Developing a Service Oriented IT Platform for Synchromodal Transportation

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Abstract. Due to rapid global economic growth and competition, there is an increased pressure on logistic companies. On one hand, they have to be flexible and agile, to meet Service Level Agreements (SLA's) with clients, while on the other hand they have to comply with government regulations and environment protection laws. Better utilization of different modes of transport and improved decision making can contribute to solving both these challenges. This requires increased co-operation between logistic service providers (LSPs). Our aim is to develop an IT platform which facilitates increased cooperation between logistic partners and allows them to function in a synchromodal way. We use the principles of Service Oriented Architecture (SOA) to design the IT platform. Using this platform, a single consignment can be fulfilled using different modes of transport and unforeseen problems in transportation can be dealt with. A consortium of leading Dutch logistic companies will be the test bed for this research.

Keywords: Service Oriented Architecture, SOA, Synchromodal, IT platform, Logistics, Multimodal, Transportation.

1 Introduction

The core of all business depends on logistic. Raw materials have to be shipped in and products have to be shipped out to markets. These markets can be as near as the next village or as far as another continent. Customers are increasingly becoming more demanding and aware. They demand their goods as early as possible and in the best condition. Apart from this there are government restrictions on CO_2 emissions [3] and a constant increase in competition. Moreover, unexpected condition such as delays, traffic jams etc. can further make it difficult for a logistic company to fulfill an order in time. Business for logistic companies is not simple. In today's world a single consignment from source to destination involves many logistic companies having different modes of transport and using different IT systems.

3PLs (3rd party logistic service providers) are companies which have resources of their own and take orders from clients to fulfill a complete shipment. 4PLs [1][5,6] (4th party logistic service providers) are those LSPs which do not have resources for transportation but make use of their network, contacts and knowledge to fulfill an

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entire shipment (see Fig. 1). Although logistic companies already cooperate for operations [1], there still is considerable scope of improvement.

Firstly, there should be increased usage of diverse modes of transport thereby reducing the pressure on roads [3]. Secondly, in case of an untoward incident or unexpected situation, LSPs should be able to change the current mode of transport. Thirdly, there is a lot of information available (like weather, real-time traffic condition etc.) which can be incorporated in logistic planning. Lastly, becoming more environment friendly. Efficient utilization and sharing of resources between logistic companies is required to reduce pressure on a single mode of transport and reduce CO_2 emissions [3][9].

Moving toward synchromodal transportation [4][9] can provide the above improvements. In synchromodal transportation the decision for the next part of transportation is made as late as possible to account for any unexpected situation and take advantage of the new information. As the name suggests, the synchronization of modalities of transport is the corner stone for synchromodal transportation.

Three major outputs are expected out of this research, firstly, an in-depth study of state-of-the-art techniques used by logistic companies for cooperation and day to day operations. Secondly, a SOA [7,8][10] inspired IT integration platform which facilitates synchromodal transportation and use of real time information. Lastly, a working prototype, as a proof of concept. The research plan and the preliminary results are explained in the following chapters.

2 Background

This research is a part of a bigger project. The other parts of the project are concerned with data management and efficient planning for synchromodal transportation. A consortium of small and medium sized Dutch logistic companies is involved in this research. All these companies are based in The Netherlands. University of Twente is also a part of the consortium and is responsible for the research on synchromodal transportation. The logistic companies in the consortium are responsible for facilitating the research by providing information and insight about their current way of working. Also, they are a crucial source of input for understanding challenges in the way of synchromodal transportation. Thus, the main stakeholder for this research are the consortium partner, logistic companies outside the consortium and vendors of various sensor devices. Other stakeholders include the European Union, environmentalists and the government. The terms logistic company and logistic service provider (LSP) are used interchangeably in the text.

3 Research Questions

The problem statement for this research is - *Design* a *Service Oriented IT platform* for *logistic companies* which *hides* their *internal business processes* and IT architecture and facilitates *better coordination* between them, thereby enabling them to operate in a *synchromodal* way.

1. *Design.* This is a design science research [11,12], as it involves the design and development of an IT integration platform (the artifact).

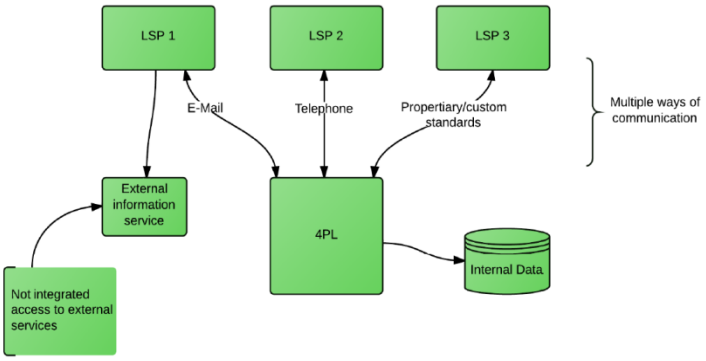

Fig. 1. A model showing current functioning of a 4PL and partner LSPs

2. *Service Oriented IT Platform.* The IT platform will be designed on the principles of SOA. This is a design criteria for the artifact.
3. *Logistic Companies.* The main stakeholder for this research.
4. *Hides, Internal Business Processes, Better Coordination.* The artifact (i.e. IT platform) should be at a higher level of abstraction and independent of the internal implementations [2] of different logistic companies. This is also a design criteria and follows directly from the 2nd point above.
5. *Synchromodal.* This is the desired effect of the artifact on the domain, i.e. by using the artifact the stakeholder must be able to function in a particular fashion (synchromodal way).

RQ1: Who are the stakeholders for this research, what are their goals and their priorities?

RQ1.1: How is the current logistic landscape and what are the current ways of working? How efficient are these w.r.t synchromodal transportation?
RQ1.2: What are the major challenges in the way of synchromodal transportation?
RQ1.3: What are the expectation of the stakeholders?

RQ2: What are the requirements of the artifact w.r.t. to the stakeholder?

RQ2.1: How will the stakeholders benefit from this platform?
RQ2.2: What are the desired results w.r.t. to these requirements? When are the requirements said to be met?
RQ2.3 What are the different treatments available?
RQ2.4 What is the justification for choosing a particular treatment?

RQ3: How can the artifact be validated?

RQ3.1 Which technologies and systems are currently being used? How good or bad is the performance of these systems?

RQ3.2 How good or bad is the performance of the artifact? Are the effects of the artifact in line with the goals of the stakeholders?

4 Resources

There is limited literature available in the field of synchromodal transportation. So, information has to be gathered via interaction with the consortium partners, different academic conferences and research groups working on similar topics. Yet, previous approaches for multimodal transport will be studied. Since a great degree of cooperation between LSPs is required for synchromodal transport, therefore the business models, process models and IT models of LSPs have to be studied in detail. Any previous approach involving the application of SOA [8] principle in developing an interaction platform will also provide useful guidelines. An important feature of this research is that it is very close to industry and involves frequent information exchanges.

5 Research Plan

This research follows the design science research methodology. Fig. 2 shows the steps in a design science research cycle. Currently, this research is in the first step, i.e. problem investigation. Thus, the focus is on understanding the problem and all its facets clearly. The next step is to choose the best treatment (a way of solving the problem), called the artifact. The third step is validation of the artifact followed by its specific implementation.

The implementation step may provide inputs for even better understanding of the problem, which were perhaps not evident during problem investigation. In context of this research, understanding the requirements of the different LSPs and their present way of working is an important part of the problem investigation. For this purpose a 4-step interaction scheme with different LSPs in the consortium has been formulated. The first step is to know the company, its stake in the research and an overview of its operations. The next step is for getting further information with the help of a questionnaire. The questionnaire will be filled by the LSPs employees which have a knowledge of the processes and technologies used by the company. Based on the result of Step 1 the questionnaire for different LSPs may be different. The third step involves making a generic process model based on communality analysis. In the final step, the design of the artifact is done in consultation and with further inputs from the LSPs.

6 Preliminary Results

The first step has been completed for 5 LSPs in the consortium. To better understand the operations and challenges being faced by the LSPs we present the profile of two of them. The real names of the companies have been suppressed because of privacy requirements.

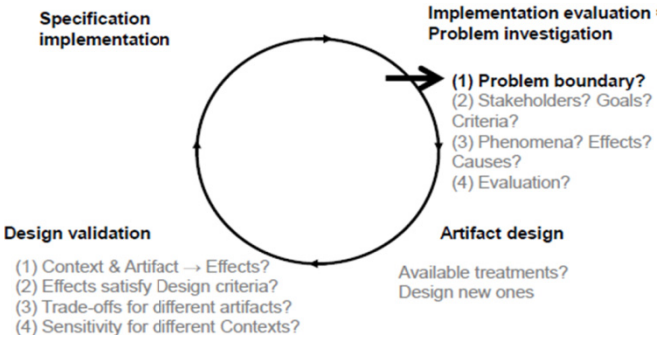

Fig. 2. Design Science Research Cycle [11,12]

ALPHA B.V: is a medium sized 4PL, having international operations, based in the eastern part of Netherlands. Its partners operate on road, rail and sea. Yet, logistic planning is done statically. Dynamic planning which is aided by weather or traffic information is not done. ALPHA doesn't get location data from deep sea vessels, trucks and trains that are involved in a particular shipment. Most of the communication with its partner LSPs is via email or telephone. A significant amount of human experience is involved in choosing the best combination of partners for particular SLA.

BETA B.V: is a small sized logistic company in the western part of Netherlands. Its operations are on road and in the sea. Most of the communication and data collection involved in fulfilling an SLA is manual. Raw data is collected from various sources and manually entered in excel sheets. A significant amount of human experience is involved in planning and forecasting since there is no real time data integration with planning of consignments. One of the biggest challenge in the way of synchromodal transportation is the absence of a common IT platform to integrate data from diverse sources and aid in planning. Planning is done statically and is largely non flexible in case of unforeseen circumstances.

We can conclude that logistic companies are different by their very nature and in different stages of development. Some are quite established, having much experience and a large market share. They have their own way of working and have fixed clients. Others are new, open to new technologies and trying to carve a market share for themselves. Considerable human intervention is involved in planning. There isn't a contingency plan for unexpected situations. An employee in a LSP was asked, *what happens when you know that there is high probability of delay in the shipment arriving at the port?* He replied, "*We just send the truck, and ask the truck to wait. May take a few minutes or even a full day*". Planning data is derived from diverse sources and is scattered. Mostly, raw data is manually fed into systems. Most LSPs want to move to a synchromodal way of working and thus there is a strong impetus to incorporate real time data and be prepared for last minute changes and delays.

7 Evaluation

The evaluation of the artifact is an important part of design science research. RQ3 is concerned with the evaluation of the artifact. The working principle of the artifact will

be used to develop a game. This game will be played by the different stakeholders and will help them to better understand the benefits provided by the artifact and the corresponding organizational, procedural and behavioral changes. The idea behind this research is to allows different logistic companies to do business together. Yet, the IT platform should not cause deadlock. This is to be proved mathematically. The artifact will be presented to stakeholders to know whether the artifact meets required goals. Moreover, experts in the field of logistics and SOA will also be involved in the evaluation of the artifact. A prototype of the IT platform will be developed as the part of this research. This prototype will be used to carry out case studies. The learnings from the case studies will be used to make improvements in the prototype. These case studies will serve as a proof of concept for the artifact. The stakeholders can use these case studies to analysis what more needs to be done to function in a synchromodal way.

Some assumption will have to be made for the evaluation of the prototype. These assumptions can't be stated now, but they will become clear as the research progresses.

8 Discussion

Each logistic company is unique in itself. When they are supposed to work together in a consortium, differences become apparent at various levels. There are difference in the usage of technology, desire to expand, concerns over data security, enterprise architecture maturity etc. Moreover, two LSPs which are partners in one consignment might be competitors in some other. So, a healthy relationship and trust has to be developed for a synchromodal way of working. This ensures that one strong partner doesn't overshadow a weaker partner. The results of this research will have important scientific and engineering contributions. *Generalizability,* the research method used in this research and the results are not necessarily case specific. They may be used in different contexts. Moreover, the artifact will also be reusable (with minor changes) in different contexts. *Innovativeness,* this research will deliver a new application, which did not exist yet. The results will guide future research in the domain of synchromodal transportation. *Application of SOA,* the engineering contribution of the research is that it serves as a proof of concept for SOA and its application for solving challenges in the field of logistics.

9 Conclusion

The road towards synchromodal transportation is not easy. It's always difficult to design systems for whom a fit-for-all approach is necessary. Yet, the benefits of synchromodal transportation are numerous and have positive effects not only on business but also on society and general well-being. In this paper we have introduced the research idea, presented a research plan and discussed the preliminary results. Many concepts will become more clear and new challenges might become apparent as the research progresses.

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