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Hoppe, Mirko
Schramm, Hans-Joachim

Use of Interorganisational Systems - An Empirical Analysis

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Use of Interorganisational Systems - An Empirical Analysis*

Mirko Hoppe and Hans-Joachim Schramm

Abstract

Electronic linkages between organisations enabled by interorganisational information systems (IOS) such as Electronic Data Interchange (EDI), Internet-based applications or cargo community systems are becoming increasingly important. Recently, many studies have examined the impact of electronic integration in logistics chains. However, there is a need to examine which factors on the perceived level of an interorganisational partnership are important for the management of information systems.

We extend further the information processing model based on Galbraith [1] and Bensaou and Venkatraman [2] in a logistics network context. Their theoretical concept gives some explanations about a fit between information processing requirements, as determined in partnership design, and the information processing capabilities realised in information systems. This was further explored conducting a survey amongst German network organisations of freight forwarders in groupage service or contract logistics as a starting point because of their common usage of different interorganisational information systems. Surprisingly, our study shows only a slight influence of interorganisational tasks on the management of information systems. Moreover, our findings suggest that employment of IOS across firms observed is limited by structural factors (i.e. asset specificity) and nature of interorganisational relationship (i.e. trust, power). These factors are positively associated with satisfaction about information systems usage and performance.

Key Words: interorganisational information systems, information processing model, co-operation, logistics networks, freight forwarder networks

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1 Introduction

Confronted by issues of globalisation, deregulation and competition pressure, more and more firms are seeking to build up network organisations in order to cooperate with other companies. Consequently, the number of business partners and interfaces are increasing as well as the complexity of coordination. To some extent, advances in information technology (IT) and recent developments in interorganisational information systems (IOS) help to challenge these problems in designing and managing networks. We understand as IOS 'as systems that process and share information by electronic means across organisational boundaries'. Especially in the case of freight forwarder or other transportation service provider co-operations, we identify IT-systems for fleet-management or tracking and tracing purposes, Electronic Data Interchange (EDI), Internet-based applications and cargo community systems as the most significant IOS technologies available to achieve higher levels of interorganisational co-ordination.

Actually, the present extent of information processing tasks and the enormous potential of standardisation by usage of IT seem to justify the large investments in this field. However, we found a different level of acceptance and employment of IOS in freight forwarder networks supposing, that every business process needs not to be necessarily supported by IOS. Furthermore, we hypothesised about conditions in an interorganisational cooperation, which limited the effectiveness of electronic integration.

Up to now, performance of electronic integration has been mostly discussed from a technical or IT-driven point of view. Rather, this contribution gives implications from a managerial point of view. We exam preconditions and requirements which are related to integration and usage of IOS.

An information processing model, based on an organisational design framework of Galbraith [1] and the work of Bensaou and Venkatramen [2], is presented as a theoretical base (see section 2). It explores the relation between requirements of a task (first dimension) and available capacity (second dimension) provided by coordination mechanisms. The model asserts that performance of a task (third dimension) is determinate by the fit (or match) between requirements and available capacity. For instance, high information requirements must be matched with high information capabilities. In this study, we focus on usage of IOS standing for mechanisms to coordinate an interorganisational task. In the context of freight forwarder networks, the model is being interpreted as follows: The first dimension stands for information processing requirements focusing on the needs of tasks and partnership in logistics networks. Then, IOS as information processing capacities occur as the second dimension together with a critical analysis regarding their function in the transport industry. The third dimension of the model, so called performance, can be interpreted as the matching between requirements and capacity in a given context. Next, section 4 includes a description of methods and results of an empirical survey conducted among freight forwarder networks in groupage service or contract logistics in Germany. Finally, the paper ends with a discussion on relevant results and managerial implications. One of our results concludes that partially nature of a task and mainly quality of a partnership between firms in logistics networks limit the operational performance of electronic integration usage.

2 Theoretical Considerations

Already in the 1970's, Galbraith began with his work to explain different variations in organisational forms of firms observed by him. He proposed that a key function of organisations is the processing of information in order to coordinate the execution of a task [1]. However, not all information available to interpret can be processed, mainly due to bounded rationality and/or processing capability of individuals [3]. Therefore, Galbraith concludes, that the more complex an overall task, the greater the problem of coordination. Specifically, information processing capacity depends on the specific organisation structure faced by decisions rules, methods (today often subsumed under the term technology), environment and structural design of organisation (e.g. departmental interdependence). In addition, Bensaou and Venkatramen [2] extended this framework to an interorganisational level. In the information processing model presented in *Figure 1* there are three dimensions.

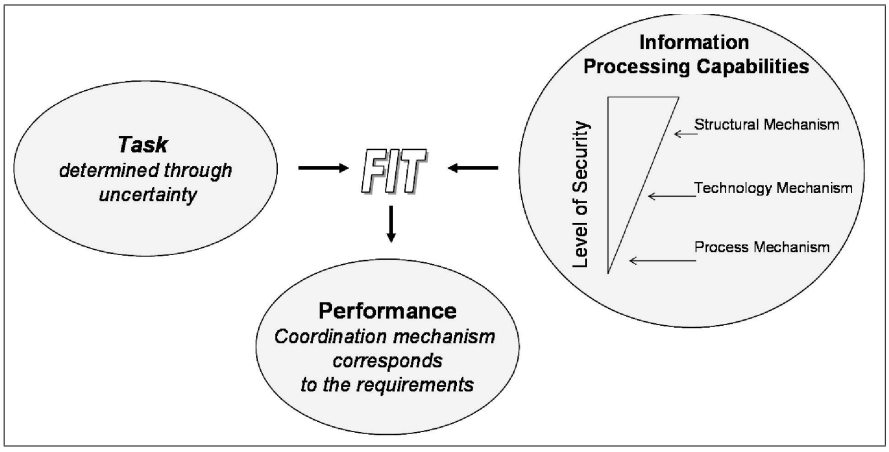

Figure 1: Information Processing Model (Based on [4])

The first dimension describes **information processing requirements**. All of these needs of a task derive from uncertainty. Uncertainty can be defined as the difference between the information required to perform a task and unknown information. In the following, it is essential to highlight that all types of requirements are consistent in the sense that they are described through uncertainty as a key explanation. For instance, uncertainty can arise due to a missing confidence in a partnership or a high variety in a task execution.

Information processing capabilities are provided by co-ordination mechanisms that share information across organisational boundaries. Bensaou and Venkatraman [2] classified them in terms of structural, technology and process mechanisms. Structural mechanisms consist of rules, programs and direct contacts. This type is suitable to coordinate tasks with a high formalisation of information exchange resulting in an overall low uncertainty. Moreover, technology mechanisms represent employment of present IT or, in more detail, scope and nature of electronic linkage between two members. In volatile environments, process mechanisms like conflict resolutions, joint actions, task force and commitments are appropriate for coordination [5].

The model further asserts, that information processing needs should be matched to (or fit with) information processing capabilities. For instance, if a daily task is coordinated by a process mechanism (e.g. through a team), the expenditure (e.g. opportunity cost) will exceed utility (e.g. solution of a task). Obviously, it is better to use a structural mechanism like a rule. Summarising this, high (low) requirements must be matched with high (low) capacity in order to achieve **performance goals**.

In the context of our empirical analysis in section 4, these dimensions of the model might be interpreted as follows in section 3 starting with identifying explanatory variables for information processing requirements.

3 Dimensions of Information Processing Requirements

Looking closer at the dimension of information processing requirements, two major types can be recognised, namely (a) needs in task function and (b) needs in partnership. We chose these two different types because of several reasons. First, the requirements give a reasonable detailed explanation about daily business operations in an interorganisational cooperation [6, 7]. Second, regarding to interrelation of the following hypothesises, the information processing requirements increase in dependence of task and interfirm relationship uncertainty [4]. For instance, uncertainty arises from exceptions in a shipment process. Simple tasks in a stable freight forwarder partnership characterised by low conflicts give rise to few exceptions during a shipment process in a logistics network.

The **needs of the task function** can be described along different dimensions. Two of them are degree of formalisation and analysability of a task [8]. For instance, we can hypothesise that formalisation of task is a decisive factor to use IOS. Analysability refers to known procedures to perform a task [9]. Further, we can propose that tasks being not analysable cannot be planned and so therefore, an employment of IOS seems not to be very useful. In addition, with a detailed examination of kind and importance (or value) of a task we attempt to know more about the mutual business operations between firms including support of IOS. So, our first hypothesis is:

H1: Requirements of an interorganisational task will moderate with relationship between IOS and performance.

Furthermore, we argue that there are three primary source of partnership uncertainty: trust, cooperation and conflict resolution [10]. These variables exhibit the needs of a partnership. Obviously, partners share information in a trusted relationship rather than they do in a low trust situation. Thus, management of IOS needs mutual goals in planning, usage and adaptation of these systems. So, our second hypothesis is:

H2: Requirements of a partnership will moderate with relationship between IOS and performance.

Beside these first two main hypothesises given above, we suppose that the requirements of a partnership is affected by some other variables like

- unbalanced power relations
- compatibility of goals

- degree of intensity (in a relationship)
- number of partners

being at the same time common attributes of a partnership. We assume that they have a direct impact on partnership requirements. Therefore, it is worth to formulate four other hypotheses closely related to *H2*.

Balanced power relations can consider being of preeminent importance in a partnership and in management of electronic linkages, too [11]. It can be best described as a continuum starting with a democratic system and end with full concentration of power. On one hand, power concentration has the advantage, that finance risk or implementation tasks of IT are concentrated on one partner. On the other, power of one partner involves problems like missing mutual goals or missing readiness of other partners in innovation, respectively research and development. Whatever, we suppose that power is not a moderate variable between IOS and performance but has an indirect impact over partnership. Hence:

H2a: Power has a direct impact on partnership.

In comparison to one single organisation, normally partners in an interorganisational relationship have no readiness to stick together at one mutual goal [12]. Different perceptions, communications breakdowns or ideological differences are often causes of conflicts occurring. Conflict itself is defined as a situation in which one partner perceives another partner as engaging in behaviour. Therefore, conflicts between partners arise often due to incompatible goals. In our context, we suppose effectiveness of IT usage depends on the **compatibility of goals** between partners, or:

H2b: Compatibility of goals has a direct impact on partnership.

Next, the **degree of intensity** in a relationship reflects the extent of mutual business operations between partners, expressed in terms of duration and type of contract. According to duration, a contract with limited term, ensuring of security in sharing information like transparency of costs or knowledge exchange is always problematic because it allows opportunistic behaviour. Regarding type of a contract, (neo)classical and relational contract types can be distinguished [13]. Under high expectation of continuity, partners perceive less uncertainty about their counterparts, sign more likely a (neo)classical contract, and are better predisposed to sharing information with IOS [14]. Therefore, the following hypothesis:

H2c: Degree of intensity in a relationship has a direct impact on partnership.

Some researchers already described a significant relationship between increased levels of IT investment and smaller firm size [15]. Their findings give evidence that employment of IT leads to a decline in average size of firms. In contrast and similar to *H2c*, we suppose that their results also must reflect the sociopolitical processes inherent in relationship as well. Because of increasing number of partners, there are risks, which cannot directly controlled by one single member. Specifically, we argue that perception of fairness (i.e. the extent to which risks, benefits or burden mutually shared) in a network of known partner reduces uncertainty about partner's inclination and potential intentions of opportunistic behaviour.

In essence, a limited **number of partners** encourage cooperative behaviour of using IOS:

H2d: Number of partners has a direct impact on partnership.

3.1 Dimensions of Information Processing Capacity

At the beginning of this section, there were two questions implicitly raised: (a) Which kind of IOS are employed in the transport industry, especially in the context of freight forwarder networks? (b) How we can operationalise usage of IOS? One approach to the first question is to distinguish different kinds of IOS along their principal functions as shown in *Figure 2*.

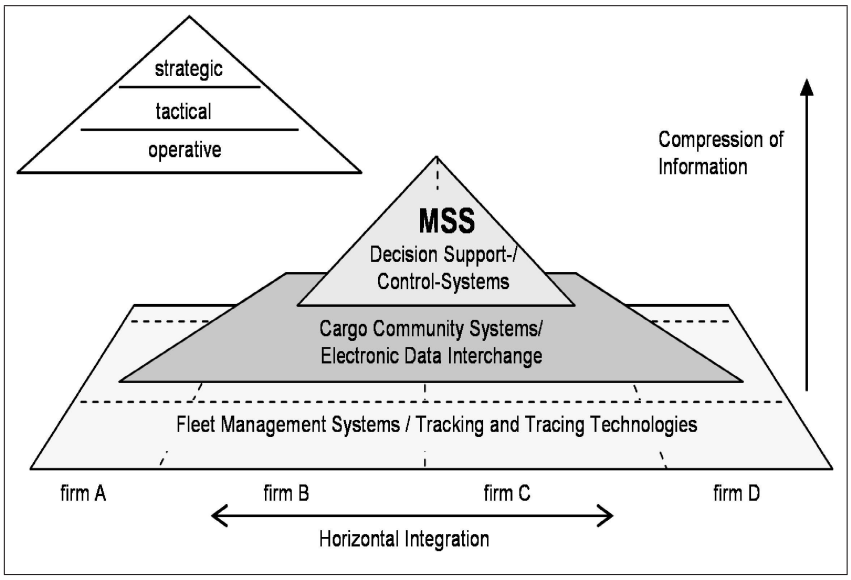

Figure 2: Systems of IOS used in Freight Forwarder Networks (Based on [7, 16])

As a result, we differentiate IOS as being located at an operative, tactical or strategic level. Looking in horizontal direction, IOS form an information link between different freight forwarders or other transport service providers connected to each other whereas in vertical direction, a process in concentration of information takes place in order to support top management decisions at the highest level.

At the **operative level**, a predominant function of IOS is to collect information about the current status e.g. of goods and vehicles. At this stage, IT-systems for fleet-management or tracking and tracing purposes are employed. They can provide in-transit visibility of shipments like information about a traffic jam or an accident and so they can give early warning messages to reduce delays. Being on a higher stage, IOS of the **tactical level** use information of the operative level and allow with IT-systems like EDI, Internet-based applications or cargo community systems an electronic document exchange, which makes it possible to transmit shipment information from one partner to another [17]. Following Behrens [18], IOS of the

strategic level are well known as Management Support Systems (MSS). Compressing information from lower levels, they can be further divided in Management Information Systems (MIS) or Decision Support Systems (DSS) [19].

Referring to the second question addressing operationalisation issues, we focused on technology mechanisms as the information processing capacity excluding abovementioned structural and process mechanisms (see chapter 2). These dimensions of IOS as a processing capacity are borne from investment in IT, as well as depth and intensity of their usage [4]. Investments in IT always seem to reflect the effort of an IOS implementation to a high extent. In addition to this, depth of IOS can defined as a proportion of interorganisational network size and the number of partners with someone maintains electronic links, whereas intensity includes the degree of usage and integration of IOS into daily business. Consequently, higher intensity provides greater amount of information exchange. We follow the assumption, that variety of these variables describes information processing capacity.

3.2 Dimensions of Performance

Performance is always difficult to operationalise, because it can be measured in too many different ways. At the very beginning of our study, we wanted to focus on one single measure of performance being relevant in our context. In our specific case, we chose in first instance delivery service as the only measure of performance. To us, delivery service consists of several components like delivery time, quality of transport, flexibility and delivery costs [20]. Unfortunately, we recognised a low response rate to our questions about delivery service. Therefore, we used cost reduction perceived by employing IOS as a second best solution to measure performance, because this was the only variable left related to IOS with explanation power to performance.

3.3 Summary of the Research Design

As explicated over the last sections, the idea was to explore further the usage of IOS to achieve performance goals on an interorganisational level. In addition to this, we wanted to know more about requirements described as needs in task and partnership moderating between usage information processing capacity and performance. *Figure 3* summarises the hypothesises once more. We employed a conceptual model to configurations by research design as necessary to specify indicators for a strict derivation of empirical configurations.

In order to confirm preceding considerations, we collected data from executives in charge of cargo operations in freight forwarding networks of groupage service or contract logistics in Germany. Investigations of these above described issues are shown in the following sections.

4 Empirical Analysis

4.1 Sampling Frame and Survey Layout

The sampling frame of our empirical study was collected from recent research studies and own investigations [21, 22, 23, 24]. Scanning through these sources we identified about 50 freight forwarder networks widely similar in strategy, transport system structure and usage of IOS. Specifically, most of them pursued a product strategy focusing on low to middle valued cargoes. The oldest co-operation agreements of

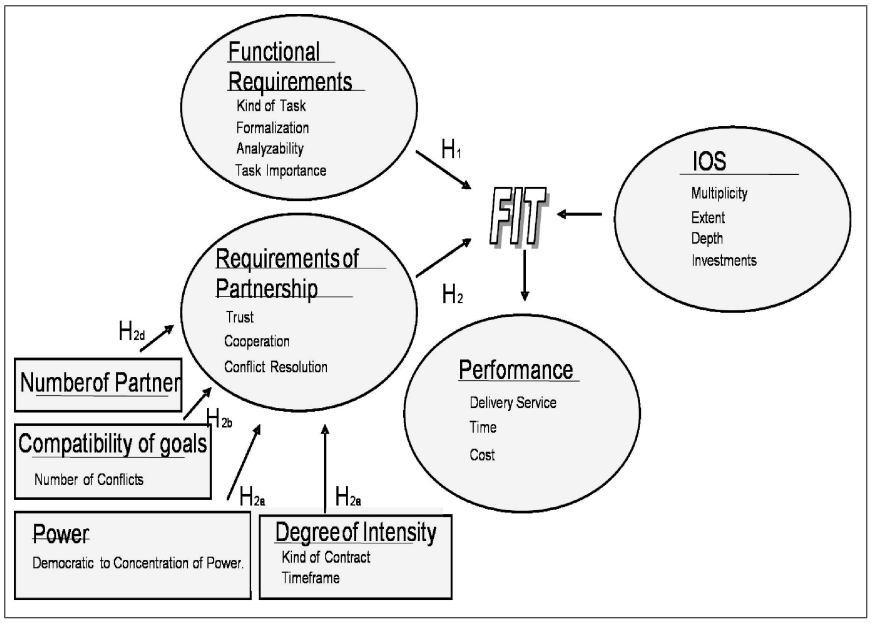

Figure 3: Information Processing Model - transformed into a Research Design

predominant mid-sized companies were found mainly in the field of groupage services and contract logistics [21]. Other areas of co-operations are based in courier, express and parcel services but also in highly specialized segments like refrigerated transports, hanging garments or food and consumer goods distribution. A common feature to all of these co-operations above mentioned is, that their integration strategy building up a interorganisational network has mainly focused on the domestic market [6], and their transport structure shifted from point-to-point networks to hub-and-spoke networks. According to a technology strategy, they had developed tracking and tracing technologies as well as interorganisational information systems for monitoring network-wide performance.

Based on the conceptual model of section 2, a structured questionnaire was developed along these above described three dimensions and pre-tested in four companies. The information processing requirements were determined by a Likert Scale using ranges from a negative score -3 (low) to a positive score of +3 (high). Further, data about IOS used was collected to investigate the communication process relating to IOS in these interorganisational networks. In addition to this, the questionnaire contained some questions about sociodemographic data and measures of delivery service in order to measure performance.

Pretests of instruments were conducted with two senior executives of different freight forwarder networks to clarifying issues facing the daily business and use of IOS. Afterwards, the survey was started in April 2003. The questionnaires were administered to headquarters but also to dominant partners found mostly in loose co-operations. Referring to the method of data collection, it was a combined email and telephone survey. After a first contact, principally structured interviews based on a questionnaire were conducted by telephone at once or after sending the questionnaire by email upon request. At the end, a total response rate of 58% was

reached leading to a sample size of 29 freight forwarder networks. The following sections present some of the results from this survey.

As we stated in our first hypothesis, requirements of an interorganisational task moderate with relationship between usage of IOS and performance. As a first and foremost natural way to explore this empirically, multiple regression analysis (MMR) is always recommended. However, doing this, we found no significant results, which seem to be simply caused by our small sample size. Therefore, we decided to employ correlation analysis with variables of performance regarded as a constant in the following. This was an viable approach in 23 of 29 cases, because these respondents achieved likely the same level of performance relating to cost reduction by IOS usage. Examining the Spearman rank nonparametric measure of correlations, we found different results.

4.2 Survey Results

Table 1 provides the results for *H1*. In terms of task formalisation, we observed no significant correlation between functional requirements and employment of IOS at the 0.05 level.

Variable observed	R^2	sig.	Rating
Formalisation of Task	-0,47	0,821	not significant
Analysability of Task	0,405	0,055	low significant

Table 1: Correlation between Functional Requirements and Employment of IOS

Especially, our findings show, that IOS usage for customer services were characterised by missing flexibility. Moreover, interorganisational networks indicated the lowest cost reduction through IOS usage in field of customer service.

According to the analysability of tasks, we found a (low) significant relationship between functional requirements and employment of IOS. It is important to note that correlation analysis per se does not allow us to draw any conclusion about direction of causality. Moreover, a relation could be interdependent allowing us to a two-way interpretation of data obtained in the survey regarding the analysability of a task. On one hand, the better the analysability of a task is, the better IOS usage will be. On the other, business processes are more transparent because of usage IOS. The results indicate that partners of logistics networks have to establish mutual logistics procedures and practices, because highly analysable movements of shipments can be preplanned. Hence, the better a known procedure specifying the sequence of a shipment, the more useful is employment of IOS in relationships between partners in a logistics network.

Testing for *H2* we discovered a significant relation between requirements of a partnership and the usage of IOS in terms of trust (see *Table 2*). This result can be interpreted in different ways, too.

Variable observed	R^2	sig.	Rating
Trust	0,393	0,047	significant
Conflict Resolution	0,220	0,281	not significant
Cooperation	0,107	0,601	not significant

Table 2: Correlation between Requirements of Partnership and Employment of IOS

We supposed readiness to use IOS increases with partner trust. However, in addition to the other non-significant relations (conflict resolution and cooperation), trust could also increased through IOS usage. Or restated in terms of the supply chain literature: these findings demonstrate benefits to use a socio-technical approach towards understanding use of IOS technologies for coordinating supply chain operations.

In *Table 3*, the results of testing *H2a* to *H2d* are shown. Surprisingly, all but one of the variables observed are highly non-significant in our sample.

Variable observed	R^2	sig.	Rating
Power	0,042	0,839	not significant
Effort of Implementation	-0,652	0,948	not significant
Size of Terms of Vehicles	0,263	0,194	not significant
Size of Terms of Employees	0,213	0,295	not significant
Degree of Intensity	0,340	0,090	low significance

Table 3: Correlation between Attributes of Partnership and Requirements of Partnership

Only the degree of intensity has low significance at the 0.1 level. These results seem to be reliable because under high expectation of continuity, partners always perceive less uncertainty about hidden intentions of their counterparts. In our study, partners with a high extent of mutual business operations realised complete electronic documentation of outbound shipments.

Considering an all over low significance of variables to describe the relationship between attributes and requirements of partnership, we directly tested for a correlation between attributes of partnership and usage of IOS and got high significant results for the variables power, effort of implementation and degree of intensity as shown in *Table 4*.

Variable observed	R^2	sig.	Rating
Power	0,659	0,000	high significance
Effort of Implementation	-0,519	0,000	high significance
Size of Terms of Vehicles	-0,173	0,399	not significant
Size of Terms of Employees	0,126	0,541	not significant
Degree of Intensity	0,453	0,020	high significance

Table 4: Correlation between Attributes of Partnership and Usage of IOS

Our findings did not support that number of partners (included size in terms of vehicles and employees) improved or limited IOS usage. Regarding to power,

questions of IOS implementation (i.e. IOS investments) were decided very often by powerful partners or network headquarters. The advantage of such an approach is that they were able to decide about IOS planning and implementation issues within a short time. The disadvantage is that all risks relating on IOS were concentrated on few partners. According to effort of implementation, there is a negative significance. For instance, the results draws up low efforts to exchange knowledge are related with high readiness in IOS implementation across organisation boundaries.

Apart from this correlation analysis as shown above, of course, several other aspects were observed in the empirical study not included in this contribution, but it is worth to present one additional finding.

Comparing organisational structure of freight forwarder networks and their usage of IOS, we explored three distinct stages of development shown in *Table 5*. Looking at the years of introduction shown in brackets for three forwarder networks, we can easily see a process of step-by-step adoption of IOS with in increasing co-operation.

	Organisational Structur	Usage of IOS
First Stage (1982/1966/1986)	Loose co-operation, only peer to peer relationships between all members	Only conventional media (i.e. phone, facsimile, letter)
Second Stage (1988/1987/1991)	Leaded co-operation with a central headquarter	Implementation of barcoding systems, central dispostion and EDI
Third stage (1996/2002/2003)	Democratic cooperation with high group cohesion and joint stake holding	Central data warehouse, common projects of IOS

Table 5: Lifecycle of Freight Forwarder Networks and Usage of IOS (Adapted from [7])

Specifically, these logistics networks started co-operation with simple logistics transactions like exchange of cargo and/or capacity. These simple logistic transactions are normally linked with low risks and can be performed via conventional media. In the following, both volume and scope of logistic operations enlarged. Thereby, the number of interfaces increased as well as the number of partners and finally the complexity of co-ordination issues, which had a direct impact on IOS usage. Furthermore, these three freight forwarder networks reviewed describe the degree of interorganisational cooperation stability and the impact on IOS, as already discussed above.

Dynamic development from simple to complex logistics transactions and change in the organisation structure with higher expenditure in co-ordination issues between freight forwarders give implications about a concept divided in phases to developed electronic integration in logistic networks.

5 Conclusions

Information transfer across boundaries of organisations is a necessity, a challenge and a chance. But to gain profit out of this situation, it is important to know more about the peculiarities of IOS.

Comparing development of interorganisational cooperation and IOS usage, we recognised an important influence of **organisational structure**. Specifically, the degree of stability of interorganisation cooperation is a decisive factor, which influences the extent of IOS usage. As a result, at the beginning of common work, there should be used conventional media, including no high risk of sharing information, investments or dependence. The usage of standard hard- and software can reduce costs. Further, if relationship will be more intensive, it is possible to realise IOS with higher specification as well as implementation costs.

The empirical findings discussed above indicate that **task requirements** affect the interorganisation processing capacity. Thus, analysability of a task was explained as being a significant factor. First, we suggest to structure tasks in parts, which are necessary to coordinate either in a centralised approach with backed by IOS or decentralised approach without them. Second, it is essential to provide detailed definitions for products and services reducing complexity of information.

In addition, our study explored dimensions of **partnership requirements**. The fact, that power is positive associated with IOS usage should be regarded in different ways. At the beginning of IOS implementation, a dominant role of one partner is better than looking for solutions together with a lot of partners. Then all partners may participate in experience and developments of IOS already reached by one partner resulting in a lower financial risk. Later, the partners of a logistics network should decide if a concentration of power is still advantageous.

As a contribution to theory, the conceptual model developed in this contribution may serve as a starting point to test other determinants of IOS as done in the present study. In addition, the research design could be used in other research fields, too. For instance, while we have explored horizontal co-operation in logistics networks, further research may explore vertical integration and relationships managed through IOS between producers and suppliers in a supply chain. Furthermore, it is essential to highlight that such an empirical study presented here can only be snapshot. Especially, examining questions about electronic linkages, it will be necessary to reflect life cycle of technological and organisational changes over a longer timeframe.

As a contribution to practice, the propose that, although a lot of studies explore the impact of electronic integration in logistics chains, it is also essential to look closer on factors of the perceived level of an interorganisational co-operation limiting the effectiveness of electronic integration. For instance, there are no sustainable improvements possible if one only invest in IOS without reorganisation of business processes affected by them.

Regarding our results, the study reveals that dimensions of task and partnership interact with dimensions of information processing capacity in order to predict the performance of IOS. Our empirical findings indicate three closely intertwined factors. First, we found a significant role of organisational requirements and task needs. In addition, the quality of partnership between members of such freight forwarder networks depends heavily on their personal attitude and their willingness developing

and employing IOS. To sum up, the usage of IOS as a common technology strategy is limited by requirements of organisation structure, interorganisational task and quality of partnership between firms cooperating with each other.

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