digital communication through apps can facilitate the work".

Cross-case analysis

Based upon the Matrix and with the attributes of the 4PL a cross-case analysis was conducted according to Yin (2012). Hitherto, individual case studies have been analysed based upon actors. The cross-case analysis facilitates the consolidation of single case studies into a complete study. The objective is to examine how particular attributes (of the 4PL) are influenced, applied and understood by actors. This is important since the activities of actors influence the work system of the 4PL. Moreover, a cross-case analysis enables researchers to identify differences among actors, which may help to indicate the potential for development for the group of actors examined as well as the entire sector. The following factors/attributes/characteristics/parameters are analyzed for their development potential. Selected quotes of interviewees are indicated between double quotes:

- Infrastructure: the category 'infrastructure' comprises human, IT and technical resources.

  - In terms of human resources, especially within wholesale businesses as represented by actors of F1, there is no shortage of qualified personnel. "...those who have difficulty to recruit young trained stuff should blame themselves". Merely the chief of logistics mentioned that due to the reform of the German armed forces there is no more training of truck drivers. He predicts that "... during the upcoming years all logistics firms will have problems to recruit truck drivers".
  - IT and technical resources: In particular, larger companies (F1-F3, F6) operate system environments with open interfaces and technical standards. However, communication with process-relevant actors takes place via telephone or fax. The reason for this is the preference for personal contacts and thus higher levels of trust. Nonetheless, the experts from the case studies F1-F3, F6 and F7 see the potential for a central IT platform with unified interfaces and data formats, that would be used for communication and information exchange in the agricultural bulk logistics sector. These actors state that "...the implementation of a platform which manages order processing has huge potential".
- Environment: A number of organizational, cultural marketing, technical and institutional impacts affect the work system. Legal impacts alone have a strong regulatory influence on the sector. "We are heavily regulated in all areas connected with the term 'animal feed'. The legal framework increasingly reduces freedom of action. We attempt to proactively protect ourselves by analysing the quality of the goods." Furthermore, the entire sector is subject to the cultural influences of the agriculture. Throughout the interviews experts pointed out that they have grown up on a farm and are shaped by the agricultural environment. Naturally, this results in substantial experience and specific knowledge. Many of the agreements made are therefore primarily verbal arrangements which require a high degree of trust. Nevertheless, all actors are affected by the general structural change resulting in new products and services with investments in information and communication technology (F1-F3, F6).
- Strategies: Most actors pursue the objective of improving efficiency. Only the actors F4 and F5 strive for a consolidation strategy: "We want to stay small, but maintain high quality. We do not want to expand". The actors F1-F3 prefer cooperation. This is reinforced by the cooperative nature of the firms interviewed. The various strategies are reflected in the figures of the enterprises: "Target level is a return on sales of about 1%". "We want to belong to the two to three high-performance market participants within the sector". "We want to grow sustainably".
- Participants: All interviewed actors (F1-F7) participate significantly in the work system of the agricultural bulk logistics sector. For the steady flow of goods, the work system is developing a growing technical potential which requires IT service providers for the maintenance of the system F1-3, F6). Furthermore, in some cases additional market participants for the trade such as trade

partners (F1, F3, F7) and stock exchange partners (F1, F7) are involved. Several external services are implicated. For instance, actor F7 collaborates with a management consultant, and actor F5 collaborates with a financial service provider. Both examples of the involvement of external services result in the acquisition of new ideas and stimuli. Although the prevailing means of transportation handling is done via telephone and fax, a digitization and thus transportation handling via 4PL is conceivable. "We can easily imagine that we are capable of dispatching external trucks. This is in part already implemented; however, using old means". This idea can only be fully implemented if a 4PL service provider has full access to all information regarding order situation and capacity of all of the involved actors.

- Information: As is the case for any work system, the agricultural bulk logistics has access to a data pool in the form of industry information (F1-F7). In addition, participants exchange information such as order placements. Based upon this transportation orders are acquired and transportation documents generated. Information about the status of transportation handling is only selectively available. Actors are capable of assessing available transportation resources as well as stock overview based upon their experience. However, in this way forecasts of subsequent planning activities are not possible. Loading and unloading capacities can only be dispatched based upon the experiences of particular actors (F1-5).
- Technologies: There are significant divergences in perspectives among the relevant actors. Whereas, telephone, fax, email, internet access and mobile radio is common technology, a collaboration based upon online tools, RFID or bar codes have not yet been implemented. Although larger companies have access to modern IT infrastructure such as enterprise resource planning systems (F1-3, F6) or customer relationship management systems (F1-2), there are no interfaces (EDI) for the avoidance of redundant or faulty input among other actors. This can partly be deduced from the actors specific strategies as well as the lack of IT systems and their limited accessibility, which makes it difficult to assess the added value of these systems. These actors only use GPS for navigating their vehicles (F1-F6).
- Process and activities: The cases F1, F2 and F6 operate a business process management; hence business processes are recorded and control mechanisms are implemented. The actors F1-F3 and F6 employ subject-specific customer consultation to stimulate business activities. In the case of transportation handling telephone or paper-based correspondence is used as a means of information management. Thereby, service providers are selected intuitively and control mechanisms are only implemented occasionally (F1, F4, F5, F6).
- Product and services: Essentially, each of the case studies have 1-X products or services available. All cases use contract management as well as a documentation management. The actors F1 and F2

apply market analyses and inventory management. According to the self assessment of actor F1 and actor F6 they are competent in process and product development as well as business optimization and the management of the logistics chain. Furthermore, they offer training to other market participants. An efficiency-oriented planning of the logistics chain including controlling is only implemented occasionally. However, none of these actors has experience in IT consulting nor do they have the know-how to put the aforementioned potential into practice.

- Customers: Transport demand is the main characteristic of a typical customer in this work system (F1-F6). Apart from actor F2 all actors aim to increase efficiency. Moreover, they are open to the outsourcing of activities. The actors F1 and F6 prefer the increased implementation of IT approaches. All interviewees affirm the willingness to invest in the improvement of information flow.

Based upon the results of the cross-case analysis as well as the matrix generated, the assignation of actors interviewed including their individual perspectives on work system issues to the main functions and elements has been accomplished. The numbers in table 5 represent the experts 1 to11 based upon table 4.

The analysis leads to the insight that none of the actors offer IT consulting within the category (element) 'product and services'. This may explain why online tools, bar codes and RFID are not employed within this workflow system.

In addition, differences between the theoretical and the sector-specific requirements based on the WSF could be identified. Whereas the WSF element "Process and activities" focuses on theoretical issues such as service management and service provider selection in practice consulting and business process management are more important. Considering the category “participant” the supplier has been addressed in the literature.

Next to trading partners suppliers are also important in practice. However, here the focus is on employees who are capable of reducing the workload of the 4PL. In terms of information demand sector information was of central interest for practical reasons. However, the literature focuses on transport resources and orders. Furthermore, transportation orders are of practical relevance.

The element 'technology' provides a potential to introduce scientific knowledge into practice. For instance, the scientific literature describes online platforms that are not yet implemented in practice.

Furthermore, in the literature products and services focus on supply chain managers (planning, control and tracking). The function planning is of particular interest in practice. The case studies reveal further important functions such as contract management and document management which complies with the generally recognized requirements within the sector based on the legal requirements such as food guidelines.

The elements customer, environment and infrastructure address the same issues both in science and practice. Within the element infrastructure the willingness to invest plays a central role. However, in terms of strategy differences are detected: whereas examples form the literature emphasis the cooperative approach, experts interviewed focus on efficiency improvement.

Finally, the matrix demonstrates that F3 (dark gray) aggregates most attributes that indicate a high potential for the employment of a 4PL.

Table 5: Cross-Case – 4PL matrix model

WSF element	4PL Attributes	Case Study - Experts											
		1	2	3	4	5	6	7	8	9	10	11	∑
Process and activities	*Service Management*			X			X			X			3
	Service provider selection			X				X					2
	Information Management	X	X	X	X	X	X			X			7
	Business Process Management	X		X	X	X				X			5
	Controlling	X	X	X			X						4
	Consulting	X		X	X	X	X			X			6
Participiants	*Suppliers*	X		X			X			X	X	X	6
	Trading partners	X	X	X			X				X	X	6
	Producer	X	X	X						X			4
	IT service provider	X	X	X	X	X				X			6
	Management consultant										X	X	2
	Financial services provider					X							1
	Employee	X	X	X	X	X	X	X	X	X		X	10
	Exchanges		X	X							X	X	4
Information	*Transportation resources*			X	X	X		X	X	X			6
	Transportation orders	X		X	X	X		X	X	X	X	X	9
	Status overview	X			X					X	X	X	5
	Transport documents			X	X	X	X	X	X				6
	Stock Overview	X	X	X	X	X	X		X	X		X	9
	Sector information	X	X	X	X	X	X	X	X	X	X	X	11
	Order and sell orders	X	X	X	X	X	X			X	X	X	9
	Loading and unloarding resources			X	X	X	X		X				5
	Risk assessment		X							X			2
Technologies	*Used Technologies*												
	Online platform												0
	Internet	X	X	X	X	X	X	X	X	X	X	X	11
	RFID												0
	Phone	X	X	X	X	X	X	X	X	X	X	X	11
	E-Mail	X	X	X	X	X	X	X	X	X	X	X	11
	Fax	X	X	X	X	X	X	X	X	X	X	X	11
	Barcode												0
	Mobile phone	X	X	X	X	X	X	X	X	X	X	X	11
	Paper	X	X	X	X	X	X	X	X	X	X	X	11
	Automated Technologies												0
	ERP System	X	X	X	X	X	X			X			7
	EDI	X	X	X			X						4
	CRM	X	X	X		X							4
	GPS			X	X	X		X	X	X			6
	Decision Support System						X						4
Products & services	*Efficient supply chain planning*	X	X	X			X	X	X	X			7
	Process and poduct development	X	X	X						X			4
	Market analysis		X		X	X							3
	Business Prozess Optimization	X		X						X			3
	Contract Management	X	X	X	X	X	X			X	X	X	9
	Control of supply chain	X		X			X			X			4
	Inventory management	X			X	X	X						4
	Shipment tracking	X		X	X	X							4
	Return management	X		X	X	X	X			X			6
	Document management	X		X	X	X	X	X	X	X	X	X	10
	Quality management			X	X	X	X	X	X	X	X	X	9
	Supply chain controlling			X									1
	IT-Consulting												0
	Financial implementation and Insurance		X		X	X							3
	Training and Services			X		X				X			3
Customer	*Transport requirements*	X	X	X	X	X	X	X	X	X			9
	Increase outsourcing	X	X	X			X	X	X	X			7
	Increase efficiency	X	X				X	X	X	X	X		7
	Informations & Technology	X								X			2
Environment	*Sector knowledge*	X	X	X	X	X	X	X		X	X	X	10
	Cooperation	X					X						2
	Applied ICT	X		X			X			X			4
	Products and Services	X	X	X	X	X	X	X	X	X			9
	Resources	X	X	X	X	X				X			6
Infrastructure	*Data transparency*	X	X	X			X			X	X	X	7
	Data quality	X	X	X	X		X			X	X		7
	Data integrity	X	X	X	X	X	X						6
	Willingness to invest	X	X	X	X	X	X	X	X	X	X	X	11
	Open systems	X	X	X	X	X	X			X			7
	Technical standards and interfaces	X	X	X	X	X	X						6
	Knowledge management									X	X		2
Strate-gies	*WSF strategy cooperation*		X	X	X	X	X						5
	WSF strategy efficiency improvement	X	X	X	X		X			X	X	X	8
	∑	48	39	54	40	40	43	22	22	46	24	23	

Discussion

The research effort described in this article focuses on the analysis of the 4PL approach within the agricultural supply chain and within the framework of bulk good logistics. Based upon the selected literature the attributes of a 4PL approach are identified and analyzed with respect to industry-specific characteristics and the elements of a case study matrix (see table 5). This effort not only provides insights for further research but clearly reveals results that are relevant for the practice, that taken together may be used for further development of a 4PL platform. As a result, the list of questions as posed in section 2.2 can be answered as follows:

- Which actors use the system? All actors involved in the supply chain would use this system if the application of a 4PL approach results in an increase in efficiency as well as a better integration of all actors.
- What is the benefit of the system? The main benefit would be the reduction of empty mileage based upon improved planning. Furthermore, better communication as well as a transparent information flow including standardized interfaces are possible.
- Where will the system be applied? The interviews revealed that the implementation of the 4PL approach within the sector takes place mainly at the secondary level. The actors at this level carry out most of the bulk transport. Moreover, the infrastructure required for a possible implementation of 4PL is already available. In addition, initial 4PL structures have already been installed based upon the available network of the actors.
- When can the system be applied? An implemented 4PL would be used for transportation handling within the sector if a benefit is generated, and an integration of actors including their specific characteristics and requirements is feasible.

With this research effort a method for information management within a supply chain with respect to the design level, (degree of) organization, applied software as well IT integration has been successfully applied. The entire approach has been implemented with a view to a possible application of a 4PL based upon a WSF. Design levels have been incorporated with the help of the case study research based upon the WSF. The importance of the main attributes of the 4PL approach has been analyzed based upon the WSF as well as along the work system. All aspects of the work system have been indexed and analyzed in the sector.

Summary and Outlook

The application of a 4PL for supply chain management can be accomplished based upon recent information and communication technology. It can contribute to the increase in efficiency (within the supply chain) on a long-term basis. Presently, the recently developed 4PL concepts (Win 2008) are increasingly employed in practice (Partsch 2011). The objective of this article is a systematic overview of the attributes of a 4PL based upon the available literature, and the testing these attributes against all relevant criteria for a possible application in practice. The state of the art of IT as well as the incorporation of the involved actors were of special significance. Hence the result may not only be of importance for the academic world but also for real-world applications. First of all, our contribution demonstrates a procedure for the analysis of a supply chain for the introduction of a 4PL. Furthermore, the attributes of a 4PL have been derived in a sound manner. Second, this research effort provides an in-depth analysis of the 4PL approach, and encourages its introduction in other supply chains. In the event of a successful introduction of 4PL in a supply chain an increase in efficiency may be expected. Third, this contribution to the research reveals opportunities which can be exploited for the benefit of the successful introduction of 4PL. In this context, actor behaviour/interests must be regarded.

Finally, we believe that the results of this research may be of special interest to the relevant actors of the logistics industry as well as the IT sector. The 4PL serves as a tool to integrate the two different sectors. In view of the rising volume of goods traffic on the global scale IT networking and intelligent planning are of increasing relevance within the logistics sector. Hence, every supply chain has to factor that in.

In addition to the results, limitations have also been revealed which may indicate the need for further research. This research has developed a matrix drawn from the literature and a cross-case analysis. The selected articles are the basis for the matrix. However, the existence of other relevant literature and databases that have not been taken into account with relevant context cannot be entirely excluded. Moreover, the cross-case analysis employs actors of a specific supply chain. Hence, results may not be directly applied to other supply chains, nor should these be used for a comparison among various supply chains. This may be a starting point for further research based on the matrix.

Another limitation with regard to the case studies is data acquisition with the help of expert interviews. Errors may occur due to lack of comprehension, linguistic barriers or lack of trust between interviewer and interviewee.

Although we have put much emphasis on a comprehensive introduction to the topic, individual perspectives, the positioning of a firm within the supply chain and different professional experience may have biased the responses.

Furthermore, case studies, depending on the sample size, are limited in terms of the extent to which they can be generalized. Nonetheless, the authors believe that the results based upon the available data are relevant for the agricultural bulk logistics sector throughout Germany.

This study may be the basis for further research in this field. For example, stakeholder analysis could be applied. This may contribute to an increase in the efficiency of an applied 4PL approach for the benefit of all participating actors. Moreover, this research effort has the potential to contribute to the development of a 4PL approach for its application in the German agricultural bulk logistics sector.

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Beitrag 6: Process reengineering by using the 4PL approach – a case study on transportation processing in the agricultural bulk logistics sector

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Process reengineering by using the 4PL approach – a case study on transportation processing in the agricultural bulk logistics sector

1 Introduction

Under the pressure of the steadily increasing world population and the concurrent decrease of agriculturally productive land ("Agriculture in the Global Economy", 2014), the field of agricultural logistics is becoming progressively important worldwide. At the same time, speculative business transactions that involve agricultural goods are increasing (Moon, 2011). In addition, fluctuating harvest volumes add to the volatile factors that influence the agricultural supply chain. Regulatory food safety requirements in Europe and Germany in particular prescribe the traceability of goods (Fischer *et al.*, 2009). As also in the agricultural supply chain, transportation is subject to logistical limitations, such as costs, cargo capacity and time, a strategic supply chain management is of growing importance within the agricultural sector. This requires the implementation of new, innovative approaches for business processes (King *et al.*, 2010). For this reason, the research effort described here aims to overcome actor-based barriers and to create the conditions necessary for changing the implementation process at an early stage. With the aid of the process reengineering method, changes in the implementation process are described and implications for the transportation process are revealed.

Supply chain management is a concept that endeavours to improve the coordination of activities among firms involved in the value-added chain across corporate firewalls in a multi-functional way (Cooper *et al.*, 1997). To this end, the focus is on process orientation including management across corporate firewalls (organisational) and the coordination of product flows as well as information flows (both of which are technical processes) (Waters, 2003). The objectives of a supply chain management are: the shortening of process cycles, the enhancement of service levels and the increase in the flexibility of logistic activities for the reduction of resources consumption within the supply chain (Wildemann, 2001).

In light of these objectives, a multitude of complex challenges have to be faced. These challenges can be met by both organisational and technical means (Rajaguru and Matanda, 2013). The organisational aspect is addressed by introducing a Fourth Party Logistics Service Provider (4PL) or a Lead Logistics Provider who enables a planning approach within the supply chain (Kasperek, 2013; Win, 2008; Yao, 2010; Vinay, V. P. *et al.*, 2009). In doing so, the 4PL employs all involved actors according to their core competencies, which in turn requires a suitable technical infrastructure.

Information and communication technologies (ICT) address the technical aspects of supply chain management (Bowersox and Closs, 2011; Closs and Goldsby, 1997; Bharadwaj, 2000; Spanos *et al.*, 2002;

Giannopoulos, 2004; Golob and Regan, 2002). Marchet *et al.* (2009) distinguish between the different ICT applications for supply chain management and transportation handling: transportation management, supply chain execution, field force automation as well as flow and cargo management. Transportation management encompasses ICT applications for traffic planning, optimisation and handling of transport, consignment tracking as well as payment transfers (Mason *et al.*, 2003, Tyan *et al.*, 2003). Supply chain execution applications comprise automated information flow as well as real-time management for the distribution of vehicles (Giaglis *et al.*, 2004). Field force automation applications use mobile radios and optimise business processes, which may result in a reduction in the labour force needed. Flow and cargo management applications are employed as reporting tools (e.g., for driving time, down time or distribution time). Furthermore, ICT applications are employed as real-time controlling instruments (e.g., distribution plans).

Business process management is the link between technical and organisational measures (Yu *et al.*, 2011). Moreover, business process management is an efficient tool for analysing, modelling and implementing business processes (Smith and Fingar, 2003).

The research described in this article applies business process management in order to analyse the transportation processing within an agricultural supply chain with the implementation of a 4PL approach. Based upon a simulation, the organisational and technical implications are analysed for all involved actors (Bae and Seo, 2007). This simulation is divided into (1) input analysis, (2) process analysis and (3) output analysis. The analysis of the organisational implications helps to address the question of how to change the behaviour of involved actors as well as their readiness to cooperate (Verdonck *et al.*, 2013). Therefore, the distribution of client orders, the bundling of transport resources, the enhancement of resource use and the reduction of transport costs through collaborative transportation planning are examined (Verdonck *et al.*, 2013). This is important for the effectiveness of the 4PL approach (Section 2).

The analysis of the technical implications for the transportation process that is to be modelled is intended to reveal the implications for the ICT applied (Zhang *et al.*, 2011). Therefore, the communication speed, the transparency of information and the related flexibility for processing the transportation are the main parameters (Marchet *et al.*, 2009). At the same time, the analysis of process-, waiting- and down times are analysed for a direct comparison between the situation model and the target operating model.

The ultimate objective of the analysis of technical and organisational implications is to respond to the research question (RQ) concerning the advantages of innovations, the responsibilities of the involved actors and the added value that can be achieved when a 4PL is applied in the sector of agricultural bulk logistics (Stefansson and Russell, 2008; Selviaridis and Spring, 2007) (RQ1). Thus, the assessment of the added value as well as the related saving potential gained through the integration of a 4PL constitutes a good way to evaluate whether future ICT investments are justified or not (RQ2).

The paper at hand is structured as follows: Section 2 describes related work and background information that provide the foundation for the research methods as described in section 3. The application of these methods within a case study is explained in section 4. Finally, the results of the simulation are summarised in section 5. The article concludes with section 6 on implications and limitations of as well as requirements for further research.

2 Theoretical background

Transportation is a key process within the agricultural supply chain because of the physical link between contractor and client (Coyle *et al.*, 2003). For this reason, transportation management is a segment of the supply chain. It provides the holistic planning as well as the control of the material flow. This notwithstanding, transportation is subject to a supply chain-induced pressure to increase efficiency (Mason *et al.*, 2007). Collaborative transportation planning that integrates all involved actors is seen as an opportunity to minimise inefficiency (Mason *et al.*, 2007). Therefore, all actors are involved and challenged to reduce their own inefficiencies in order to thereby increase the efficiency of the entire chain. A number of scientific articles describe the 4PL approach with the objective to implement the previously described improvement for the entire group of participants (Hingley *et al.*, 2011). Win (2008, p. 677) describes the 4PL as follows:

“A 4PL is an independent, singularly accountable, non-asset based integrator of a client’s supply and demand chains. The 4PL’s role is to implement and manage a value creating business solution through control of time and place utilities and influence on form and possession utilities within the client organization. Performance and success of the 4PL’s intervention is measured as a function of value creation within the client organization.”

Although there are a few more definitions for a 4PL, we selected Win's definition to serve as a basis for our article. The fact that his definition was applied in some literature works already confirms that transportation management constitutes, among many other services (e.g., consultancy, assessment or IT provision), the core task of a 4PL. The Metro Group is one example from literature in which a 4PL is employed for transport control and planning of internal goods flows (Prümper and Butz, 2004). Another example is the chemical industry in the US where the 4PL is used on a multi-actor level for the planning of up to 20% of the entire transportation processes of the sector (Partsch, 2011).

The objective of a 4PL is the efficient use of resources within the supply chain. Due to his cross-sectoral overview of transport orders and cargo capacities, the 4PL is capable of managing transportation processes efficiently. However, all involved actors within the supply chain as well as their respective requirements must be factored in. To do this, the application of information and communication tools (ICT) is of significant importance (dos Santos Viera *et al.*, 2013; Piplani *et al.*, 2004). In this respect, the transfer of ICT to the actors of the supply chain as well as the reduction of barriers is a particular factor that must be examined (Evangelista *et al.*, 2013). ICT comprises telephone, mobile phone, Fax, EDI, RFID, email as well as platforms with software modules like transport order management, transport planning, transportation management and transport controlling. All such technologies support the application of the 4PL (Nissen, 2001; Mattfeld and Robra-Bissantz, 2012). The objective of applying ICT is the improved transparency of communication and information exchange as well as information flow. All this enables the 4PL to provide an adequate planning as well as the management and control of functions (Bourlakis and Bourlakis, 2005). For this reason, business processes that incorporate organisational, strategic and IT-affirming aspects are required (Grover *et al.*, 1995).

For the development of business processes the term “process” is important. Harrington (1991) defines it as the transformation of inputs into outputs. Inputs may be resources or requirements, whilst outputs are products or results. An output may or may not add a value to the process and could be an input to another process.

Business process management has undergone a transition from mere process modelling to the analysis of entire settlement processes including their infrastructure (Georgakopoulos *et al.,* 1995). A number of studies demonstrate various methods for process management (Adesola and Baines, 2005; de la Fuente *et al.*, 2010; Harmon, 2010; Stefanovic *et al.*, 2009; Persson and Olhager, 2002). Each method is customised to the particular demands of the related (real-world) project (Klein, 1994). Hence, the various examples of process reengineering from literature represent a variety of case studies with particular optimisation objectives (Kohlbacher, 2010). However, in all these case studies, varying values and representation procedures are employed. Thereby, an increase in the use of software is observed (González *et al.*, 2010). Whereas Klein (1994) applies a set of directives for the selection of the related research approach, Kettinger *et al.* (1997) demonstrate the specific steps of a process re-engineering approach as well as the relationship among these steps. Moreover, specific methodologies such as the Process Re-engineering-oriented Organisational Change Exploratory Simulation System (PROCESS) are described. These approaches represent both Organisation Re-engineering (OR) as well as Business Process Re-engineering (BPR) in order to improve customer orientation (Chen and Tsai, 2008). Bevilacqua *et al.* (2009) describe a BPR taking IT- and workflow management systems into account where process modelling is implemented with software support (Adamides and Karacapilidis, 2006). Groznik und Maslaric describe a “methodology for distribution channel re-engineering” in order to foster practice-oriented research. This methodology is divided in six steps, which are implemented during the process re-engineering. With the use of a case study, this approach was tested with the help of the 'igrafx' tool (Groznik and Maslaric, 2012). In terms of process reengineering, the 4PL approach faces a variety of challenges such as the involvement of relevant actors and the related organisational consequences. At the same time, the 4PL approach entails a modification of the IT systems with technical consequences for the applied ICT systems. For a business process-reengineering endeavour, such as the innovative implementation of a 4PL, a range of methods are needed that describe the process reengineering (see Section 3). In addition, the effects of the reengineering of business processes have to be described, whereby business processes depend on a group of logically-related tasks.

If a simulation approach is applied, the impact (by comparing the input and output parameters) and the process activities will be presented. Vidalakis *et al.* (2011) apply a simulation-based approach in order to examine a supply chain in the building sector. Thereby, they include the involved actors as well as the implications for both inventory and transportation costs. Islam *et al.* (2013) apply a similar approach: truck transport of maritime container shipments are reengineered with the help of a business process simulation. The focus of this simulation is the reduction of empty mileage and better planning of transport capacity. As an example of the agricultural supply chain, Windisch *et al.* (2013) demonstrate the application of business process analyses including a simulation of the reduction of harvesting costs in the area of forest biomass procurement. In this case, business processes for the handling of the delivery chain (number and duration of the processes) are of particular significance.

3 Methodology

With the challenge of increasing the supply chain efficiency, two methods are introduced. Both methods a case study approach with practical relevance and construction-oriented research in form of a simulation were applied (Wilde and Hess, 2007). Case study research is an approved method when addressing the questions of why and how. Furthermore, this research method is of practical relevance (Yin, 2012). In our case, the more specific questions are: Why does the application of a 4PL constitute an added value for the agricultural supply chain? How can the implementation of the 4PL be realised? While the case study does not provide any prospects for possible future developments, a simulation is able to answer 'what if?' questions. In this specific case, the consequences of the implementation of the 4PL in a supply chain are queried. By combining the two methods, this research endeavour brings a twofold added value: 1) the case study of the supply chain can reveal weaknesses in efficiency and make current problems and processes transparent; 2) the simulation enables the testing of scenarios without monetary investments. In this way, scientific findings and consequently practical measures may be derived. Because of the combination of the two methods and the resulting need for stakeholder participation, this research may be characterised as transdisciplinary research.

Figure 1 provides a graphical presentation of the methodology used. The definition of the research scope is described in section 2. The literature search was carried out with the keywords “process reengineering” and “simulation”, in order to achieve a comprehensive overview of the topic as introduced. Within the time frame of 1990 to 2014, the databases, Emerald, EBSCO, Science Direct and Wiley served as data sources. Based upon the data acquired, a “process reengineering methodology for a 4PL simulation” was developed. This simulation also includes the analysis of several process reengineering approaches. The methodology is divided into eight steps. These can be clustered as an input analysis (Step 1-3), a process analysis (4-7) and an output analysis (8). These steps factor in both case study research (Step 1, 3, 4, 6, 8) as well as the simulation (Step 2, 5, 7). However, the boundaries between particular steps are indistinct. The steps are described as follows:

1. Analysis of framework conditions

Prior to designing the simulation model, it is necessary to fully capture the case study including the relevant issues and the objectives of all actors involved within a given sector (Bevilacqua *et al.*, 2009). The decision makers with a defined set of targets (Kohlbacher, 2010; Groznik and Maslaric, 2012) as well as the actors who are supposed to provide the information required for the case study are of central importance (Yin, 2012). Due to the integration of the decision makers in the case study, the demands of clients and carriers as well as the related services and processes of the supply chain can be deduced (de la Fuente *et al.*, 2010; Chen and Tsai, 2008). At the same time, the roles and responsibilities of the stakeholders as research partners in the project are determined. The term ‘project organisation’ is defined by Adesola and Baines, 2005; Klein, 1994; Kettinger *et al.*, 1997; Castano *et al.*, 1999).

2. Selection of software, tools and methods

A literature review is necessary for analysing all available methods with respect to their application in the logistics sector. After all research partners have agreed on an appropriate modelling method, this method can be adopted for the application in the intended case study. Subsequently, the required tools and the necessary software can be selected (Castano *et al.*, 1999). After the analyses and selection of tools and methods, the data acquisition can be formulated (González *et al.*, 2010).

3 Data recording

According to Groznik and Maslaric (2012) as well as Bevilacqua *et al.* (2009) the architecture for data recording can be designed in the form of a defined standard. This standard includes media discontinuities, cooperation efforts, recording of process times, query times, waiting times and costs as well as the ICT (infrastructure) employed. According to Yin (2012), a testing of data records and required modifications to data recording must be implemented during the pretesting phase. Thereafter, data recording is implemented while actor perspectives are identified during the expert interviews. This enables scientists to comprehend the entire process involved in the agricultural supply chain (Kettinger *et al.*, 1997; Yin, 2012; Adesola and Baines, 2005).

The process analysis (Step 4-7) can start with the data generated from the input analysis. The process analyses examine the processes, the current and the target situation.

4. Modelling of the current situation

Having finalised the data recording, the model is designed based upon the compiled data (Klein, 1994; Chen and Tsai, 2008; Groznik and Maslaric, 2012). In this process, the identification of key actors within the supply chain is indispensable. The importance of actors can be identified with the help of media discontinuities at IT interfaces or differences in the ICT application (Bevilacqua *et al.*, 2009).

5. Simulation of the current situation

Following the design of the model, the simulation and validation of the recorded data may be implemented (Persson and Olhager, 2002). For this purpose, the simulation results are discussed with the actors involved. This helps to verify observations as well as the representation of practical phenomena in the model. The validation of simulation results is highly important for the demonstration of practical relevance (González *et al.*, 2010).

6. Modelling of the target situation

Once the model of the current situation (Step 4) is validated and verified (Step 5), the new supply chain approach may be implemented. For this purpose, new organisational and technical aspects and opportunities, such as new actors and institutions, IT-Platforms and ICT changes have to be factored in (Bevilacqua *et al.*, 2009). Moreover, Castano *et al.* (1999) and Klein (1994) state that human factors are subject to changes during the process analysis (i.e. skills, teams and management structure). Furthermore, target criteria as described in the first step must be incorporated (Groznik and Maslaric, 2012).

7. Simulation of the target situation

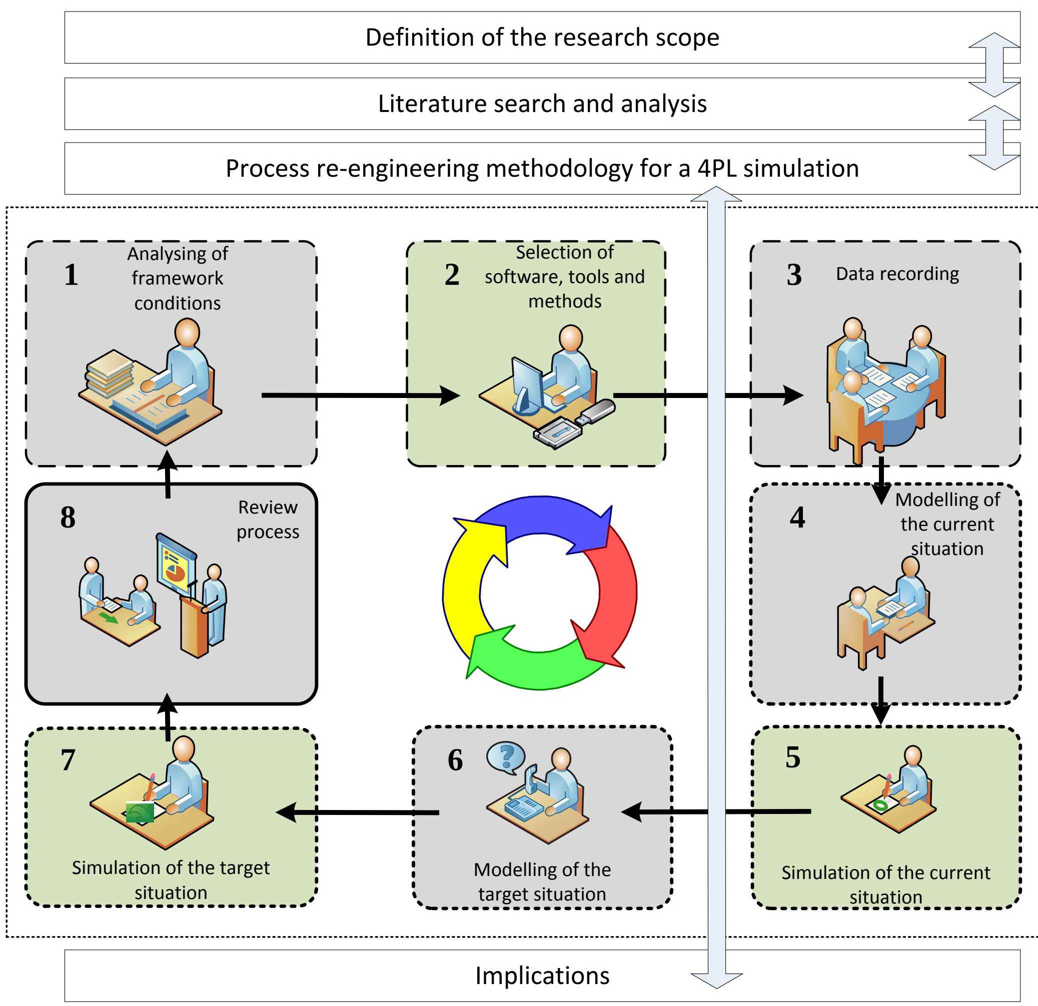
After modification of the target model, the corresponding simulation follows Groznik and Maslaric (2012). Based upon the model, several experiments (with varying input variables) can be executed, where Steps 6 and 7 may be processed differently (Persson and Olhager, 2002). Several experiments are needed in order to be able to simulate volatile influences of practical situations.

The final step of the process reengineering methodology for a 4PL simulation is the output analysis referred to as the 'review process' (Step 8). The output analysis reveals the effects of the reengineering process on decision support.

8. Review process

A strategic decision for the achievement of a particular goal within the sector can be determined through a comparison of the simulation results (de la Fuente *et al.*, 2010; Groznik and Maslaric, 2012; Castano *et al.*, 1999). Furthermore, comprehensive trainings of all actors involved are needed in order to implement the new processes (Adesola and Baines, 2005; Kettinger *et al.*, 1997).

Figure 1: The process reengineering method for a 4PL simulation



4 A case study in the agricultural bulk goods logistics sector

The agricultural bulk goods logistics sector is part of the food industry and constitutes the fourth largest industry in Germany. The German Farmers' Association estimates that in this sector there are about 5,900 firms with approximately 555,000 employed people (German Farmers' Association, 2014). The agricultural bulk logistics combines agriculture, trade and food industries. In 2012, the overall volume of agricultural goods transported in Germany was 3.7 billion tonnes, 76% of which (2.8 billion tonnes) was transported via road (Federal Ministry of Food, Agriculture and Consumer Protection, 2012). The bulk goods were predominantly transported in full truck loads. The main factors influencing the mode of transportation are volatile market conditions induced by unpredictable harvest volumes and trade activities especially in the stock markets. The relevant actors in the sector are traders who are distinguished by their roles in primary cooperatives, secondary cooperatives and local trade. Other relevant actors are farmers, carriers and processors. Each of these actors may play several roles that can be realised in parallel. These roles or functions include trading, transportation, receiving, processing and dispatching goods. This variety of functions has implications for the transportation handling which is currently managed with mobile phones on an ad hoc basis. Based upon the existing cooperative structures and the function of the secondary cooperatives at the wholesale trading level, the objective is to achieve a cooperative process for transportation in which all actors are involved and employ the 4PL approach. Moreover, the objective of the reengineering approach was the analysis of implications, such as the reduction of lead times for transportation, which is assumed to reduce transaction costs. Furthermore, the opportunities for an increased transparency in the transportation processes, more specifically in the freight capacities, the actors' resources for loading and unloading as well as the ICT employed, are examined. The "process reengineering methodology for a 4PL simulation" as introduced in section 3 is applied to the analysis of the case study.

4.1 Input Analysis

Analysing framework conditions (Step 1)

The main characteristics of the agricultural bulk goods logistics sector are explained in section 1 and in the paragraph above. In the effort to build a comprehensive picture the secondary cooperative, one of the key decision makers within the sector, serves as our research partner. The secondary cooperative's key role depends on the management of a freight volume of approximately 50,000 full truck loads which are mainly dispatched on an ad hoc basis. At the same time the secondary cooperative possesses the suitable infrastructure for the implementation of the 4PL approach in the agricultural bulk goods logistics sector. For the physical transportation process several service providers are involved as further research partners. Our analysis is based on 11 interviews conducted with experts in the period of February to May 2014.

Selection of software, tools and methods (Step 2)

Based upon the analyses described in the research objectives and in literature, various notations and application software were examined. As a result, the Process Simulator 2014 (Pro Model Corporation) was selected. With the assistance of this software, processes can be depicted in the form of flow charts and actors can be included in the organisational structure. Moreover, each particular process step is modelled. Furthermore, performance indicators, such as processing time, lay times, and buffer or turnaround times can be recorded. Based upon the selection of performance indicators, a data record sheet was developed.

Data recording (Step 3)

Two experts from the sector validated the data record sheet by means of a pre-test. After the final modification of the sheet, the data recording was accomplished through six expert interviews as well as the analysis of the process description of actors.

4.2 Process analysis

Modelling of the current situation (Step 4)

Based upon the data records, the modelling of the current situation was implemented as depicted in Figure 2. This figure presents the actors and the processes in the form of flow charts. The arrows indicate information flows. In addition, different sub-processes (SP 1-12) are defined. These processes describe a chronological sequence, which also facilitates the differentiation of the actors in the processes. The following actors (Table 1) and sub-processes are defined:

Table 1: Actors and Functions

Actor	**Function**	**Actor**	**Function**
Consignee	buys goods	Dispatcher	dispatches transport
Accountant	processes financial and accounting data	Freight forwarder	organizes transport
Trader	buys and resells goods	Carrier	transports goods
Transportation handler	checks transport orders for traders	Consignor	sells goods

Sub-processes

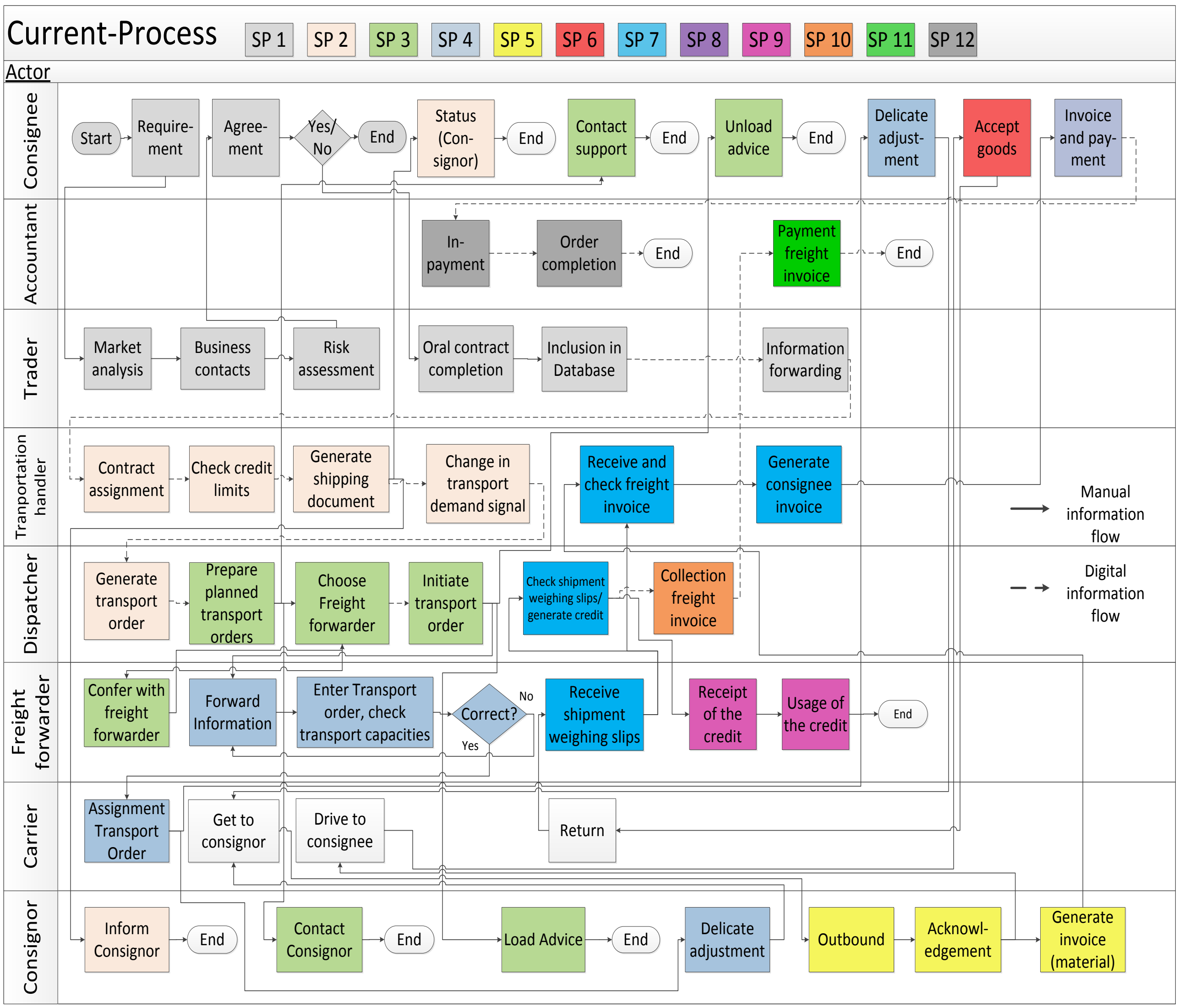
- SP 1 describes the transaction between the consignee and the trader. Prior to a transfer order, there is a trade transaction between these actors. These activities are based upon strategic decisions with time frames between 1 month and up to 2 years. The communication is telephone-based, and the communication medium is paper-based.
- SP 2 describes the preparation for the transportation. The process conditions are monitored by the

transportation handler until the transport demand signal is forwarded to the dispatcher. Other actors involved such as the consignee and consignor are informed via fax and telephone.

- SP 3 describes the transport order generation and planning that are mainly undertaken by the dispatcher. First, the consignee and the consignor are contacted via telephone to request preferred transportation times. Second, freight forwarders are contacted via telephone to ask for their transport capacity. Third, all actors involved agree on the preferred time slot at which the transport order is generated for the carrier; the respective information are sent via fax/post. At the same time, consignee and consignor are briefed via telephone.
- SP 4 describes the administrative process at the freight forwarder. This actor directly incorporates all messages received via (paper) mail or fax in his capacity planning. In case the capacity of the freight forwarder is exhausted, a carrier takes over and prepares the transportation. In case the capacity of the freight forwarder is available the remaining details with the consignee and consignor are matched via telephone.
- SP 5 describes the administrative process between the carrier and the consignor. The carrier takes over the loading of the bulk goods. A hard copy weighing slip documenting the load is generated. Then, the physical transport starts. Additionally, the consignor generates an invoice for the goods transported and sends it to the actor who is taking care of the transportation.
- SP 6 describes the administrative process between the carrier and the consignee. The physical transport process ends with the unloading of the bulk goods. Also, the carrier receives a weighing slip for the kerb weight. Then, both weighing documents (loaded and unloaded vehicle) are sent to the freight forwarder. In the real world the carrier delivers the weighing documents to the freight forwarder only once a week, which generates additional waiting times.
- SP 7 describes the first step of the administrative process of the transport payment. The freight forwarder receives the weighing slips and sends these to the dispatcher. The dispatcher controls the documented transport and forwards the weighing documents to the transportation handler. Based upon both the invoice for the goods and the weighing slips the transportation handler can generate the invoice for the consignee.
- SP 8 describes the administrative process of settling the trade payables between the transportation handler and the consignee. The invoice is sent (paper mail) to the consignee who completes this step by a payment.
- SP 9 describes the second step of the administrative process of the transport payment. Based upon the controlled weighing slip the dispatcher sends a cheque to the freight forwarder. Using the credit balance, the transport payment is made. At the same time, an internal freight invoice is generated.

- SP 10 describes the collection of internal freight invoices. This is indispensable since invoices are paid only once a month. The process of internal freight invoices is already digitalised.
- SP 11 describes the payment of the freight invoice between accounting and dispatcher.
- SP 12 describes the settlement of trade payables between the consignee and the accountant. Once the payment has been made, the complete business transaction is concluded. All actors have received payments, and all services have been performed.

Figure 2: Model of the current situation



Simulation of the current situation (Step 5)

Based upon the input parameters (lead time, process time and waiting, lay and transfer times) of the data recordings as well as the data from real-world transportation activities within the years 2011 to 2013, a simulation was performed. The processing time of each sub-process was critically reviewed and if necessary improved until approximately 50,000 transportations per year could be represented. In this way, the model complies with real-world requirements.

Modelling of the target situation with the application of the 4PL approach (Step 6)

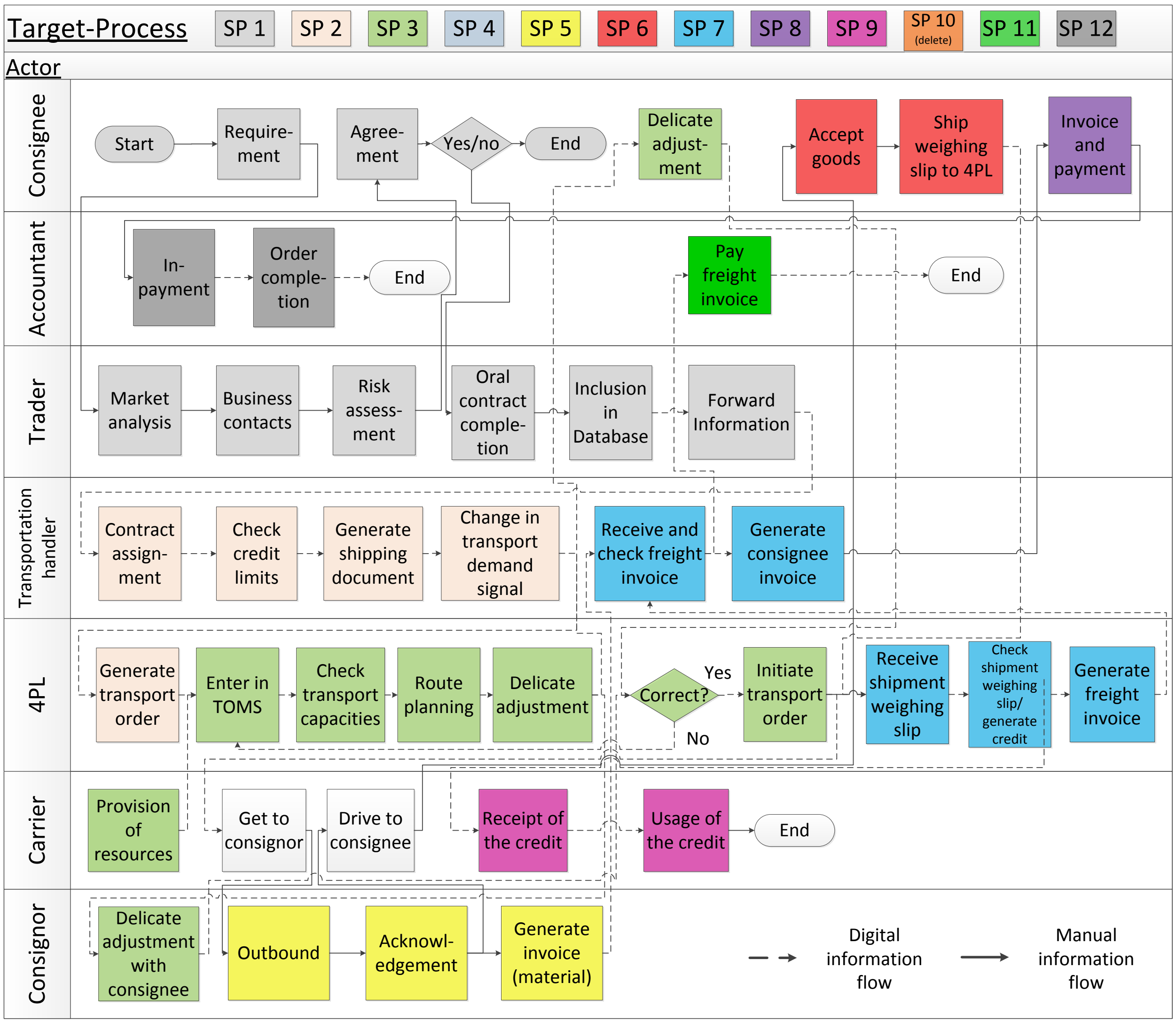
Based upon the 4PL parameters as described in literature, we carried out organisational and technical modifications in the modelled process in order to achieve the target situation. From an organisational perspective, the 4PL was implemented to include the functions of: (1) transportation handling, (2) resource planning, and (3) control of the transportation handling. Technically, all manual means of communication (written orders, Fax) were converted into digital information by means of the following modes: operational IT platform, web browser, EDI and email. These modifications were evaluated and rated by the experts involved. As a side effect, the scientists and practitioners exchanged their experiences, and a potential future application in a real-world situation was discussed. Figure 3 represents the modelled target situation with the application of the 4PL approach. The following list provides the modified sub-processes:

- SP 1 was not modified. The experts did not suggest a modification;
- SP 2 was modified. The transportation preparations were entirely digitalised and transferred to the 4PL. No additional actors are required at this point. The experts confirmed this modification step;
- SP 3 was partially modified. More specifically, this was accomplished through transport order generation and planning, which is mainly a 4PL task. The entire communication process is now digitally processed via the 4PL platform. This platform contains the functions: transport order acceptance, transport order planning, transportation handling and transportation controlling. Furthermore, it provides both a well-structured information flow and a semi-automatic planning process for transport orders. In this way, the transport orders of all actors are pooled as a basis for route planning. The consignors, consignees and carriers involved have access to the information relating to the status of the planning and handling of their orders (XXX insert after review process, 2014.);
- SP 4 was digitalised and implemented in the 4PL platform process;
- SP 5 was digitalised. Now, the carriers are in a position to instantly transmit the weighing results to the 4PL platform via smart phone. In this way the transportation status of each load is made transparent and retrievable at any time;
- SP 6 was digitalised. The transport is confirmed, and the weighing slip of the kerb weight is transmitted to the 4PL platform in the same way as described in SP5;
- SP 7 was modified so that the entire information flow is digitalised now. After verification of the

weighing documents, the 4PL generates the invoice and transmits it to the transportation handler digitally;

- SP 8 was modified. The invoice is sent to the consignee manually. Yet, the verification is easier because the transportation information is retrievable from the 4PL platform;
- SP 9 was not modified. The experts did not suggest a modification. However, all information is now digitalised;
- SP 10 is no longer necessary because the 4PL generated a direct invoice (SP 8).
- SP 11 was not modified. The experts did not suggest a modification.
- SP 12 was not modified. The experts did not suggest a modification.

Figure 3: Model of the target situation



Simulation of the target situation with the application of the 4PL approach (Step 7)

The processing time was determined based upon the input parameters identified in the actor exchange described above. However, individual sub-processes (SP1 – SP12) were modified and then separately simulated in order to yield comparable results as well as identify the implications for each of the actors involved. The weekly working time of 40h was an input parameter for each of the sub-processes of the current situation. Subsequently, experts were debriefed in order to validate the results. The experts and scientists repeatedly discussed critical issues.

4.3 Output analysis

Analysis of results (Step 8)

As a final step, a thorough analysis of the sub processes was carried out. Table 2 summarizes these results according to the actors involved. Based on the sub-processes, the changes in lead time, process time, waiting and lay times are shown.

Table 2: Results of the simulation based on sub processes

Sub processes	SP 1		SP 2		SP 3		SP 4		SP 5		SP 6		SP 7		SP 8		SP 9		SP 10		SP 11		SP 12	
Current (C) Target (T)	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T	C	T
Lead Time	-	-	22.1	22.1	16.6	1.5	0.8	0.0	0.7	0.6	0.5	0.5	0.2	0.2	1.4	0.2	1.8	1.8	0.1	0.0	0.2	0.2	0.2	0.2
Process time	-	-	0.2	0.2	0.5	0.7	0.4	0.0	0.6	0.6	0.5	0.5	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.0	0.1	0.1	0.2	0.2
Waiting, lay and transfer time	-	-	21.9	21.9	16.1	0.8	0.4	0.0	0.1	0.1	0.0	0.1	0.0	0.0	1.2	0.1	1.6	1.6	0.0	0.0	0.0	0.0	0.0	0.0
Involved Actor																								
Consignee	x	x	x		x	x	x				x	x	x	x										
Accountant																					x	x	x	x
Trader	x	x																						
Transportation handler			x	x											x	x								
Dispatcher			x		x										x				x					
Freight forwarder					x		x								x		x							
4PL				x		x										x								
Carrier						x	x	x										x						
Consignor			x		x	x	x		x	x														

5 Results of the simulations

The processes implemented in the current model are the starting point for the simulation with the selected process simulator software. Based on this, the current order volumes of 50,000 orders per year were simulated. This was followed by the process re-engineering through implementation of the 4PL approach. In this way, the generated results are not only relevant for the entire simulated process but also for the actors involved as well as the implications of the 4PL approach. The simulated processes depend on: the mean of process time, waiting time and lay times associated with the sub processes. With regards to the actors, the technical and organisational implications are described. In order to justify investments in the 4PL, the added value for the actors and the savings potential are examined. Accordingly, examples are provided in the following sections that are based upon the results summarized in Figure 3. Furthermore, we make a comparison of the target and the actual figures in Table 2.

5.1 Results of the simulation processes

The simulation of the target situation results in a reduction of lay and transfer times by 41%. This is because of the ICT and IT interfaces employed. These interfaces have been standardised and digitalised according to the aforementioned IT platform. Despite the implementation of the 4PL, the sub processes 1, 2, 7, 9, 11 and 12 in the simulation model remain unchanged, whereas the sub processes 3, 4, 5, 6, 8 and 10 are modified.

- SP 3 was improved since the 4PL platform took over the transportation planning process. By reducing waiting, lay and transfer times. The overall lead time was reduced from 16.1 to 0.79 hours. However, the processing time of sub-process 3 rises from 0.5 to 0.69 hours. This increase is the result of the initial, one-time data entry relating to the transport orders as well as the planning steps that are taken by the 4PL. The automated planning provided by the 4PL platform results in an enormous reduction in waiting, lay and transfer times. Routes are generated based upon the pooling of transport orders. While without the involvement of the 4PL, transport orders had been processed individually, now the routes are generated based upon multiple orders.
- SP 4 was improved because there are no double entries by actors in several media (mainly fax and printed documents) any longer.
- SP 5 was improved since the digitalised information, including the feedback to the 4PL platform, eliminates the need for double entries, reduces the paper-based system and optimises the general information flow. However, this has little influence on the processing time for the consigner, which is expressed in the lead time. Yet, the implementation of the 4PL enables a verification of the transportation status with feedback to the 4PL platform.
- SP 6 was improved since countersigning and verification of the transport documents at the unloading point are digitalised. By digitally transmitting the weighing slip from the unloading point to the 4PL, there is a higher potential for accelerating the unloading process. Through the involvement of the 4PL, the waiting times can be reduced. The lead time, however, remains the same.
- SP 8 was improved since the manual process entails waiting times and double entries. Within the scope of the 4PL approach, this process can be accelerated. Reasons for this are the digitalised information flow and the unobstructed access to the master data.
- SP 10 was improved since the (manual) collection and sending of freight invoices can be dispensed with, because this procedure is entirely taken over by the 4PL. The significantly faster information exchange associated with the use of the 4PL-based platform makes all relevant documents, that record transportation handling, instantly available for all actors. As direct accounting is possible, the collection of invoices has become superfluous.

In summary, the application of the 4PL approach for transportation handling, including the related technical and organisational modifications, resulted in an average reduction in the runtime for a transportation order of 39% (from 44.58 hours to 27.26 hours). The entire transportation handling process time was reduced by 14% (from 3.158 hours to 2.73 hours). This is because a cooperative transportation planning procedure comprises fewer steps than an ad-hoc planning approach. The number of processing steps was reduced from 36 to 30, which equals a reduction of 17%. While the current ad-hoc planning process relies on a manual communication among the actors, the 4PL approach applies a unified communication platform. The platform employed in the simulation reduced the number of phone calls by 75%. Many of those represented a duplication of effort. The fax communication was completely replaced by email and EDI applications. This exchange of communication means as well as the removal of another source of redundant data input accelerated the information flow. Transportation handling with the 4PL approach and the related IT platform resulted in 64% of the tasks being accomplished automatically. At the same time, manual tasks were reduced by 56%. Manual tasks are data input or document preparation by individuals which can be minimised by software applications.

5.2 Impacts on the processes of the actors

In order to encourage actors to apply a 4PL within the sector, a clear explanation is necessary that sets out the implications for all actors involved. The organisational and technical implications for each of the actors can be described as follows:

- Accountant: the activities of the accounting departments are not affected by the implementation of a 4PL.
- Trader and transportation handler: Trade is a determining factor for the transportation demand. Until now, this was also true for transportation handling. There are no technical alterations, neither for the trader, nor for the transportation handler. A faster recording of trading activities can be achieved by a faster information feedback. Both have an impact on the processing of documents, such as delivery notes and weighing slips. Moreover, a strengthened willingness for cooperation and the sharing of transport orders can significantly enhance the application of a 4PL. This effect increases with the quantity of transport orders.
- Dispatcher/freight forwarder/4PL: The tasks of the dispatcher and the freight forwarder can be taken over by the 4PL. While during the ad-hoc process in the current real-world situation double entries are normal, these can entirely be avoided when involving a 4PL. Furthermore, routes can be generated automatically and presented to a dispatcher. Hence, the 4PL functions as a decision-support system. In terms of strategic transportation planning, it is not only expected to decrease the processing time, but also to reduce empty mileage. This is because the automatic route planning replaces the ad-hoc planning. From an organisational point of view, the functions of the freight forwarder and dispatcher are merged within the 4PL. From a technical point of view, the implementation of an IT platform is required. This has a reducing effect on the process times for

transportation planning and handling.

- Carrier: The real-world carriers can take over the usual transportation handling. However, investments in ICT infrastructure are required in order to directly communicate with the 4PL. Moreover, the information flow can be accelerated because orders arrive digitally on their terminals, and may be accepted or rejected instantly. In addition, delivery notes can be reported back within a short period of time. Planning in the form of round trips results in a more efficient use of cargo capacities. This is because of a significantly reduced rate of empty mileage. Furthermore, as a result of the central resourcing of the carriers' cargo capacities, the planning of the 4PL can be accomplished with a needs-based approach by factoring in loading capacity and current position of a vehicle. Likewise, this effect applies to disturbances in the transportation handling, such as traffic jams or technical failures, which the 4PL is able to respond to by revising plans in a flexible way.
- Consignee/consignor: These two actors receive transparent information on the status quo of transported goods in a way that loading and unloading equipment can be supplied on time. Moreover, transportation information is ubiquitously available, and this positively influences the decision-making process. Due to an instant and direct processing of communication as well as the supervising function of the 4PL, the information flow can significantly be accelerated and transparency is increased.

5.3 Implications and risks of a 4PL application

During the simulation with the 4PL approach, some risks that could diminish the added value and the savings potential of the 4PL were identified. All actors involved are aware of the risks within the sector. More specifically, experts are familiar with the risk of a reduction in cargo capacity which might be a result of the more efficient use of resources. A common argument is: "We need sufficient cargo capacity during the harvesting period". Actors, who cooperate within a 4PL process, might see their personal preferences neglected in relation to the procurement. Technical risks are predominantly associated with defective terminal equipment. The actors only accept technical innovations that are easy to implement, suitable for daily use and easy to handle, which was confirmed during the expert interviews. However, some statements, such as "it would be fine, if an App could replace the fax machine", indicate an openness towards technical innovations. When the effort is made to introduce a 4PL in the sector, all actors involved have to be informed of the added value and profitability potential as well as the associated risks. Ultimately, the added value is the system of centralised planning within the sector. Based on a decision-supporting planning process, it is possible to optimise the route planning. In contrast to the current ad-hoc planning approach, a 4PL is capable of significantly reducing empty mileage and improving the utilisation of available transport equipment. Based upon the available input data the simulation of the target situation results in a reduction of lay and transfer times by 41%. The applied planning tool as introduced in this article can avoid 7.54 million kilometres of empty mileage (based on 50,000 full truck loads per year) which results in savings of about 4.76 million Euros per year. This tool also calculates empty mileage reduction in the form of working hours (savings of 1.43 million Euros by 125,665 working hours at an hourly rate of 11.25€/h), fuel costs (fuel consumption of 32l/km at a diesel prize of 0.84€/l generates savings of 2.03 million Euros), and toll fees (60% of 7.54 million kilometres are toll routes: 4.52 million kilometres multiplied by €0.288/km toll fee generate a saving of 1.30 million Euros). Moreover, this implies a reduction in processing time. Whereas the current ad-hoc planning bears the possibility to enhance the processing of transport orders only by higher personnel costs, the simulation revealed that significantly more transportation orders can be processed when involving a 4PL. Moreover, the 4PL platform enhances both the information flow among actors and the transparency with respect to the status of an order.

The 4PL platform also enables a transparent representation of cargo capacities across the sector. Furthermore, master data have to be entered in the system only once and blank forms are standardised, which again increases the savings potential.

In light of the savings from the transportation handling as well as the improved planning procedure, new investments in ICT can be justified. Besides, the respective investments, e.g., tablets, WiFi and Apps for the carriers and components such as network computers for the consignors and consignees, are minimal and affordable. The needed IT platform for the 4PL can easily be provisioned by conventional computer systems as used in the industry. However, interfaces have to be adapted for use in transportation handling, trade and accounting departments. The costs when taking into consideration the adaption of interfaces are approximately 500,000 €. We considered hardware costs for 200 carriers for a mobile device (60,000€); additional hardware is already implemented in the industry. Further costs are generated by the interface programming and app development which require approximately 250 consultant days (mixed calculation = 375,000€). The remaining 65,000€ represent the training costs for the carriers. Overall, based on our simulation results the 4PL approach will generate cost savings.

6 Conclusions and outlook

6.1 Conclusions

First, this article describes a contribution to the methodology of process re-engineering with the application of a simulation tool that employs a 4PL approach. To our knowledge, this research approach is novel and future-oriented. The potential for optimisation that can be generated through the involvement of a 4PL application is increasing with the number of orders either from within the supply chain or from outside, thus from the agricultural bulk goods logistics sector. In order to fully exploit this potential, it is indispensable to involve all relevant actors in the integration process of a 4PL and to clearly highlight the potential therein for increasing the efficiency of the entire transportation process. The modelling of business processes has a special meaning since the results of a simulation help to encourage the willingness among actors to change existing practice. At the same time, the modelling of business processes points to the benefits that automated processes bear. This is exactly what has been accomplished with the specific case study of this research effort.

Second, the multidisciplinary character of this research initiative, consisting of case study research, simulation and stakeholder participation, resulted in the close involvement of relevant actors who took part in a wide-ranging consultation on the introduction of a 4PL and especially on process re-engineering. However, requirements of clients and suppliers could not be integrated in the simulation of the supply chain in a straightforward way (de la Fuente *et al.*, 2010). The reason for this is that the requirements of the relevant actors vary considerably. For this reason, a strict delineation of system boundaries and a selected data acquisition at an early stage of the research was necessary.

Third, the actors' demand to clearly set out the technical and organisational implications of the introduction of a 4PL was fulfilled. Although the 4PL was only represented in a simulation, tangible requirements for the development and application of user software such as apps could be defined. For this, the visual representation of the business process management was helpful to all partners involved in order to comprehend cross-sectoral processes.

Fourth, the selected modelling and simulation software provided scientists with a tool for rigorous scientific analysis, a business process simulation suitable for real-world application and a decision support for future investments.

In summary, there is a considerable potential for convincing actors of the benefits of re-engineering processes in the agricultural bulk goods logistics sector.

6.2 Limitations

In addition to the new insights as well as the benefits described above, also the limitations have to be discussed. On the one hand, the methodology described in this article pertains to the literature, but no assurance can be given that all relevant articles have been included. On the other hand, the selected method was tested with the real-world actors involved in the sector. This method may also be applied to other sectors, but there may be limitations in terms of sector-specific characteristics, processes and actors. The specific characteristics of a sector play a central role. However, this cannot be directly transferred to supply chains of other sectors. Real-world processes have been incorporated in the model of the current situation with considerable attention to detail in order to provide valid results. Despite this, simplification was inevitable, particularly in the process steps. The degree of simplification is a result of an iterative actor consultation process. This consultation is also necessary in other sectors. In this case, experts delivered data in the form of process descriptions, transport documents and assessments, which vary in terms of personal experiences, preferences, motivation and the individual willingness for change. In particular, the validation of the current situation model reveals differences in individual assessments of chronological sequences. Consequently, an overestimation of resources to be supplied was detected within particular process steps. The rectification of this problem required an elaborate coordination process. The target model must be validated in a similar manner.

6.3 Outlook

This article describes the simulation of a 4PL approach for transportation handling within the supply chain management of the agricultural supply chain. An application of this approach to other sectors may raise a number of issues. At the same time, an application of this approach beyond the scope of the case study, even on an international scale, is of interest since structures within the agricultural sector vary by countries or continents. Furthermore, the entity or actor capable of representing the role of a 4PL must be clarified ex ante. A Capability Maturity Model Integration (CMMI) has the potential to support a classification of relevant actors which might help to assess their stance and capabilities within the entire organisation of the sector. Such a model can help to accelerate the procedure of process re-engineering. Moreover, an agreement is needed that defines how the monetary benefits of a 4PL application can be fairly and equitably distributed among the actors involved.

In general, the actors in the agricultural bulk logistics sector, who have been involved in the case study, indicated a willingness to change. Furthermore, the implications for the sector as a whole are demonstrated in detail by the simulation. As a consequence, investments in ICT as well as increased cooperation among actors are encouraged. Based on these insights, strategic measures relevant for the entire sector as well as specific measures for the actors can be defined. The highest potential for optimisation has been detected in the area of cooperative transport planning by the 4PL, the reduction of redundant work and the minimisation of information flow delays. The integration of the 4PL has distinctive implications for process innovation within the entire sector. These innovations are required in light of current organisational and technical structures. Yet, the concept of this IT platform for the 4PL requires more research in order to be fully and effectively implemented in current real-world systems. At the same time, ICT prototypes must be implemented for use by the actors involved. In summary, our simulation results show that the integration of a 4PL in the agricultural bulk logistics sector promises an improved use of resources and leads to cost savings, provided that volatile fluctuations within the market are taken into consideration.

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Beitrag 7: The Fourth-Party Logistics Service Provider Approach to support Sustainable Development Goals in Transportation – A Case Study of the German Agricultural Bulk Logistics Sector.

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The Fourth-Party Logistics Service Provider Approach to support Sustainable Development Goals in Transportation – A Case Study of the German Agricultural Bulk Logistics Sector

Abstract

The approach to integrate a fourth-party logistics service provider in the German Agrigultural Bulk Logistics sector marks a new concept that aims at achieving sustainable development goals in transportation, i. e., by realising full truck loads. Against the background of steadily growing transport volumes, it is of paramount importance to develop sustainability concepts in order to mitigate the impacts on the environment. At present, the processes in the domain of the German Agricultural Bulk Logistics sector are characterised by bulk transports, small and medium sized actors and paper-based processes, which offers high potential for process optimizations in terms of sustainability. Therefore, the German Agricultural Bulk Logistics sector currently explores the approach of including a fourth-party logistics service provider into its transport processes in order to render these more sustainable and reduce costs. The objective of this paper is to present the general idea of implementing a fourth-party logistics service provider into a transportation (planning) process, to clarify the different functions of the participating parties and to introduce the modified transportation planning process as artefact. By means of a mixed method approach, we deliver qualitative insights based on semi-structured interviews and quantitative insights based on simulations. Effects and benefits of the approach are identified by means of a case study. Involving the fourth-party logistics service provider as well as the associated transportation planning process in the mentioned logistics area can lead to cost savings up to 38%, helps to reduce environmental pollution and mitigates social barriers in form of existential fears. The results demonstrate the applicability of the fourth-party logistics service provider approach in the sector and underline that this approach supports the achievement of sustainable development goals in transportation. Furthermore, we identify sustainable characteristics and present the mixed method approach which functions as an assessment framework for the fourth-party logistics service provider approach. Furthermore, by adopting the documented features of sustainable supply chain management in the fourth-party logistics service provider approach, an additional value is generated.

Keywords: 4PL; Sustainability in Transportation; Supply Chain Management; Transportation planning; Case study

Introduction

Presently, agricultural supply chains are embedded in a complex global network including actors from the producer to the consumer. This comprises all involved production steps and processes such as dispatch and transportation as well as the distribution of food (Ahumada and Villalobos, 2009; Beske et al., 2014; Trienekens and Zuurbier, 2008). At the same time the demand for safe and sustainable products of high quality is increasing (van der Vorst, et al., 2009). Transportation plays a central role in the sustainability of a product from the beginning of the harvesting process to its delivery to the consumer (Konieczny et al., 2013). From an economic point of view transportation has to meet the six main objectives of logistics: deliver the right product, at the right time, at the right location, in the right quantity, with the right quality and for the right price (Seeck, 2010). At the same time transportation should be performed in an ecologically sensitive manner in order to reduce environmental impacts. Furthermore, transportation should consider social aspects of sustainability including the interests of all involved actors (Ciliberti et al., 2008).

Initial shipment from the harvesting fields to the warehouse stage, as well as to processing companies, is done in the form of bulk goods transport. The annual volume transported by the agricultural sector in Germany is approximately 3,595,373,000 tonnes, of which 76% (2.8 billion tonnes) are shipped by commercial road transport, 90% of which is inland transportation (Federal Ministry of Food, Agriculture and Consumer Protection, 2012). As a further example, the agricultural sector in the US transports 512,000,000 tonnes of grain per year: 60% of this by road transport, 28% by rail and 12% by water (Association of American Railroads 2013). In light of enormous global shipping turnover as well as the growing and accelerating pace of trade, business logistics increasingly becomes the focus of transactions among traders, consigners, consignees and producers. This results in new challenges for planning, transactions and the management of transportation. Presently, the agricultural supply chain still has efficiency optimisation options (Beske, et al., 2014; Fischer, 2013; Grimm, et al., 2014).

The main difference between agricultural supply chains and other supply chains is the permanent modification of goods from the harvest to the processing stage (Ahumada and Villalobos, 2009). Furthermore, the harvesting process is exposed to fluctuating weather conditions, which may result in limited time slots for transportation (Ahumada and Villalobos, 2009). Hence the harvesting period may be a special challenge for transporting and distributing agricultural bulk goods. Frequently, these goods are shipped to warehouses or processing companies. Throughout the year both storage levels and import and export volumes of goods are transported. Transportation therefore requires short planning horizons, especially for the transport of harvested crops (1 - 4 hours) and for the year-round supply for processing. Import and export volumes and long-term scheduled demands of the industry can be handled by longer planning horizons (8 - 80 hours). As in the agricultural sector, the margins of the logistics sector are small

(Lowe and Preckel, 2004). Moreover, the logistics sector has to cope with challenges such as haulage, transport time, flexibility, quality, sustainability and reliability in general (Islam, et al., 2013). For instance, the consequences of growing traffic volumes are a decrease in the profitability of shipments as a result of traffic jams, increased time for transportation and a decrease in the reliability of deliveries (Golob and Regan, 2002). Furthermore, transportation costs increase due to steadily increasing fuel prices, toll charges and anticipated duties (Green, 2014). The dominance of road transportation has a negative impact factor for CO_2 emissions and thus for sustainability in general (Abbasi and Nilsson, 2012). Although cooperative production methods are not uncommon within the agricultural sector, cooperative approaches such as transportation networks are rarely implemented in the agricultural bulk logistics sector (Salleh et al. 2009).

The aforementioned problems of the sector demonstrate the need for solutions that may be implemented through various approaches. The transportation sector contributes 14% of global CO_2 emissions as a result of the means of transportation including road, rail, air and (marine) navigation (EEA 2012, 2014). Alternative approaches are the development of intermodal transportation (Macharis and Bontekoning, 2004) or truck sharing (Islam and Olsen, 2014). However, this requires cooperation and a minimum degree of collaboration of all involved actors. Dekker et al. (2012) demonstrate the added value as a result of increased efficiency as well as CO_2 reduction due to intelligent planning of the supply chain including the related transportation. They, furthermore, describe measures such as pricing, supply chain planning as well as strategic and operative decision support within the field of supply chains. The transportation segment has a high potential of improvement in terms of procurement, production concept, distribution of production facilities, means of transportation, routing, and transit time as well as various transportation concepts (Dekker, et al., 2012; Schönberger and Kopfer, 2009). One option to provide a planning and service instance for the supply chain is the introduction of the 4PL approach (Vinay, et al., 2009).

This article focusses an investigation of the 4PL approach within the agricultural bulk logistics sector to improve sustainability in transportation. While the 4PL approach is implemented in practice, a scientific discussion about the effects and benefits is missing. The target of a 4PL as a superordinated planning agent within a supply chain is a significant reduction in resource use, thus contributing to a more sustainable transportation sector. The 4PL operates as a network integrator within a given supply chain. Its objective is to employ involved actors and available resources efficiently; therefore processes and information and communication technology are needed. Based on previous research, transportation planning could be identified as the main function of a 4PL in the agriculture bulk logistics (Own source). As a consequence the 4PL transportation planning process is presented and assessed by sustainable characteristics. For the assessment a mixed method approach together with the insights of the case study is followed. Semi-structured interviews and simulations of the business process and of the route planning process allow a scientific and practical assessment. These results can be applied as decision support for the 4PL approach. Using this mixed method approach, we answer the following research questions:

RQ 1: *How can the transportation planning process (with an integrated route planning) for the 4PL be designed?*

RQ 2: *What is the added and sustainable value of the 4PL approach in the agricultural bulk logistics sector?*

Our literature search could not detect any significant scientific activities on the application of a 4PL with a focus on transportation planning in the agricultural bulk logistics sector. Such a research effort requires the involvement of all relevant actors including their potential to increase efficiency for a successful implementation. The objective is to show the effects for transportation planning taking into account the specific requirements of the sector, the available calculation time and the cost savings. Furthermore, the results have consequences for the sustainability of the operation, which should be delineated.

This article is structured as follows: section 2 provides a delineation of the 4PL. Section 3 introduces sustainability characteristics. The research methods are discussed in section 4, and section 5 describes the application of the methods. The results are presented in section 6. The article is concluded with a discussion of the results in section 7 and a summary in section 8.

Fourth Party Logistics Provider (4PL)

A 4PL is a neutral provider of various services within the supply chain. This provider does not supply assets but endeavours to utilise all provided resources efficiently and sustainably while integrating all involved actors (Hingley et al., 2011; Mukhopadhyay and Setaputra, 2006; Win, 2008). One objective of the 4PL is to minimise individual inefficiencies and, at the same time, increase the efficiency of the entire actor network. The main task is to plan both the supply chain process and transportation. This planning is accomplished by employing IT networking and platforms (Mammitzsch and Francyk, 2012). Therefore, industry-specific exigencies must be taken into account, and corresponding knowledge is required (Bourlakis and Bourlakis, 2005).

Thus, in the context of bulk logistics, it is indispensable to have a sound knowledge of the structures and circumstances in this domain. Therefore, the potential for the increase of efficiency and resources conservation must be examined, and actors must be involved in the process in order to generate win-win situations (Hingley et al., 2011). Figure 1 describes the actors under the supply chain approach in the current situation together with the idea of the 4PL approach in the target situation. Based on the material flow the involved actors (producer, primary cooperative, agricultural trade, freight carrier, processors and secondary cooperative) are presented together with the information flows. Thereby, a farmer, who generates bulk goods, is designated as producer. After the harvest, primary cooperatives or agricultural trades buy up the goods which entails corresponding transports. The secondary cooperative then bundles the harvested goods based on information from the primary cooperative and agricultural trade. A processor has a demand for bulk goods as his role is to produce food products or animal feed. As a result, a commercial transaction between the secondary cooperative, the primary cooperative or agricultural trade arises, in the course of which transport orders are generated for the freight carriers. The secondary cooperative instructs freight carriers with the transport, whereas the primary cooperative and the agricultural trade have their own transport resources. Every actor tries to use the transport resources efficiently, but based on the existing distribution planning and the implemented information flow a structured optimization is virtually impossible. In this context, the experts interviewed estimated that there is an empty mileage (i.e. mileage by empty trucks returning to their home base or by empty trucks repositioning to pick up their next load) volume of approximately up to 90%. The advantage of the 4PL approach is that the empty mileage can be reduced by means of a systematic bundling of transport volumes and a larger planning (data) base. The 4PL approach represents a centralized planning, distribution and management organisation for a network of multiple actors, which enables those actors who have transport resources to minimize their empty mileage (Hingley et al., 2011). Moreover, each of the involved actors is in a position to minimize his respective inefficiencies (Win, 2008). In our case, shorter distances to the next loading point are computable. The effective use of information and communication technologies (ICT) supports the 4 PL based supply chain management (Zhang et al.,2011).

For a better understanding of the process, the different process phases are presented in Figure 1. The black arrows show the information flows between the actors in the current situation. The grey arrows show the information flows with the idea of a 4PL approach. The actual information flows are based on expert interviews. The data were acquired between February 2014 and May 2014. The authors interviewed eleven experts in the sector, so that each actor has been interviewed. From the findings, the information flows could be derived. The desired information flows were generated by the authors based from the findings of the literature (Hingley et al., 2011; Win, 2008) and after explaining the 4PL approach in the context of the interviews.

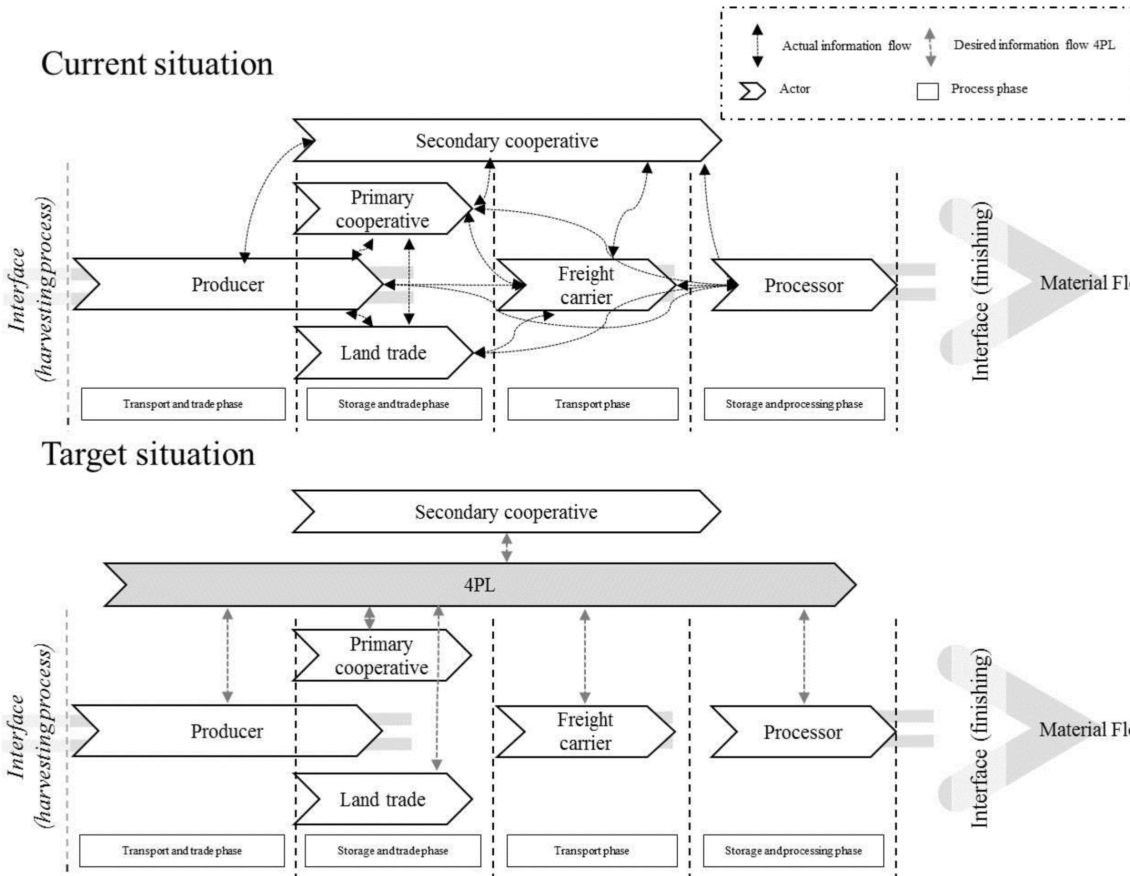

Figure 1: The current and target situation of the Supply Chain

Sustainability and process characteristics

For an implementation of a 4PL as an intermediary in a network, sustainability characteristics are of particular relevance. Based on Elkington (2000) the objective is to estimate the added value that a company creates economically, ecologically and socially (Govindan et al., 2013; Nikolaou et al., 2013). One requirement for a successful 4PL approach will be to incorporate the actors of a transport network, and to enable an improvement in logistics performance. Based on the added value, disadvantages of uncoordinated actors' activities (waiting times, empty runs, high fuel consumption, low capacity utilization) can be minimized. A 4PL can generate a profitable contribution if a resource efficiency of the resources of the network actors can be provided. Therefore, the three characteristics (economic, ecological and social) can support the assessment:

Economic challenge

Following Govindan et al. (2013), the economic criteria can be collected from multiple reviews that focus on an economic supplier selection (Boer et al., 2001; Ho et al., 2010; Huang and Keskar, 2007).

Furthermore, economic outcomes like financial benefits have to be identified (Eltayeb et al., 2011). Adapting this insight to the challenge of a 4PL approach, the listed criteria (Govindan et al., 2013) can be specified. These are costs, delivery reliability, quality assurance and technological capability.

Costs are divided into: production costs, order costs and logistics costs. Production costs (EC1) are defined by the price paid for processing a shipment. The order costs (EC2) include the costs invoiced in the form of planning effort by the 4PL. Logistics costs (EC3) include all costs generated for the physical transport. The challenge of a 4PL is to minimize the sum of all costs with intelligent planning.

The delivery reliability consists of the sub criteria `lead time` and `on time delivery`. The lead time (EC4) depends on the time between placement and arrival of an order. On time delivery (EC5) describes the ability to follow the defined delivery schedule or transport plan.

The quality criteria can be divided in quality assurance and rejection ratio. Quality assurance (EC6), especially in the food sector, is important because only certified vehicles and actors can be employed for the transport process. The rejection ratio (EC7) shows the number of rejected materials by the quality control of the processors.

The technological capability includes the sub criteria technology level, capability of development and design. First of all, the 4PL has to implement a technology infrastructure within the actor network (EC8). Another challenge is the development and design of future services (EC9) under the assumption of customer and supplier requirements (EC9).

Ecological challenge

The ecological challenge for a selection of a green supplier (Govindan et al., 2013) is documented by systems and methods that integrate sustainability in supply chains (Bai and Sarkis, 2010; Kuo et al., 2010). Furthermore, frameworks are described that follow an evaluation (Nikolaou et al., 2013; Tseng and Chiu, 2013). In addition, examples and activities like ecodesign, green purchasing, reverse logistics, collaboration of suppliers on environmental matters, and the implementation of environmental management systems into suppliers' organizational structures are described (Eltayeb et al., 2011). Based on these insights and the identified criteria of Govindan et al. (2013), the ecological challenges for the 4PL approach can be divided into pollution production/reduction, resource consumption, eco-design and environmental management system.

Pollution production/reduction (EO1) describes the average air emissions, waste water, solid wastes and harmful materials produced or minimized by the 4PL approach. Resources consumption (EO2) refers to the consumption of energy. Eco design (EO3) represents the activity to generate services for reducing the consumption of energy and waste. The last ecological challenge for the 4PL approach is the implementation of an environmental management system (EO4) for the sector in collaboration with the actors of the network.

Social challenge

Following the idea to define sustainability characteristics for the 4PL approach, there is a third dimension: the social challenge (Bai and Sarkis, 2010; Nikolaou et al., 2013). In this connection, the social responsibilities that stakeholders, consumers, non-governmental organizations and companies carry, are described. The idea is to sensitize all participating business partners to a socially and environmentally friendly behaviour and thus to create a general code of conduct to that effect (Ciliberti et al., 2011). In consideration of Govindan et al. (2013), the social measures of the 4PL approach comprise internal and external social measures. Internal social measures are good employment and labour practices as well as occupational health and safety. External social measures can be classified as the influences from the outside, thus from the logistics sector and the contractual stakeholders. The measures in the domain of the 4PL approach can be supplemented as follows:

There are various kinds of working models that can render employment practices (SC1)social, e.g., flexible working hours and homeworking. Besides, due to the digitization that is associated with the 4PL approach, also the requirements on employees are increased and necessitate an adaption of the working conditions. And also the communication level changes with the digitization, as most of the processes now are computer-based. The internal health and safety (SC2) aspects may be neglected because the focus is on planning and tracking services. Nevertheless, freight transports have to be processed in accordance with occupational safety and health regulations.

The influence of the sector (SC3) comprises: service infrastructure, cultural assets, economic welfare and futher expansion of the 4PL approach within the actor network. In addition, higher degrees of cooperation as well as an intensive communication with the 4PL and among the actors of the network are required. This may involve the introduction of reliable partnerships or alliances among network actors.

The influence of contractual stakeholders (SC4) has a significant impact on the success of the 4PL approach, because the 4PL actor does not have own assets, such as trucks. Partnerships among actors including the 4PL require norms and procurement standards to ensure an effective employment of a 4PL within an actor network.

4PL transportation planning process

One main benefit of the 4PL approach is the application of a comprehensive and integrated transportation planning process (according to DIN 66001) as depicted in figure 2.

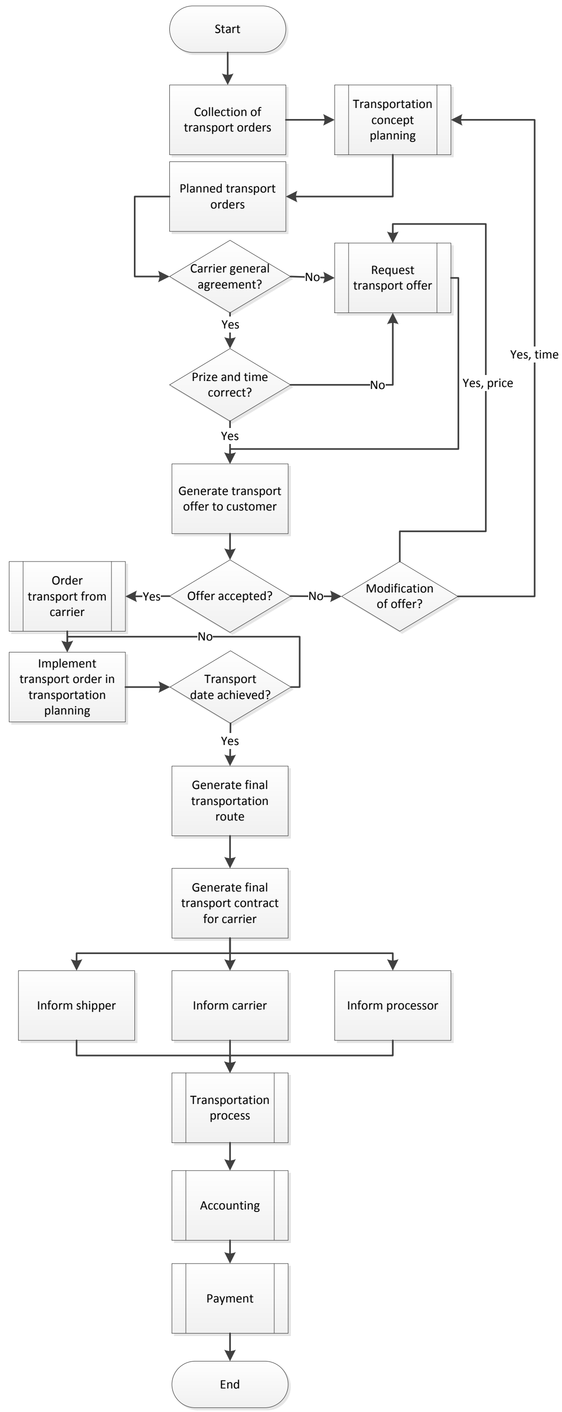

Figure 2: The Model of the 4PL transportation planning process

Based on the requirements of the sector, a 4PL transportation planning process was designed by the authors. The design is based on transport order processing from the literature considering (e.g. Flender, 2010) the 4PL approach. The first step of the process is the collection of transport orders (TO) from the network. Based on a summary of transport orders the transportation concept planning is ready to start. At this point, transport routes are calculated considering the economic, ecological and social requirements. A transport route depends on a number of 2-10 TO within a time frame of a week. Each TO is planned exactly. Thereafter, the carriers are selected out of a data base by means of general or special agreements as negotiated among the actors. But also optimization parameters, such as the shortest path to a loading place, are considered. If the data base does not identify an available transport capacity, a respective request in form of a transport offer is initiated and submitted to further carriers. This can also be required in case the price and time are not appropriate for the carrier, or in case the offer is not accepted by the customer. As far as price and time are verified by the carrier, the carrier is then enabled to deliver the assigned route. Following the carrier's conformation, the 4PL generates a transport offer for the customer and for each TO. If all customers accept the offer, the transportation order follows from the carrier, and the transport order will be implemented in the transportation planning. If the customer doesn't accept the offer, a modification loop in the form of time or price revisions follows. If the delivery date is scheduled, a final transportation route for each of the carriers is generated incorporating the same parameters as in the transport concept planning. For this route a transport order contract is issued, and all actors are informed. The transport process starts, and is controlled and tracked by the 4PL until the payment process is finished.

Following the 4PL transportation planning process according to the economic, ecological and social challenges of the added value of the 4PL approach, each process step has to be considered and checked in form of the improvement potential and the changes. Furthermore, the process steps have the potential to improve sustainability. However this requires the involvement of all actors in relevant process steps in order to contribute to the 4PL transportation planning process. In the next section we examine the 4PL approach including the 4PL planning process according to the research methods provided.

Research Methods

This research effort applies a mixed methods research approach. Based upon the unstated premise of applied science with practical relevance, both quantitative and qualitative research methods and data are employed (Recker, 2013; Venkatesh et al., 2013). The mixed methods approach has the ability to address the confirmatory (RQ2) and exploratory research questions (RQ1). Both qualitative and quantitative methods can arguably be used to address similar research questions, qualitative methods have typically been used more in IS and other social sciences for exploratory research in order to develop a deep understanding of a phenomenon. The 4PL approach comprises a mix of economical (e.g., resource efficiency), technological (e.g., applied IS/IT, digital transformation of processes (4PL process)), ecological (e.g., reverse logistics) and social aspects. The social aspects within the 4PL approach aim to manage people and to establish a set of values or principles that encourage organizations to act in a responsible manner. The mixed methods research can leverage the complementary strengths and non-overlapping weaknesses of qualitative and quantitative methods. Furthermore, it enables insights that none of the methods could offer when applied alone (Johnson and Turner 2003). Only the combination of methods allows to offset the disadvantages that certain methods involve can be offset (Greene and Caracelli, 1997). The semi-structured interviews (qualitative data collection approach) allowed us to gain deep insights from comprehensive reports and descriptions of the sector. Our business process simulation of the 4PL transportation planning process including a simulation of the transportation concept planning based on practical data (quantitative data collection) allowed us to develop a broad understanding of the planning process effects of a 4PL approach. Finally the mixed method approach provided an opportunity for a greater assortment of divergent and/or complementary views (Venkatesh et al., 2013). These views enrich our understanding of the 4PL approach und help us to appraise the boundary conditions of the approach and the relationships and open new avenues for future inquiries.

Semi-structured Interviews

Semi-structured interviews were carried out to focus the practical relevance for the sector. The implementation of a 4PL approach describes an innovative development for the sector. Considering this background it was important to allow the researcher to develop a keen understanding of the topic of interest of the sector. Additionally, the semi-structured interview method provides clearly structured instructions for interviewers, so that reliable and comparable qualitative data could be provided. The main topics of the 4PL approach could be analysed by the actors. Furthermore, the actors got a detailed impression of the 4PL approach so that barriers and attributes related to fear of change could be answered. In the end, practical quantitative data could be provided by the actors, which were needed for the business process simulation.

Business Process Simulation

The business process simulation enabled process diagnosis by simulating real-word cases. Experts and involved actors can check modelling or propose modifications of the original process model (van der Aalst et al., 2003). The actors of the processes were involved and process times, waiting times and lead time could be checked (quantitative research). The simulation technique connects the strategic aims in consideration of sustainability factors in order to achieve a successful 4PL implementation. For this the 4PL, the transportation planning process has to be modelled (Figure 2), whereby the process step "transportation concept planning" was identified as key for a resource efficiency of the resources of the network. A detailed transportation concept planning simulation was developed through programmed software. Both the business process simulation and the detailed transportation concept planning simulation can be used to test the validity of empirical results for an application of the 4PL approach.

For the business process simulation, various process notations and application software were examined. As a result, the Process Simulator 2014 (Pro Model Corporation) was selected. With the software, processes can be depicted in the form of flow charts, and actors can be included in the organisational structure. Moreover, each particular process step can be modelled. Furthermore, performance indicators, such as processing time, lay times, and buffer or turnaround times, can be recorded.

For the transportation concept planning simulation, we examined special factors of the agriculture bulk logistics sector. For example, the time frame for a transportation concept planning, the direct dispatching of bulk goods, the limitations of the resources, etc. to generate a better understanding of how transportation planning time affects the target of resource efficiency. Based on a literature review, we selected heuristics for the transportation concept planning to compare existing action patterns for dispatching transport with the simulated approach (Griffis et al., 2012; Confessore et al., 2008; Rothlauf, 2011). The input parameters for the transportation concept planning were transportation demand orders. These orders comprise loading (P_i) and unloading (D_i) locations, a time slot for transportation and tonnage of the transportation volume. Based upon the transportation demand order, transportation assignments (TA) with a capacity of 25 tonnes each (carrying capacity of a single truck (C)) are generated. The sum of all TA represents a planning pool for a transportation concept planning within a planning horizon. The planning horizon may comprise time spans from several hours to months. This affects the timeframe; for example, 1-8 hours during which the 4PL can use for this process step because the planning of the nearest TA describes the critical starting point. A longer calculation time of the heuristics in this process step is usually followed by a better use of resources because empty mileage is further reduced.

Application of the methods

The application of the methods is divided according to the mixed method approach. First, the semi-structured interview approach is described together with an accurate description of the agriculture bulk logistics sector. This is followed by a description of the simulation.

Semi-structured interviews in the agriculture bulk logistics sector

In collaboration with representatives of the sector’s secondary cooperative a list of relevant actors in the northern German region was generated. This list included producers, primary cooperatives, agricultural trade, freight carriers, processors and secondary cooperative. The list was filtered and sorted according to the priorities function, experience and spatial distance. In this way the context of the supply chain was provided that included all actors that were interviewed. The survey was designed in a way that the actor with the highest priority for a function was approached first. If no response was received within two weeks the next actor in the priority list was approached and so forth. This approach was implemented on a rolling basis until each function was assigned an actor. The data capture was accomplished between February 2014 and May 2014. After initial telephone contact with the respondent all required information was emailed to the respondent in order to prepare him/her for the interview. In order to increase the validity and appropriateness of the study the following principles have been applied (Yin, 2012): (1) the use of several sources of evidence, (2) the generation of a case study data base, and (3) the selection of a tool for the presentation of evidence. In compliance with the first point as well as for the purpose of increasing the robustness of this research, various sources have been tapped for the presentation of evidence. Moreover, semi-structured interviews have been applied in order to capture additional insights and to enrich the findings of the 4PL transportation planning process. Furthermore, notes have been taken during the interviews and all interviews were audio-recorded. All recordings were transcribed and received a unique consecutive number. In compliance with Yin's second and third principles a case study database based on MAXQDA was set up. First, mere observations and raw data could be clearly separated from interpretations, research questions and conclusions. Second, empirical data served as verification for the 4PL approach.

In total 17 expert interviews between 27 and 86 minutes were conducted. The expert interviews revealed the demand and the potential for a 4PL transportation planning process. The previous planning process was manually implemented. Each transport assignment was dispatched via telephone. In doing so each carrier as well as each loading and unloading dock was contacted.

Simulation of the 4 PL transportation planning process

The simulation of the complete business process "4PL transportation planning process" could be checked based on the information flow together with the experts (Reference after Review Process). The main planning process of the 4PL approach was named transportation concept planning and transportation planning. This section describes the application of heuristics based upon the database of bulk transport handling between 2010 and 2012 in order to identify the implications for efficiency and sustainability of transportation concept planning and transportation planning. First, a prototype of the 4PL platform was designed. This 4PL platform consists of a transport order planning module, a transport implementation module and a mySQL database. This database features a praxis-oriented dataset including elements such as loading and unloading address, customer data, goods, quantity, price, transport demand number and TA number. The research team generated the required spatial data of the loader and processors based upon an open source GeoConverter (gpso) and these data were entered into the calculation. Based upon the aforementioned data pool it was possible to profile sector-specific parameters realistically. Sector specific parameters included special transport equipment for bulk goods (walking floor vehicle, silo vehicle, dump truck), bulk good quality, timeframes for loading and unloading. With the use of the data for the loading and unloading positions, and implementing the desired time slot for each vehicle operation, each transportation assignment was available in the form of a transport order detection within the mySQL database.

Various heuristics like genetic search (GS), simulated annealing (SA) and tabu search (TB) were implemented in the transportation module (using a Java application). These heuristics are linked to the mySQL database which contains all transport assignments as recorded in the data pool. Due to challenges such as volatile fluctuations influencing the sector including weather conditions during the harvest, short-term orders by industry, long-term contracts, short-term handling of large volumes of imports and exports as well as various possible planning horizons, a whole array of simulations for the comparison of heuristics were designed. Based on realistic data 4000 to 5000 TA per month build the database for a transportation concept planning. In order to simulate a realistic planning horizon, orders of magnitudes of 20, 50, 100 and 1000 TA have been selected. A total of 200 potential carriers were used in the data pool. Furthermore, the run time of the heuristics was defined as follows:

- 1h for a short-term dispatch in order to respond to disruptions (truck breakdown, traffic jam, waiting for loading or unloading);
- 2h for the dispatch of daily business either ante meridiem or post meridiem;
- 8h for dispatch overnight.

Depending on the parameters defined above various optima may be calculated.

The objective of the simulations was a comparison of the heuristics applied in order to reduce empty mileage. The increase in efficiency as well as the reduction of CO_2 emissions could be derived from the reduction of empty mileage. The following assumptions had to be made:

- Bulk goods that may not be transported consecutively were excluded from the simulation;
- A truck was either entirely loaded or empty;
- Trucks drove with an average velocity based upon statistics from the case study;
- Legally-imposed driving times were taken into account;
- Distances between loading and unloading docks were beelines.

Due to the multitude of parameters influencing the experiments a distinction was made between external parameters and heuristics-specific parameters. The external parameters comprise:

- Velocity of vehicles - defined as 60 km/h;
- Maximum driving times - defined as 40 hours per week. The legally prescribed maximum is 56 hours per week. The difference complies with the buffer of possible delays according to Regulation (EC) no. 561/2006. 2006, article 6, section 2;
- The cargo capacity - defined as 25 tonnes per truck.

The heuristics-specific parameter settings for TS, extended TS (eTS), GS and SA as well as the hardware and software use for the simulations are described in the appendix.

Results

The results of our research have been divided into the simulation results and the results based on the semi structured interviews. We present both categories in a structured way. First, we present the simulation results which describe the quantitative results of the transportation concept planning and transportation planning as part of the whole 4PL transportation planning process (Figure 2). Based on the simulation and the comparison of the results, an assessment of the heuristics can be carried out. For the 4PL approach it can be identified which heuristics generates the best results in consideration of TA and calculation time (6.1). Following the quantitative results in savings of empty mileage of the simulation, we assess the complete 4PL transportation planning process according to the economic, ecologic, and social challenges using the mixed method approach (6.2).

Simulation results

In total 72 simulation experiments have been performed. Table 1 lists the results of these experiments including empty mileage savings, TA (20, 50, 100, 200, 1000, 2000) and the related procedures (TS, eTS, GS, SA). The empty mileage saving is calculated from the empty mileage resulting from manual transport planning in the current situation (adhoc) subtracted from the empty mileage which are generated by the automated transportation concept planning process. Based on the empty mileage saved the efficiency improvement of the case study is presented.

Depending upon both TA specifications and computing runtime the simulations resulted in different values for empty mileage savings. Consequently, the direct implications for transportation cost savings can be provided. For instance, with the eTS procedure the average cost savings are 36% with a 1h runtime of the transportation concept planning process. With a runtime of 8h the SA procedure generates cost savings of 38%.

TA	Procedure	Empty mileage savings (km)			Cost savings (%)		
		1h	2h	8h	1h	2h	8h
20	TS	2088	2088	2088	38.6	38.6	38.6
	eTS	2117	2117	2117	39.2	39.2	39.2
	GS	1943	1943	1943	36.0	36.0	36.0
	SA	2117	2117	2117	39.2	39.2	39.2
50	TS	3423	3744	3968	22.5	24.6	26.1
	eTS	4118	4160	4182	27.1	27.4	27.5
	GS	3257	3257	3929	21.4	21.4	25.9
	SA	3612	4012	4142	23.8	26.4	27.3
100	TS	10440	10440	10850	35.3	35.3	36.7
	eTS	11000	11000	11101	37.2	37.2	37.5
	GS	9489	9525	9525	32.1	32.2	32.2
	SA	10625	10689	11204	35.9	36.1	37.9
200	TS	18103	18116	19055	34.2	34.2	36.0
	eTS	22815	22839	23936	43.1	43.1	45.2
	GS	19871	20516	21293	37.5	38.7	40.2
	SA	18976	22665	24440	35.8	42.8	46.2
1000	TS	71022	74371	74377	31.6	33.1	33.1
	eTS	76660	76782	77187	34.2	34.2	34.4
	GS	44066	52632	64355	19.6	23.5	28.7
	SA	76653	82349	83192	34.2	36.7	37.1
2000	TS	129164	145412	154519	29.3	33.0	35.1
	eTS	156723	157814	159492	35.6	35.8	36.2
	GS	77590	88230	112323	17.6	20.0	25.5
	SA	150664	153190	166742	34.2	34.8	37.9
TS Ø empty mileage savings in %					32.3	33.6	34.7
eTS Ø empty mileage savings in %					**36.0**	36.2	36.7
GS Ø empty mileage savings in %					27.4	28.6	31.4
SA Ø empty mileage savings in %					34.2	**36.4**	**38.0**

Table 1: Empty mileage savings and cost savings results according to TA and procedure

As a result of the limited runtime (1h, 2h, 8h) the eTS procedure achieved the best results at a 1h runtime in comparison with the other procedures within the same time frame. In the case of longer time frames SA appears to be the best solution. Furthermore, route planning with a pool of 200 TA achieves the highest optimisation potential of 46.2% within the SA procedure. The Tabu search (TS) as well as genetic search (GS) result in significantly poorer outcomes in comparison with an extended tabu search (eTS) and simulated annealing (SA). Furthermore, the degree of optimisation is especially high during the first simulation hour.

Results of the 4PL transportation planning process

Based on the interviews and experiments the challenges for the 4PL transportation planning process can be specified. The subprocesses of the entire 4PL transportation planning process are of particular importance, so that the decision fields of the process were neglected. Based on the mixed method approach we collected information for each subprocess and general statements for a 4PL approach in the sector. Results, findings and impacts are presented in according to the economical, ecological and social challenges. Table 2 describes the challenges in combination with the subprocesses and the methods used. An `I´ indicates information derived from the semi-structured interview. An `S´ indicates that this information is based on the simulation of the transportation concept planning (6.1) and a simulation including the complete 4PL transportation planning process. The simulation of the complete 4PL transportation planning process was carried out based on a business process simulation (Process Simulator 2014 - Pro Model Corporation).

In addition, the heuristics and the heuristics-specific parameter settings for the simulations are described in the appendix.

			4PL transportation planning process																
			Collection of transport orders	*Transportation concept planning*	*Planned transport orders*	*Request transport offer*	*Generate transport offer for customer*	*Order transport from carrier*	*Implement transport order in transportation planning*	*Transport date achieved*	*Generate final transportation route*	*Generate final transport contract for carrier*	*Inform shipper*	*Inform carrier*	*Inform processor*	*Transportation process*	*Accounting*	*Payment*	***4PL Approach***
Economic challenge	***Production costs***	EC 1		**S**							**S**					**S**			
	Order costs	EC 2		**S**	**I**						**S**					**S**			
	Logistics costs	EC 3		**S**	**I**	**I**					**S**	**S**				**S**			
	Lead time	EC 4		**S**			**I**				**S**	**I**				**I**	**I**	**I**	
	On time delivery	EC 5			**I**		**I**			**I**	**I**	**I**				**I**	**I**	**I**	
	Quality assurance	EC 6			**I**		**I**				**I**	**I**				**I**	**I**	**I**	
	Rejection ratio	EC 7	**I**								**I**					**I**			
	Technology level	EC 8	**I**	**I**			**I**	**I**	**I**	**I**	**I/S**	**I**	**I**	**I**	**I**	**I**	**I**	**I**	**I**
	Design of future services	EC 9				**I**	**I**												**I**
Ecologic challenge	***Pollution production/ reduction***	EO 1	**I**	**S**							**S**	**I**				**S**			
	Resource consumption	EO 2	**I**	**S**			**I**	**I**			**S**	**I**				**S**			
	Eco design	EO 3																	**I**
	Environmental	EO																	**I**

	management system	4																	
Social challenge	***Employment practices***	SC 1				**I**					**I**			**I**		**I**			
	Health and safety	SC 2				**I**					**I**			**I**		**I**			
	Influence of the sector	SC 3	**I**		**I**		**I**	**I**		**I**	**I**	**I**	**I**	**I**	**I**		**I**	**I**	
	Stakeholder influence	SC 4	**I**		**I**			**I**		**I**		**I**	**I**	**I**	**I**		**I**	**I**	

Table 2: Overview of challenges in combination with the subprocesses of the 4PL transportation planning process

Production costs: Based on the simulation of the transportation concept planning process and the process step of generating the final transportation route, the price for the processing of the shipment will decrease. This depends on the reduction of empty mileage of 36-38% in comparison with the current adhoc process of the agricultural bulk logistics sector. Based on the assumption of 200 daily TA a savings potential of approximately 116 km per TA can be estimated within this case study (about 50,000 TA per year). Hence, within a year roughly 5.8 million kilometres of empty mileage could be avoided.

Order costs: Order costs which are generated in form of a planning function of the 4PL will be higher during the first step because the IT infrastructure has to be implemented first. Furthermore, the total number of employees which are involved in the process will be the same during the first step of the implementation process. Over the long-term the order costs per TO will be reduced. This is because the technology used and the infrastructure of the 4PL is capable of handling a high volume of transport orders with decreasing costs per TO. The target as defined by an expert is, “The logistics should offer economical and reliable transport”.

Logistics costs: The transportation concept planning process changes the process for a carrier whereby currently an order of one transport (TA) is generated to an order of one route of transports. A route is specified by 2–10 TA over an extended period of time (1-2 weeks). This results in better resource utilization because transport equipment is planned over a long term basis. Thus more transport orders can be executed and empty mileage is minimized. The simulation correlates with the view expressed by one expert: “We worry about the logistics and just take the tours that make sense for us. In addition, we try to combine routes”. In the end, lower fuel consumption, an optimisation of the assignment of staff and a minimization of the toll costs results in minimized logistics costs. These costs depend on the planning function of the 4PL approach. Moreover, assuming average fuel consumption of 32l per 100 km and net costs of €1.15 per litre of diesel, the saving potential for annual fuel costs is approximately €2,134,000. Furthermore, at an average velocity of 60km/h, 96,666 working hours could be saved, which correlates with €1,087,500 in labour costs at an average hourly wage of €11.25. However, the aforementioned model assumptions must be considered since the route network was designed as beeline distance time. In addition fuel savings must be adjusted by roughly +30%, which correlates with €966,570. Furthermore, 60% of the routes are toll roads (€0.288/km), which results in cost savings of €2,171,520. This amounts to annual cost savings of €6,359,990. These calculations refer to current route planning activities of the partners within the case study. For this case the research revealed that the number of TA reaches an optimum level for efficient route planning. Empty mileage savings range between 76.5 km/TA (2000 TA/2h runtime) and 122 km/TA (200 TA/8h runtime). Based upon the available dataset the optimum number of TA is 200.

Lead time: The simulation of the 4PL transportation planning process results in a reduction of lay and transfer times by 41%. This depends on the implementation of the new technology in a more digitized way. The experts confirmed “that the adhoc process is managed by mobile phone, paper and fax”. The adjustments of the communication media enable an acceleration in the information flow. In the end the lead time for one transport order will be minimized from 44.582h to 27.266h which is a reduction of 39%.

On time delivery: For the 4PL approach the on-time delivery will be a key figure for revising the transportation route planning. The experts stated that on-time delivery can be a cost factor because processors allocate delivery time slots in a way that loading or unloading is possible. If a time slot is passed this results in longer waiting times and costs. With the 4PL approach in combination with the IT infrastructure and a track-and-trace system the loading or unloading time can be tracked in a transparent way. This is beneficial for all actors involved in a transport order.

Quality assurance: Quality assurance is a particular feature based on expert information. This is because only certified equipment for food transport is allowed to be used (“All carriers must be certified in QS and GMP”). This has to be incorporated in the planning of a transport order as well as in the final route planning because not all bulk products can be transported consecutively. This means that cleaning of the equipment is possible and should be incorporated in the route planning procedure.

Rejection ratio: The rejection ratio is a key figure in the further development of the 4PL transportation planning process. Rejection is caused by the poor quality of the delivered material. In the agricultural bulk logistics sector samples are generated in the loading process and at the unloading point of the processor. A poor quality of the sample goods results in the rejection of the shipment, and the goods must be delivered to another processor with other specifications. For this a completely new transport plan has to be generated.

Technology level: Development of the technology is a primary objective of the experts. The sector is willing to invest in new infrastructure and new technologies like smartphones, applications, communication platforms and ICT. All experts acknowledge the benefit of introducing new technologies

("We can improve the communication by implementing ICT", "ICT will reduce my manual workload", "Technology improvement will increase transparency in order execution"). The problem is that only isolated solutions are developed, but no solution across sectors is available on the market. The technology level can be described based on various statements: "We have a SQL database with an Access platform that we have created. In addition, of course, we use smartphones, e-mail and fax. I would also like to use an app to make communication with the staff more efficient and in real time", "We mainly use the phone and the computer. After that fax and e-mail", "We use the fax machine 99% of the time". All experts have high expectations of the new technologies introduced by the 4PL. The Internet and a service platform of the 4PL will define the future whereby the communication will be smartphone- and application-based.

Design of future services: The 4PL approach as an intermediary of a network has the opportunity to implement new services for that network. The interviewed experts agreed that a cooperative approach including each of the actors could be beneficial for the sector. They also confirmed that cooperation is of high interest for generating win-win-situations, and to minimize the problems caused by ad hoc planning. New services will be a further step of 4PL development for the sector. These developments could include an improvement of networking of service-providers, selection of service-providers, organization of service chains, generating of orders, acquisition of new customers, development of sector-specific standards, provision of key figures, provision of status reports, generation of freight documents, consultative skills, advanced technology capability, business process outsourcing, beyond logistics, project management, innovation and continual improvement of the sector.

Pollution generation/ reduction: Empty mileage savings result in CO_2 and other emission reductions (Federal Environmental Agency for humans and the environment. Data on transport, 2012). Based upon the reduction of empty mileage (including the +30% adjustment) the 7,540,000 road kilometres saved correspond with a reduction of 735t of carbon dioxide (CO_2) and 3.7t of nitrogen dioxide (NO_2). Further CO_2 reductions resulting from activities such as decreased use of printing paper and auxiliary electricity will occur but cannot be validated.

Resources consumption: Reduced consumption of resources is a consequence of a reduced empty mileage. The fuel consumption will be minimized per TA. Savings in time transport equipment (trucks) represents a further decrease in resources consumption.

Eco-design and environmental management systems can be seen as an advanced development step for the 4PL approach and for the entire transportation planning process.

Employment practices: The employment practices will change for all involved actors. This is due to the introduction of contemporary communication media. While telephone, paper and fax are currently the main media, the internet and a service platform of the 4PL will be the future media (digital). As a result all administrative employees can work more flexibly and home office opportunities are created. For the employees of the carriers the employment practice will change in a more structured and planned way because complete routes are ordered instead of random orders. The fully digitized technology and infrastructure will support a significant reduction of work related to filling out forms and processing of paper documents. A negative effect could be that truck drivers cannot return home on a daily basis.

Health and safety: The 4PL approach has a significant effect on the health and safety of truck drivers. Based on a comprehensive planning approach and a track and trace of the transportation route the 4PL approach provides instant intervention in the event of traffic jams or other disturbances. In this way the stress factor can be minimized.

Influence on the sector: For the sector as a whole the 4PL is a new and innovative approach. In general the sector has a conservative attitude towards new technologies and new means of communication. The actors in the sector have built up long-term experiences and long-term cooperation. The first step for introducing a 4PL approach in the network will be the implementation of service infrastructure. Service infrastructure defines the 4PL-platform and the new communication media. Based on the infrastructure new processes have to be implemented and the effects of the simulation will follow. Once these process are in place economic growth can be expected which positively effects the development of the 4PL approach in the network.

Stakeholder influence: Due to the 4PL-based comprehensive transportation planning process the 4PL would take on a cross-sectoral role within the bulk logistics sector. Independent planning activities of carriers have to be handed over to the 4PL. At the same time the 4PL can adopt a supervisory position. Hence, the core competence of carriers would be driving the planned routes. On the one hand the carrier selection process has a high influence on the success of the 4PL approach. On the other, partnerships with the processors, producers, agricultural traders and primary and secondary cooperatives are important for generating transportation volumes for comprehensive transportation planning.

Discussion

This section identifies some of the important findings of our research. The major contribution of this paper was to provide a transportation planning process for the 4PL approach and to show the added value and sustainability benefits of the 4PL approach. The results can be subdivided into practical and scientific results as well as limitations.

Practical sustainability insights

The results demonstrate a significant improvement in transportation planning within the agricultural bulk logistics sector when employing a 4PL based on the 4PL transportation planning process that has been generated. A classification is possible according to the economic, ecologic and social challenges. From an economic perspective, the 4PL generates cost savings in the production and the logistics processes. Additionally, an improvement in the order cost is possible to the extent that the technology level of the sector is improved. The technology level associated with the 4PL enables quicker information flow between the actors whereby logistics service measures like on-time delivery, quality assurance and rejection ratio can be better tracked. Additionally the technology level supports the development of future services for the 4PL approach which do not depend on the core competence of one actor so that administrative processes can be bundled and improved resulting in a win-win-situation.

Ecologically, pollution reduction can result from the planning approach employed by the 4PL. This depends on a completely new and comprehensive transport disposition which is an innovation for the sector. Depending on the level of innovation, savings in resource consumption will follow. An eco-design as well as environmental management systems could be new research areas for the sector.

Social aspects in the form of actors' willingness to participate, as well as their technological limitations in the implementation of 4PL could be identified. Willingness is limited because each actor expressed reservations and fear of change in terms of the impact on themselves. The limitations in ability is demonstrated by the fact that "there is currently no player in the sector who is able to build such a platform and operate". The necessary IT know-how is not yet available for the industry in centralized form. Through the 4PL, business actors should be open for new developments especially in a sector where substantial gains can be made. The introduction of the 4PL approach on the level of the secondary cooperative seems to be the most promising method. However, the success of this exercise depends on the height of the secondary cooperatives' trade value: a high trade value entails a high number of transport assignments (TA), which again constitute the basis for the transportation planning pool. Furthermore, the implementation of the 4PL approach on the level of the secondary cooperative has very good prospects as those actors possess the economic capacity to invest in the sector. Furthermore, they are very well integrated in the network, as our interviewed experts affirm, and are in a position to provide a proven ICT infrastructure.

Scientific insights

Scientific insights could be identified with the sustainability considerations of the 4PL approach that were taken into account and by the mixed method approach used by our research. We adapted the documented features of sustainable supply chain management (Govindan et al., 2013; Nikolaou et al., 2013) in the 4PL approach. This adaptation enables a detailed perspective of the 4PL approach with regard to the numerous interfaces (actors, information, technology, cooperation) of a 4PL. Furthermore we describe benefits of the

4PL approach in a real world scenario. However, based on further ICT development in the future a 4PL approach could be a major contribution to comprehensive supply chain management.

The mixed method helped us to generate quantitative and qualitative results. On the one hand the semi-structured interviews delivered qualitative data for social challenges. To test the implementation of a 4PL approach in a supply chain it was important to get a direct feedback from the actors. Furthermore critical aspects like existential fears and future requirements like key advantages of the approach could be identified. On the other hand, the quantitative-based simulations identified the economic and ecological aspects of a 4PL approach when introduced in the sector. The quantitative insights are important for further investment decisions and for generating various implementation steps or a supply chain strategy.

Finally, we employed the 4PL approach as an artefact based on the 4PL transportation planning process. We presented a sector which is increasingly important for supplying the population with a sustainable concept of logistics.

Limitations

A number of factors that determine uncertainty within the system must be taken into account: The selection of the heuristics was based upon a literature search. These results have been applied to a selected case study. The route planning problem described in this article is applied and interpreted frequently depending upon the scientific subject and the sector. The sector-specific focus may result in additional limitations. The results cannot be directly transferred to other sectors. The number of TA to be integrated in the transportation planning process is just one determining variable. Furthermore, the case study effort relies on a data set of 50,000 TA from just one actor. The spatial scale of the case study includes the region of Northern Germany. Other regions in Germany or elsewhere in the world may have other characteristics. The experiment used data from past route planning activities which include implications for fluctuating flows of goods. Initial feedback from interviewees in the semi-structured interviews affirms the savings potential and the need for more research.

Conclusions and further research

The results of our research presented in this article demonstrate an impressive potential for cost and CO_2 savings. Even after taking the aforementioned range (cost, CO_2) into account, the order of magnitude remains impressive. Moreover, the circumstance that a significant reduction of CO_2 emissions can be accomplished with only a moderate financial effort (e.g., relatively low investments in IT infrastructure), constitutes an excellent example for a win-win situation. In addition, should this 4PL approach be implemented beyond the agricultural bulk logistics sector in Northern Germany, it would significantly contribute to the fulfilment of the national 20-20-20 targets on greenhouse gas emissions. Furthermore, the documented features of sustainable supply chain management supported a comprehensive assessment of the 4PL approach.

Our research shows that the 4PL approach is applicable in practice. In order to implement the 4PL approach in the real world, route planning activities as well as the interests and perspectives of the involved actors must be respected. While the positive effect with regard to economic and ecological savings is beyond doubt, the process to distribute the savings equitably among the participating parties is still to be developed and thus constitutes an essential future research approach. Only if the savings achieved through the application of a 4PL are equitably distributed among the involved actors, a sustainable effect can be expected in the social dimension of this sector. In order to be able to comprehensively demonstrate the added value, performance indicators, that reveal the benefits of the 4PL in the sector and for all participating actors, must be developed. In order to allow for a more sustainable agricultural bulk sector, it is recommendable to better prepare for the 4 PL implementation. For this purpose it is useful that the 4PL takes on defined functions, such as the IT services, the consulting of the actors or the purchasing cooperation. In light of the small margins within the sector, ICT applications must be adapted or redesigned in the future in order to increase acceptance among the relevant actors. The main focus of a 4PL lies on the increase in transparency with respect to information as well as the transport market, however, this depends on the extent to which the actors are in competition with each other. For the introduction of additional sustainable concepts in the future, such as the CO_2 footprint for transportation in agriculture, political incentives may be necessary.

The scientific effort to implement a 4PL transportation planning process for full truckload shipping significantly contributes to the enhancement of the image of a 4PL approach within the agricultural bulk logistics sector. Within various planning horizons, the applied heuristics demonstrate optimised uses of resources, which makes a substantial contribution to a more sustainable transportation sector. Additionally, with our research we are the first to consider the 4PL approach from the perspective of a sustainable supply chain management and to validate this by a mixed method approach that describes an application-oriented research.

The results demonstrate the applicability of the 4PL approach and mark it as a long-term objective. Hence, the economic benefits of the actors can be improved. When assuming an improved interconnectedness and a more intense deployment of ICT, the results of this research provide a promising development for this sector and further research.

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Appendix:

The Tabu search was apriori implemented in a conventional manner, where the transformation rule corresponds with the 2-Opt procedure. The 2-Opt procedure deploys a simple neighbourhood search (optimisation). On the assumption of Euclidian distance among all nodes this procedure reconciles all edges that cross other edges in a way that a route consists of edges that do not cross each other (Nickel, Stein and Waldmann, 2014) (TS). The transformation rules are an extended version of the Lin-Kernighan heuristics (eTS). This procedure is also called variable k-opt heuristic. It includes the opportunity to exchange an arbitrary number of nodes. This is performed until a k optimum is achieved (Lin, 1965). While the value of k is constant for the k-opt heuristic, the Lin-Kernighan heuristic may vary throughout the optimisation procedure (Lin and Kernighan, 1973). The tabu list is consistent with a quarter of the number of nodes.

The temperature of the simulated annealing corresponds with the entire available runtime divided by 100. The cooling rate corresponds with the elapsed run time.

The population size of the genetic search was 25 individuals. The crossover operation is a two-point crossover. The mutation probability is 20%. The mutation operation is 50% genetic sequence reverse and 50% point mutation.

Finally the hardware and software use for all calculations was a computer with the following features: Windows 7 Enterprise-Service Pack 1; Processor: Intel® Core ™, i5-3550CPU@3,30GHz; Memory: 8.00 GB; System:64 Bit OS; JRE version: 1.7.0_45; Database server:5.6.16 - MySQL Community Server (GPL), (localhost), Java based prototype 4PL-Platform.

Beitrag 8: Crowd Logistics – A Literature Review and Maturity Model

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Crowd Logistics – A Literature Review and Maturity Model

Abstract

Crowd Logistics (CL) is identified as a topic of high importance in the area of logistics. From the practical point of view, initial experiences and realizations have already been gained, however, scientific research regarding Crowd Logistics is still in its infancy and multiple research questions are still unexplored. By means of a systematic literature review (LR) as well as a quantitative data analysis (QDA) of existing business models, we obtained a scientific definition of the term Crowd Logistics. Furthermore, we set up a research agenda to counter the open research questions. Additionally, based on the results of the LR and the QDA as well as the knowledge gained in field studies, we developed a Crowd Logistics Maturity Model (CLMM). We evaluated the CLMM by the use of an existing company.

Introduction

Currently, the topic of Crowd Logistics (CL) is of crucial importance. Uber for instance is a successful logistics provider, who is following the Crowd Logistics business model (Applin, 2015). In this business model the service is mostly yielded by the crowd (and not by the staff of the company). The persons within the crowd either demand or provide a service. Thereby, the company itself solely acts as a mediator. The mediator is responsible for the coordination and therefore mostly provides an IT platform capable to track communication, manage master data and fulfil payment transactions. This new business model is based on the idea of sharing economy through crowdsourcing and crowdfunding and benefits from short innovation to market time and new ways of customer communication (Bubner, et al., 2014, p. 22). In June 2015, also Amazon decided to use their customers (the crowd) for the last-mile-delivery (Fortune, 2015). This again shows that the topic Crowd Logistics is of great interest for practice and science alike.

In our paper, we want to analyze Crowd Logistics from the scientific and practice-oriented perspective. The aim is to give a comprehensive assessment of the status quo. We conducted a systematic literature review to capture the scientific knowledge. In order to understand the viewpoint of the industry, we performed a quantitative analysis of several case studies.

We aspire to answer the following research questions:

- How can Crowd Logistics be defined (RQ1)?

- What is the current status quo in science and practice (RQ2)?

- How can Crowd Logistics business models be assessed (RQ3)?

Our paper is structured as follows. In Section 1 we briefly describe our motivation to address the topic. Section 2 explains the applied research methodology. The definition of Crowd Logistics will be detailed in section 3. Subsequently, in section 4, we present the results of the qualitative data analysis (QDA), discuss and formulate a research agenda. On the base of these results, as well as through a broad case study analysis, we build a Crowd Logistics Maturity Model (CLMM) (cf. section 5), whereas an evaluation of our CLMM is presented in section 6. The paper concludes with a summary in section 7.

Research methodology

Systematic Literature Review & Case Study Research

We performed a systematic literature analysis (Fettke, 2006) in order to gather the scientific knowledge about Crowd Logistics. We used the keyword phrase <crowd AND (logistic* OR transport*)> and the databases EBSCOhost (all fields) and Google Scholar (only title), which resulted in 1,481 papers. These papers were checked for relevance. As the word crowd in combination with logistics is often used with the meaning "logistics FOR the masses", we identified many irrelevant papers. We only considered papers, in which the word crowd was used with the meaning "logistics BY the masses". Therefore, we first checked the abstracts. In cases where the relevance of a paper was still unclear, a second person was involved and further parts of the paper were included in the investigation. By means of this approach, we identified 14 relevant contributions which represent the final database for our analysis.

In order to gather information about Crowd Logistics from the practice, we used the methodology of case study research (Myers, 2009, pp. 73-91). Therefore, we performed an internet search (using the search engine Google) by the use of the search term "Crowd Logistics". This yielded in more than 2,150 results, which were successively further investigated. By analyzing the results we identified 79 case studies in the area of Crowd Logistics among the first 190 results. As no further relevant case study could have been identified among the results 191 to 250), we then terminated our search.

Afterward the identified 79 case studies have been completely read by three scientists. Any documents which were rather promotion than a case study as well as documents without any information about business processes or models have not been considered further. As a result, 59 relevant case studies have been identified.

Qualitative Data Analysis

The Qualitative Data Analysis (QDA) was performed with the Software QDA Miner and the extension WordStat. The Software was used to perform Text Mining as well as Content Analysis for both, the paper and the case studies. Prior to the analysis, we prepared the data according to the recommendations of Provalis Research (2010, pp.1-127) in five steps:

1. Spellchecking to avoid any spelling mistakes

2. Deletion of hyphenation, brackets and unnecessary information (like headers / footers, author information, etc.)

3. Lemmatization and stemming whereby synonyms are removed

4. Deletion of stop word

5. Review r-esults and extension of stop word list

After the data preparation, word frequencies (word count in a paragraph) and word co-occurrences (word pairs in a paragraph) are calculated. Subsequently, a cluster analysis was performed according to Jaccard similarity coefficient (Backhaus, et al., 2011, p. 403). The results were visualized in form of dendrogramms and 2D graphics for illustrative purposes.

Definition of Crowd Logistics

Crowd Logistics has its origin in the term crowdsourcing. Crowdsourcing is a neologism of the words "crowd" and "outsourcing" (Howe, 2008, p. 1), whereby "crowd" is defined as a mass of people and "outsourcing" describes the shift of processes, functions and duties to third parties. A first form of crowdsourcing was crowd working, where the crowd members act like an employee and take over the work which was previously performed "within" an enterprise (Blohm, Leimeister and Zogaj, 2014, p. 52). The development of new forms of work is massively supported by the increasing digitization of the society (Unterberg, 2010). Crowd working is organized through an information and communication platform, operated by an enterprise or an intermediary (Blohm, Leimeister and Zogaj, 2014, p. 53), which can be accessed externally via internet or internally via intranet (Leimeister, 2012, p. 390). Due to the extreme pooling of knowledge as well as the expected economic benefits, the potential of crowd sourcing is considered to be very high (Howe, 2006). However, there are no sound and reliable scientific studies on opportunities and risks (Blohm, Leimeister and Zogaj, 2014, p. 62).

A variation of the term crowdsourcing is the term crowdfunding. It is described as an innovation within the financial services industry and denotes a form of investment banking (Kuti and Madarász, 2014, p. 355). Investors buy parts of companies or invest in projects (Wieck, Bretschneider and Leimeister, 2013, p. 5) and thus become venture capitalists (Gobble, 2012, p. 4). The handling is performed on (internet-based) crowdfunding platforms, where the project is described and investments can be executed. Open research issues are seen in the field of risks and legal requirements as well as in the area of acceptance of the investors. However, crowdfunding is still in its infancy and qualitative as well as quantitative research is still missing, e.g. Ordanini, et al. (2011, pp. 443–470) and Lehner (2013, pp. 289–311). This can be assumed for Crowd Logistics as well, so that we adapt these research methods to this new realm.

As there is, to the best of our knowledge, no broadly accepted definition of Crowd Logistics, we want to characterize it by adapting the ideas of crowdsourcing, crowdfunding and crowd working to the field of logistics. Therefore, our definition is:

"Crowd Logistics designates the outsourcing of logistics services to a mass of actors, whereby the coordination is supported by a technical infrastructure. The aim of Crowd Logistics is to achieve economic benefits for all stake- and shareholders."

The technical infrastructure is mostly used as a communication medium. Therefore, an IS platform is provided, which can be accessed in a multitude of ways (mobile phone, web browser, etc.). The aim of the platform is to coordinate demand and supply for transport services. In addition, also management processes and invoice processing are tasks that are performed on the platform. The economic benefits are based on the sharing economy, a concept where an increased prosperity is achieved through sharing of goods (services, etc.) among market participants (Weitzmann, 1986, p. 470).

Following our definition, Crowd Logistics enable the generation of new logistics services and the improvement of existing logistical services (e.g., last-mile transport) in the range of volume, speed and flexibility (Bubner, et al., 2014, p. 22), which will cause economic win-win effects for all stakeholders. In general, the inquirer will get a more convenient and flexible logistics service, and the supplier achieves advantages of monetary value which would not be possible without Crowd Logistics (Pfenning, 2014, p. 4).

The potential of Crowd Logistics can also been seen from various successful companies, e.g. the taxi service Uber, the last mile delivery service Algel or the service tiramizoo, which provides same-day delivery of online purchased articles (Bottler, 2014, p. 28). Thus, Crowd Logistics can already be seen as a competitive alternative to traditional courier express package service providers (CEP).

Development of a Research Agenda

Results of Qualitative Data Analysis

In our QDA of scientific articles, we analyzed the 30 most frequent words. Conducting a cluster analysis by using the Jaccard similarity coefficient (Backhaus, et al., 2011, p. 403), six clusters were identified (cf.

Figure 1). The size of the circles corresponds to the number of word mentions; the proximity of the circles to each other describes the proximity of the words in the analyzed papers.

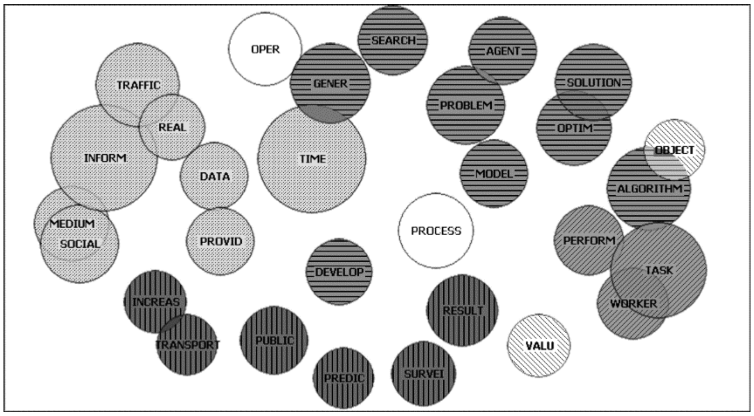

Figure 1: Cluster Analysis Result of Scientific Paper

The white diagonal striped as well as the white cluster is not investigated further, as these topics are mentioned in most analyzed papers.

The grey dotted cluster describes the usage of social media and real time data for traffic information systems. Pender, et al., (2014, pp. 501–521) conducted a literature review, which is about a network control system based on social media data. The use of real-time information for intelligent transport systems (e.g., for traffic jam management) is described by Lee, Tseng and Shieh (2010, pp. 62–70).
The dark grey vertical striped cluster deals with public transport. However, this cluster describes urban transport planning from a strategic, organizational point of view. Poister and Thomas (2007, pp. 279-289) describe how prediction can be used as an alternative for a survey, whereas Pender, et al. (2014, pp. 501–521) investigate how crowdsourcing can be used for disaster management and unplanned transit disruption.

However, Mulaik (2010, p. 34) investigates the field of crowd engineering (as part of in-house logistics) to build smart workforces. This is rather the same focus as in the case of the grey diagonal striped cluster: performance optimization of work tasks and the worker itself.
The grey horizontal striped cluster shows that optimization, modeling and algorithms are big topics in the field of Crowd Logistics. Sheremetov and Rocha-Mier (2008, pp. 31-47) describe, e.g., how supply chain network optimization can be addressed locally in order to globally optimize structures by the use of Collective Intelligence (COIN) theory and Multi-Agent Systems (MAS).

We use the information gathered from these journals as well as the identified open research questions to build the research agenda in section 0.

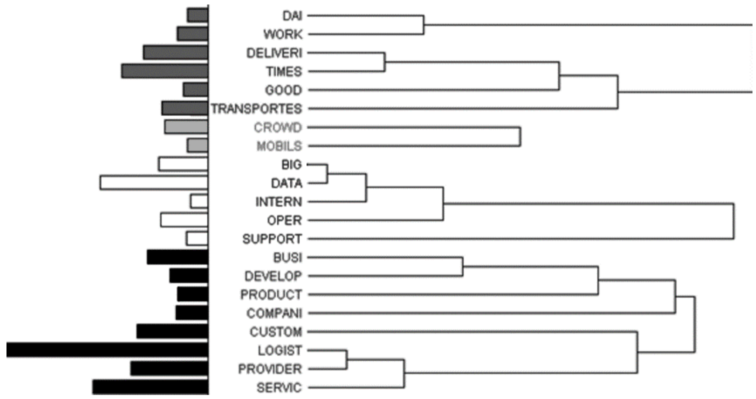

Figure 2: Cluster Analysis Result of Case Studies

The QDA of the case studies was performed in a synonymous way to the literature QDA analysis. The cluster analysis, using Jaccard similarity coefficient (Backhaus, et al., 2011, p. 403), resulted in five clusters (whereby three irrelevant clusters, that consisted of a total of nine words, have been removed from the analysis). Figure 2 shows the results of the cluster analysis in form of a dendrogramm.

The result is comparable with the result of the paper analysis. The dark grey cluster deals with delivery time optimization in the area of transport, whereas the light grey cluster mainly addresses mobile crowd solutions in the area of public transport. The topic of (real time) Big Data is described in the white cluster, whereby this data is mainly used for internal process optimization. The large black cluster again deals with strategies in form of business models and product development in the area of logistics service providers. A detailed analysis of these case studies is accomplished in section 0. The information gained is used to build the maturity model.

Result Analysis

Due to the fact that 46 % of the analyzed papers address the topic of urban passenger transport, this seems to be the most important topic in the area of Crowd Logistics. In this context, the complexity of routing algorithms is mentioned as an aggravating factor by 31 %. For a further 15 %, data heterogeneity represents an obstacle. Communication (38%) and real time data processing, however, are seen as enablers. By analyzing the papers as well as the case studies, we identified several open research topics. We summed up the research theses and displayed them in table 1.

Research Thesis		Based on
RT1	Big Data (Social Media) Analysis improves the prediction of Crowd Logistics.	(Pender, et al., 2014)
RT2	There is a need for new algorithms to manage and control the crowd, which uses the services.	(Mousavi et al., 2012, p. 2589)
RT3	Uncertainty has a negative influence on the CL algorithm forecasting quality.	(Chen, et al., 2014, p. 39)
RT4	Sustainability has an influence on Crowd Logistics.	(Echenique, et al., 2012, p. 136)
RT5	The acceptance of Crowd Logistics (Services) depends on the diffusion of the service.	(Hellerstein and Tennenhouse, 2011)
RT6	Political acceptance is an essential condition for a successful and sustainable deployment of Crowd Logistics services.	(Hellerstein and Tennenhouse, 2011)
RT7	Simulation (sentiment analysis) may discover influencing factors regarding the efficiency of CL transport networks.	(Sheremetov and Rocha-Mier, 2008, p. 45)

Table 1: Research Thesis in the Realm of Crowd Logistics

Further research is needed to explore these research theses. Therefore, we provide a research agenda in section 4.3.

Crowd Logistics Research Agenda

Based on the systematic literature review, we identified future research needs in the area of Crowd Logistics. With the help of our research agenda, these starting points can adequately be addressed (cf. Figure 3). The focus is on the development and evaluation of new business models and innovative technologies like algorithms. Moreover, also studies of acceptance and diffusion of these business models are necessary.

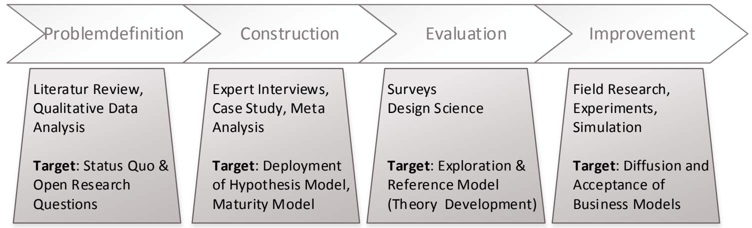

Figure 3: Crowd Logistics Research Agenda

In section 0 and 4.2, we carried out the first step of our research agenda (collection of theoretical and practical knowledge) in order to uncover research needs and topics (cf. problem definition in figure 5). The next step (construction) is to build a hypothesis model to answer RT1 to RT4. Additionally, expert surveys as well as case study analyses can be used to strengthen or extend the hypotheses. In addition, a maturity model can be built (cf. section 0) based on the insights gained from practice (case study analyses, expert interviews). In the evaluation phase, the hypothesis model can be validated in the form of an exploration model phase by quantitative cross-sectional analyzes (e.g., surveys) and further analyses of the design science approach (Hevner, et al., 2004). Subsequently, the exploration model can be used for the improvement phase in order to make continuous adjustments and further developments. Therefore, the analysis of acceptance factors (RT5 and RT 6 in table 1) can be evaluated, e.g., via the Technology Acceptance Model (TAM) (Venkatesh and Bala, 2008), by the use of the "short scale for detecting technology readiness" (Neyer, Felber and Gebhard, 2012) as well as by means of other methods from the realm of field and action research.

Crowd Logistics Maturity Model

A maturity model (MM) consists of different maturity levels by which objects (e.g., processes, software products or business models) can be assessed (Becker, Knackstedt and Pöppelbuß, 2009, p. 213). Though, MM can also be used for benchmarking, as quality and performance criteria are rated by the use of specified criteria. Each maturity level has different criteria which must be fulfilled to achieve the level. There are four or five maturity levels (Martens, Teuteberg and Gräuler 2010, p. 56). Normally, a self-assessment is performed to define the maturity of an object. However, it is also possible to use available information about an object for the definition of its maturity. Based on the evaluated level, new targets (e.g., company's strategy orientation) can be defined.

The development of our maturity model is based on recommendations of Becker, Knackstedt and Pöppelbuß (2009, pp.213-222), who suggest an iterative process of development and improvement. The model presented in this paper is the result of a comprehensive literature search and a broad case study analysis (problem definition). Thereby, the case study analysis incorporates input from thirteen companies (Bringbee, Uber, Lyft, Algel, MyWays, Hailo, GetTaxi, myLorry Food Express, checkrobin, mytaxi delivery, mytaxi, blackbay and MOBMover). The goal of our MM is to uncover improvement opportunities for Crowd Logistics Provider. Attention should, however, be paid to the fact that we present the results of the second iteration of the development process. A corresponding improvement will follow shortly (cf. section 0). We performed the development of our MM in 2 steps: Definition of the maturity criteria (step 1) and definition of maturity levels (step 2). Step 1 is divided in 4 sub-steps.

The first sub-step defines the model content by identifying the relevant design level. We considered organizational and subject-specific aspects and used existing maturity models in the area of logistics and business information systems for adaption.

The second step is to analyze and define possible dimensions for the MM. Therefore, we used dimensions from existing maturity models (like CMM (Paulk, 1993) and SPICE (El Emam, Drouin and Melo, 1998) and adapted them to the area of Crowd Logistics. Further, by means of the case study analysis, we identified additional dimensions. Then, we grouped the identified four main dimensions in categories.

The third sub-step is to devise the attributes for each dimension. As the assessment and definition of the maturity are based on an achievement of these attributes, they form an important pillar. The aim is to ensure significance, comprehensibility, identifiability and objectivity. As it is the objective to further develop the MM, the attributes should be flexible and extensible. The results from the QDA provided first ideas for the creation of attributes. By the use of creativity techniques, three researchers performed the further development.

As a last step, we defined which attributes of each dimension are connected to the individual maturity levels. We decided to use a four-level structure, as this is adequate to ensure a differentiation. Moreover, this approach allows for enough flexibility needed for further development. Afterwards, we analyzed the dependencies of the attributes for each dimension. As some attributes require prior attributes and build on one another, an individual analysis was not possible, which is why we executed a holistic examination. By investigating the dependencies and the structure, the different attributes were assigned to the different maturity levels, whereby a cumulative approach was used at some dimensions. For all dimensions, we considered the possibility for further development.

State	Percent	Commentary
Not achieved (N)	0-15%	Criteria not or poorly fulfilled.
Partially achieved (P)	16-50%	Criteria partially fulfilled. Improvements are possible and recommended.
Largely achieved (L)	51-85%	Criteria largely fulfilled. Only little improvements are still possible.
Fully achieved (F)	>85%	Criteria completely fulfilled. No deficiencies.

Table 2: States for Criteria Assessment

We followed the assessment of the Spice model, where the criteria are rated by percentages of the achieved status. The classification as shown in table 2 can be used to compute the state for each criterion.

In order to achieve a maturity level, the requirements of the respective level must at least be rated "L" (largely achieved), and the requirements of the preceding level must be fully achieved "F" (Hoermann, et al., 2008, p. 10). Thus, a higher level of maturity can be reached by achieving an improvement of at least one criterion.

Table 3 contains the Crowd Logistics Maturity Model. The left-hand column shows the different maturity dimensions. The remaining columns show the attributes (requirements) of each dimension for the different levels. The "++" indicate that it is a cumulative attribute and all prior attributes must explicitly be fulfilled.

Maturity Level	1 Restrictive	2 Functional	3 Effective	4 Innovative
Environment				
Strategy	Trade Platform	Service provision	++ Service Billing	++ Service Optimization
Market	Regional	National	International	Worldwide
Acquisition	/	Internet Advertising	++ Social Media Advertising	++ bonus program
Cooperation	/	1-2 Partner	5-10 Partner	>10 Partner
Economy				
Revenue	/	Transaction based	++ Provision based	++ Subscription
Payment	/	Cash	Online-(Banking)	Secure payment
Billing	/	Paper	Digital	Monthly digital
Communication				
Access	Phone	++ Online Portal	++ App	++ Master User
Contact	/	E-Mail	++ Hotline	++ Portal
Certainty				
Transparence	/	Valuation of Company	Ranked Valuation of Service	Ranked Valuation of Service & Supplier
Supplier Verification	/	Registration	++ Authorization	++ Qualifying Certifi-

				cate
User Verification	/	Registration	++ User Profile	++ Identity check
Security	/	Legally enforceable	++ Insurance	++ Tracing

Table 3: Crowd Logistics Maturity Model

A detailed version of the CL MM with precise explanations for each attribute can be accessed via http://bit.ly/CL-MM.

Evaluation

In order to evaluate our developed Maturity Model (cf. section 0), we analyzed the company Algel. By this approach, we demonstrate how the MM can be used to determine the Maturity level and how recommendations can be derived from it. Algel (acronym for "Alles geliefert"; in English: "all delivered") is a German Crowd Logistics Provider which enables customers to generate an online shopping list. Purchasing agents (from the crowd) get the list, buy the articles at partner stores and deliver it to the costumer. Therefor they get a provision.

Maturity Level	Reached Level	Explanation
Environment		
Strategy	3 F; 4 N → 3	A service as well as billing is provided.
Market	1 F; 2 L → 2	The service is available in 4 German cities and it is expanding
Acquisition	3 F; 4 N → 3	There are all forms of commercials; however, there is no bonus program.
Cooperation	2 F; 3 L → 3	There are several local supermarkets integrated as well as 3 supermarket chains.
Economy		
Revenue	3 F; 4 N → 3	Provision based payment is implemented as well as transaction based payment. Howev-

		er, there is no subscription model.
Payment	4 F → 4	Secure payment is offered.
Billing	4 F → 4	Suppliers get a monthly bill. The customer pays directly to the supplier.
Communication		
Access	3 F; 4 N → 3	There is a portal and an app. However, there is no user management that would enable to integrate master users.
Contact	4 F → 4	Email, hotline as well as a form on the portal are provided.
Safeness		
Transparence	4 F → 4	The suppliers, the service, the customers and the company can be rated.
Supplier Verification	3 F; 4 N → 3	Suppliers must be authorized, but do not have to provide a certificate.
User Verification	3 F; 4 L → 4	User have to register, a user profile is generated. However, an identity check is possible but not obligatory.
Security	2 F; 3 N → 2	If a service is booked, it's legally binding. No insurance is provided.

Table 4: Maturity Level Assessment of a Company

As can be seen in table 4, the company would gain an overall maturity level of 2, as this is the lowest level reached at the different items. There are two items (market and security) where the level 2 is reached. The recommendation for the company would be to integrate an insurance (e.g., a third-party insurance), to improve the security level as well as to extend the service to new cities.

For each category of the maturity model, we can sum up the reached levels. For instance, if we want to compute the overall maturity level for the category communication, we will have to proceed as follows: use the level 3 (access) and 4 (contact), build the corresponding percentage, based on the highest level 4 (this will result in 75% for access and 100% for contact), and then calculate the mean (in this case 87.5%). Analogously, this needs to be done for all categories.

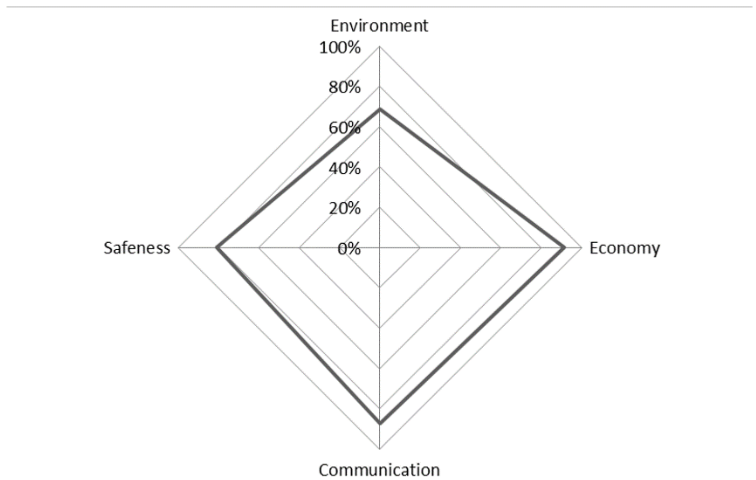

Figure 4: Strength and Weakness of the CL Company business model

As is clear from figure 4, the created company performs well in almost every category, except in the category environment. This underlines our recommendations. Our recommendation to expand into new cities will lead to a higher market value. The recommendation to raise the security measures will finally lead to a higher distribution of the service, which in turn may result in an increased request for the service, also in regions where the company's service is not yet implemented.

Furthermore, it is possible to use the chart shown in figure 4 to benchmark the company's own development or to benchmark with competitors. Therefore, the results of different analyzes can be laid on top of each other, which makes changes directly visible.

Conclusion

As we have seen, research in the area of Crowd Logistics is still in its infancy and only few high quality studies are available. For this reason we have first shown a definition of Crowd Logistics. Our literature reviews revealed only a few tentative research approaches. In practice, however, there are several companies and case studies providing insight in the current state. Primarily in the area of passenger transport and last-mile delivery, the potential is seen in an optimized use of resources (based on monetary issues and with respect to sustainability). In this respect, the main driver is the digitization of the society.

The case studies show that there are several ideas that deserve further investigation. As the considered case studies encompass several business models and different stages of realization, a cross case analysis led us to the development of our Crowd Logistics Maturity Model. It is the aim of our MM to identify weaknesses of the selected business models and to deliver suggestions for improvement. With the help of a fictive company, we have shown how the MM can be used and which recommendations can be derived from the results. Furthermore, the MM enables a benchmarking against competitors as well as a historical analysis and a demonstration of the past development.

However, we are aware of the limitations of our research. First of all, we have only investigated companies and case studies from Germany. Beyond, the MM has been developed with publicly available information only, a deeper knowledge of internal processes and the IT/IS systems is thus missing.

But as in every paper, the limitations serve as a guide for future research. In the meantime, we have conducted two iterations of MM development. Moreover, we currently conduct expert interviews in order to enhance our MM by means of sound expertise. First insights show that two new categories will be implemented (the IT/IS category and the internal process category).
Furthermore, the potential strength of Crowd Logistics should be further investigated. In this respect, quantitative data analyses as well as simulations could deliver new insights (compare phases Evaluation and Improvement of figure 3 in section 0).
Last but not least, the risks of crowd logistics business models should be identified, quantified and valued. First analyses show, that the government and the legal regulation play a major role for the acceptance and diffusion of Crowd Logistics services (cf. table 1 in section 0). The implementation of standard and new regulations may lead to further diffusion.

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