Electronic Transportation Marketplaces: How Can Green-IS Help to Promote Sustainable Logistics?

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Abstract—Electronic transportation marketplaces (ETMs) are inter-organizational information systems that provide an economic platform for the exchange of logistics services between shippers, carriers, and freight forwarders. Despite the fact that some of these marketplaces have already been in operation for over twenty years they have not achieved any significant influence in the logistics services domain until now. In a survey of logistics platforms that are active in Germany we identify the tendencies in development, success factors, and shortcomings of the current ETMs. The survey also shows that there is a significant lack of elaborated IS in the ETM domain. Current ETMs do not serve as integrated trading places, but rather as simple blackboards for the exchange of information. As a result, the missing functionalities and the lack of service quality make the current ETMs unattractive and keep liquidity in the transportation services markets low. A suitable way to deal with this problem is to offer extended functionalities, such as integrated tour planning, tracking-and-tracing, route pricing, etc., in order to make the ETMs more appealing for the users.

I. INTRODUCTION

In the light of continuously increasing demand for worldwide high quality transportation services and at the same time a shortage of natural resources, the use of environmental decision support systems (EDSS) can provide a valuable solution for this conflict of objectives. There is a simple substitutionality between the use of energy resources required for the fulfillment of transportation tasks and the use of energy consuming information technology (IT): The intelligent application of IT-based EDSS is able to significantly reduce the energy consumption for transportation tasks, e.g. by reducing the length of a delivery tour using a route planning system. In analogy to the postulate of Watson et al. [1] claiming that: Energy + Information < Energy, one could say that it is possible to replace ‘ton-kilometers’¹ by ‘bit-kilometers’ while using knowledge in the domain of information logistics to reduce energy consumption in the domain of transportation logistics. This is also reflected by the fact that IT-infrastructure accounts for around 2% of the global CO₂ emissions compared with a 23% emission share contributed by the transportation sector [2]. In Germany, road transportation contributed about 6% of nationwide CO₂ emissions in 2003 [3]. With the substitution of ton-kilometers by bit-kilometers a little energetic effort in the IT domain causes huge energy savings in the transportation domain. Such an IT infrastructure can be seen as ‘Green IT’ in the broader sense.

¹The metric bit-kilometers leans on the real world logistics metrics: weight of the load in tons multiplied with the distance of the transport in kilometers.

One of the most promising approaches towards sustainable logistics with low CO₂ emissions is to promote collaboration in the transportation industry [4], [5]. 35% empty haulage in EU’s transportation business in 2006 shows the huge optimization potential that remains unused in the current situation. A mediator for a collaboration between actors in the logistics sector could be a transportation exchange or in a wider sense electronic transportation marketplaces (ETMs) [6]. ETMs are electronic platforms that enable the matchmaking and contracting between shippers (customers of the transportation service), carriers (performing contractors hired by the transportation service suppliers), and freight forwarders (transportation service suppliers) in order to trade logistics services. For this reason, ETMs mostly support the matchmaking between transportation services requested by the shippers and transportation capacity offered by the carriers.

Classical (non-electronic) transportation exchanges already exist since the 1980’s, however, even their electronic counterparts in ETMs did not reach a significant impact in the transportation sector yet. Although the advantages and disadvantages of ETMs have already been discussed in literature [7], [8] no recommendations for improvements have been given. For this reason, we formulate some IS-related research questions derived from our core questions ‘How can Green-IS help to promote sustainable logistics?’ (see section III-A). As a base for an answer to these questions, we present the results of a survey on German ETMs that has been performed in 2009 in order to analyze their business models. Based on the results of this survey, we subsume desirable properties of future ETMs, propose technical enhancement of advanced ETMs and present a process model and an IT-architecture of an EDSS-based ETM that helps to provide a sustainable transportation business.

The remainder of this paper is organized as follows: In the first part of the paper we elaborate a detailed definition of ETMs including their scope, mode of operation, properties, assets and drawbacks. Second, we present the results of the short survey we performed on the German market and the comparison of them with the current ETMs. Finally, we present recommendations for increasing the basic and extended functionalities of ETMs in the sense of EDSS.

II. ELECTRONIC TRANSPORTATION MARKETPLACES

Since there is a broad spectrum of electronic market characterizations we give a definition of advanced ETMs at the beginning of this section. Additionally, we define the scope
of ETMs and provide an overview of their characteristic properties. The section concludes with a literature overview on ETMs providing a juxtaposition of their shortcomings and their advantages.

A. Definition of ETMs

Bakos [9] was one of the first to analyze electronic markets. He defined electronic markets as an ‘inter-organizational system that allows the participating buyers and sellers to exchange information about price and product offerings’. McAfee and McMillan [10] extend this definition by adding ‘features of administrative decision making with market pricing’. Schmid and Lindemann [11] characterize electronic markets as platforms which enable the market-based exchange of goods and services between buyers and sellers within the transaction process, consisting of information, trading, and settling phase, depicted in Fig. 1.

In the case of electronic transportation markets sellers usually offer load capacity to buyers that bid for the transportation of goods from point A to B. Additionally, ETMs can also provide value-added services which are not directly subject of the classical information and trading phase. These services, however, support the operations in the settlement phase. Such a value-added service can be a route planning module that helps market participants to organize their routes. In order to reduce inefficiencies in this two step process, it is often valuable to integrate the combinatorial route optimization process directly into the information and trading process. One way to do this is to use combinatorial auctions for the trading of transportation services [12], [13], [14], [15], [16]. The integration of collaborative route planning into the trading process of ETMs is able to reduce the ton-kilometers driven by the service providers by at least 10% [17]. An ETM that integrates value-added services like tour planning to reduce the CO2 emissions can therefore be considered as a kind of EDSS.

Starting from the work of Gudmundsson, Sänger and Wang [18], [8], [19], we provide a definition of advanced ETMs:

**ETMs are electronic platforms that enable the matching and contracting between shippers, carriers, and freight forwarders in order to trade logistics services. Moreover, advanced ETMs provide value-added service functionalities which support the business process of the market participants and help to reduce the environmental impact of transportation.**

B. Scope and operating mode of ETMs

ETMs are expected to change the interaction between parties in the logistics service industry. Traditionally these parties are shippers, carriers, and freight forwarders. They can interact in two different ways (Fig. 2 up):

- Shipper and carrier negotiate and contract directly on the fulfillment of the transportation task,
- Shipper negotiates and contracts with a freight forwarder. The freight forwarder commissions the transportation task to a carrier which accomplishes the task on behalf of the freight forwarder.

The latter way of contracting is the most common in the German market, due to the fact that freight forwarders ensure a specific service quality and the shipper is able to outsource its transportation risk.

ETMs act as intermediaries between shippers, carriers, and freight forwarders, supporting the exchange of logistics services (see Fig. 2 down). However, most ETMs are still simple information blackboards, where shippers offer transportation loads and carriers their available capacity. Freight forwarders search for offered loads, which they contract to their own carriers. In the same way, the platform allows the freight forwarder to search for free capacity to transport contracted loads. Future ETMs might integrate services offered by freight forwarders, act as virtual freight forwarders, and replace the original kind.

C. Classification of ETMs

The German ETM market is quite heterogeneous. In order to understand the structure of current ETMs, we provide a classification according to the following characteristics:

- **Marketplace Operators**
  - There are three different types of marketplace operators: a third party, a group of sellers, or a group of buyers. In seller or buyer operated marketplaces, the operator participates in the business process, hence he focuses on his self-interest. By contrast, neutral marketplaces are operated by a third party and have no specific intentions. Neutral market places provide an equally attractive business environment for all users [20], [21].
• **Market Focus**
Like in other electronic market domains, ETMs are divided into two groups: horizontal (universal) and vertical (specific) marketplaces. The latter serve specific industries, such as the chemical sector or the food industry. Those marketplaces have to be tailored to the industry’s characteristic in order to satisfy their specific transaction requirements [22]. A very specific specialization is a focus on the courier, express and parcel delivery sector (CEP) [23]. By contrast, horizontal marketplaces facilitate the transaction process of a range of industries [24].

• **Transaction Support**
ETMs can be distinguished in terms of the extent of the transaction process supported. The three different transaction phases are the information, trading and settlement phases [11] (see Fig. 1). In the information phase, participants acquire a market overview of other participants, available loads and capacity and value-added services. It ends with the submission of an offer by a participant. Within the trading phase offers are matched and terms of the contract are negotiated. In the following settlement phase, contracts are fulfilled [20], [11]. Current ETMs do not offer e-fulfillment, i.e. support of the whole transaction process. They mainly focus on the information phase, acting as simple blackboard systems [24]. We focus on four aspects of the transaction support: payment guaranties provided for the transactions of the market participants (realized by insurance companies), matching agents that help participants finding the right deal, negotiations integrated directly into the platform, and value-added services making the platform more attractive.

• **Pricing Mechanism**
ETMs use dynamic or static pricing mechanisms [17]. The latter, known as catalogs, are not an actual pricing mechanism, due to the fact that all product and pricing information are visible and fixed. Dynamic pricing mechanisms are interactive bidding processes, such as auctions or exchanges [20]. Current ETMs do not support any pricing mechanisms even though market pricing would be already useful in the information phase.

• **Market Accessibility**
There are closed and open accessible ETMs [11]. The latter allow access to all users after a registration and certification process. Closed systems are only available for a particular group of users. Interested parties have to apply for membership or be invited to join. As a consequence, industry specific user groups evolve with the intention of setting up long term contracts between the participants [19]. The advantages of these platforms are increased security resulting from a higher degree of information sharing between participants [20].

• **Term Structure**
Users of ETMs can either engage in long or short term sourcing. In short term sourcing, companies try to fulfill their immediate needs on a spot market. Long term sourcing involves procurement auctions that end up in the negotiation of frame contracts, which leads to close relationship between buyers and sellers [25]. The most advanced ETM platform currently known offer such procurement functionalities.

• **Traded Services**
Two different types of services are traded at ETMs. Shippers post loads needing transport, and carriers empty capacity. Freight forwarders offer both [8]. While the first two types of ETMs are examples for single sided markets and can therefore be considered as auctions, the latter one is a classical exchange.

• **Revenue Model**
ETMs use a transaction based or fixed fee revenue model. Fixed fee revenues are one-time subscription fees or periodical payments (somewhat like a flat rate). Transaction based costs depend on the value of closed contracts. In both cases, enrollment fees can additionally be charged [21]. Offering free memberships to a group of users is a possible way of increasing the liquidity of the ETMs making them more attractive [18].

D. **Advantages and Shortcomings**
As already mentioned ETMs could provide a significant contribution to sustainable logistics [3]. However the success of ETMs is still limited [7]. In order to find the reasons for this lack of success we juxtapose the most important advantages with the shortcomings of ETMs.

• The main advantage of an ETM is the fact that a well organized electronic market promises a higher overall operational efficiency for all participants and thus higher returns. In detail, participants have faster and easier access to a large customer/supplier base and for this reasons more business opportunities. ETMs simplify information sharing and procurement processes resulting in time and cost savings for the required administration of the business processes [26], [27]. Value-added services integrated into advanced ETMs, such as route planning services, would further increase the usability.

• An important shortcoming of current ETMs is that they mostly provide decision support only in the information phase. The important trading and settlement phases is not supported yet. Another problem is that ETMs, like other electronic markets, might be perceived as threat to traditional enterprises, especially for the freight forwarders, whose business model is challenged by electronic intermediation. In the conservative environment of logistics industry in Germany this leads to a relatively low liquidity because of weak participation, which itself reduces the attractiveness of ETMs. Transparency of prices might also be feared by the participants of traditional logistic structures due to competitive reasons. Another downside of ETMs might result from the lack of knowledge about the reputation of ETMs’ participants and missing approved security standards. This does not only include data security but also the financial solidity of the business partner [19].
III. A survey of ETMs in Germany

In the literature, there is no actual state-of-the-art survey of ETMs in the European region. For this reason we provide a short survey of current ETMs in Germany in order to identify the reasons for their limited success in the last decade. Additionally, we try to identify promising tendencies of development in current ETMs.

A. Research Approach

1) Literature background: In classical IS literature there was little work on the sustainability issue in the last decade [1]. Most work in the direction of IS supported sustainability management has been published in operations research (OR) journals. Now, the focus changed and sustainability management is in the center of innovative IS research [1]. Watson et al. [28] introduce an ‘Energy Informatics Framework’ that should help fostering environmentally sustainable development by the use of IS. Successful sustainability management by means of information systems lies at the border of management science, policy formation, IS and design science [29].

2) Research method: In this work we concentrate on the design science aspect that has been introduced into IS research methodology by Hevner et al. [29] and combine it with elements of policy formation. To guarantee the relevance of our approach, we analyze the state-of-the-art of seven major players in the German ETM in an empirical study. Quantitative and qualitative data is collected following the criteria elaborated from ETM classification given above (see section II-C) and following strength and weakness analysis (see section II-D). Data collection was accomplished by using information from companies’ websites and published reports. In addition, we have conducted structured interviews with managers from those companies. The results of this survey are used to span a strategic position matrix (SPM) describing the market position of the ETMs that are currently active in Germany. Following the research questions that will be illuminated in the next section, measures will be proposed to increase the attractiveness of ETMs. These measures include a proposal for the implementation of a decision support system for advanced ETMs that should foster the sustainable development of the transportation market. A prototype of this EDSS artifact will be implemented and iteratively improved in a design evaluation process that is close to that proposed by Hevner [29]. The rigor of the approach should be guaranteed by an extensive collection of experimental data in well defined settings. After having analyzed the supply side of the ETM domain, we will have a look at the demand side in the near future. A broader survey on the logistics services companies and their customers will be conducted. This survey is future work and is therefore not subject of this article, however, results of this survey will also have impact on the design of the EDSS proposed.

3) Research questions: Following the criteria elaborated in section II-C and strength and weakness analysis in section II-D we decompose the general research question ‘How can Green-IS help to promote sustainable logistics?’ into the following subquestions:

1) How can the introduction of design artifacts like the proposed DSS help to promote sustainable logistics
   • by increasing the perceived ease of use and utility for the participants of ETMs?
   • by reducing the hurdles for the participation in ETMs?

2) How can organizational measures help to promote sustainable logistics by fostering collaboration in ETMs
   • exogenously?
   • endogenously?

The first research question is influenced by the work of Davis and Subramani [30], [31] whereas the second question has a focus on game theoretical considerations [5], [16]. The second research question is not treated directly in this article.

B. Results

Tab. I shows the results of the survey. The first four categories provide some basic information on the companies regarded in this survey. The survey is structured according to the classification scheme that is characterized in the preceding section.

![Fig. 3. Strategic Position Matrix of the ETMs](image-url)

In order to analyze the data, we introduce the strategic position matrix which indicates the relative position of the ETMs within the market landscape and reveals their competitive value proposition. The SPM of the ETMs in the study is depicted in Fig. 3. The current state of the ETM is described by its functionality level on the x-axis and the competitive value proposition is denoted by the innovation level given on the y-axis. The size of the bubbles representing the platforms...
visualizes the number of users of the ETM service or estimates website traffic associated with the site.

The **functionality level** is measured by the availability of certain features that support the transaction process of the users. The features observed are:

- Availability of payment guarantees
- Availability of an matching agent
- Integration of negotiation support
- # of services traded in the ETM

We chose these features based on the results of our literature review on current ETMs, showing that a lack of support of the transaction process is one of the most severe shortcomings. An ETM is given a functionality level score of one if all listed features are offered.

The **innovation level** is represented by the number of value-added services offered. They give an idea of the business activity and innovation efforts of an ETM. The number of value-added services offered can also be seen as an indicator for the *ease of use and utility* perceived by the users of the ETMs. We identified altogether ten different value-added services that are listed and explained in Tab. II. To compare the number of value-added services from the different ETMs, the total number is normalized in the matrix with respect to the number of services offered by Transporeon, since it offers the most value-added services with a total number of six.

Jointly analyzing the SPM (Fig. 3) and the data collected from the ETMs (Tab. I), we draw the following conclusions:

In the case of Transporeon, its position in the competitive landscape correlates well with its actual success. In fact, it is one of the leading European ETMs. Although the platform has only been operating for ten years, it has collected a sufficient customer base and is continuously expanding its operations, with an increase in revenue of 44% between 2007 and 2008 [32]. The remaining ETMs are situated in the center of the matrix. They show medium innovation efforts and functionality. Among them are Wtransnet, Box24, and Cargoclix, which have been in the ETM business since the 1990s, but still have less than 20,000 users. Wtransnet, Box24 and Cargoclix show a differentiation strategy. Wtransnet has its focus on operations in Spain and Portugal with few competitors present in this market. In contrast to the Wtransnet platform, which does not offer any pricing information for the users, Box24 and Cargoclix do offer dynamic pricing mechanisms. Notably, Teleroute shows a lower functionality level than Transporeon, despite the fact that this company is one of the pioneers in ETM. As a result of our study, we indentify three major tendencies of development in the ETM domain: increasing popularity of tendering platforms, the development in the direction of specialized services, and the increased tendency to establish closed user groups. *Closed user groups* offer the advantages of ETMs while avoiding the shortcomings deriving from the anonymity phenomenon on the Internet, such as a lack of trust and reputation. Participants know each other within closed user groups and new members have to be invited or ask to be accepted for entry. As a consequence, services which go beyond simple postings are included and increase the attractiveness of ETMs [6]. A second tendency we identified for current ETMs is the focus on *special types of transportation services*, for example on the courier services domain. These platforms provide functionalities that are more suited to their customers and also increase their attractiveness for users. Additionally, it can be seen from our study that *procurement platforms* have become increasingly popular in ETMs. The procurement platforms are used as a way to trade long term contracts. One reason for this might be the fact that the transaction of long term contracts via ETMs leads to stronger involvement on the part of the participants and a resulting increase in customer loyalty.

According to our survey, the most important shortcomings of ETMs that can be seen as major hurdles for the participation in current transportation markets are the following:

- Limited support of the transaction process: pricing mechanisms in particular are neglected which would help to facilitate the trading and transaction process in ETMs.
- Low number of value-added services, despite the fact that value-added services could increase customer loyalty.

### TABLE I  
**CHARACTERISTICS OF SEVEN MAJOR PLAYERS IN THE GERMAN ETM**

<table>
<thead>
<tr>
<th>Cooperation</th>
<th>Transporeon</th>
<th>Timocom</th>
<th>Teleroute</th>
<th>Wtransnet</th>
<th>Box24</th>
<th>Trans.eu</th>
<th>Cargoclix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of employees</td>
<td>130</td>
<td>250</td>
<td>200</td>
<td>110</td>
<td>10</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>Number of users</td>
<td>45000</td>
<td>75000</td>
<td>70000</td>
<td>80000</td>
<td>20000</td>
<td>120000</td>
<td>17000</td>
</tr>
<tr>
<td>Marketplace operator</td>
<td>neutral</td>
<td>neutral</td>
<td>neutral</td>
<td>neutral</td>
<td>neutral</td>
<td>neutral</td>
<td>neutral</td>
</tr>
<tr>
<td>Market focus</td>
<td>universal</td>
<td>universal</td>
<td>universal</td>
<td>universal</td>
<td>universal</td>
<td>universal</td>
<td>universal</td>
</tr>
<tr>
<td>Payment guarantees</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Matching agents</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Negotiation integration</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td># value-added services</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Pricing mechanism</td>
<td>auction</td>
<td>catalog</td>
<td>catalog</td>
<td>catalog</td>
<td>auction</td>
<td>catalog</td>
<td>auction</td>
</tr>
<tr>
<td>Market accessibility</td>
<td>open+closed</td>
<td>open</td>
<td>open</td>
<td>open</td>
<td>open</td>
<td>open</td>
<td>open</td>
</tr>
<tr>
<td>Term structure</td>
<td>short+long</td>
<td>short</td>
<td>short</td>
<td>short</td>
<td>short</td>
<td>short</td>
<td>short</td>
</tr>
<tr>
<td>Traded services</td>
<td>load</td>
<td>load+capacity</td>
<td>load+capacity</td>
<td>load+capacity</td>
<td>load+capacity</td>
<td>load+capacity</td>
<td>load+capacity</td>
</tr>
<tr>
<td>Revenue model</td>
<td>transaction</td>
<td>fixed</td>
<td>transaction</td>
<td>fixed</td>
<td>-</td>
<td>fixed transaction</td>
<td>fixed transaction</td>
</tr>
<tr>
<td>Free membership</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>shippers</td>
<td>no</td>
</tr>
</tbody>
</table>
A. Promoting Sustainable Logistics by Advanced ETMs

The survey shows that most current ETMs are simple blackboards, offering little functionality. In order to change this, we propose a two-step action plan. The goal of the first step is to provide basic marketplace functionalities to facilitate transactions and interactions between the participants. Those basic functionalities are seen in other B2B electronic marketplaces; however, they have not been broadly implemented into ETMs. The reasons for this lack could be the small market size identified above and the complexity of the services traded. In the second step, we propose extended functionalities to increase unique selling propositions and thus the attractiveness of the ETM. We recommend an elaborated CRM model and value-added-services. The goal of these measures is to achieve higher liquidity and positive network effects.

In order to fulfill step number one of the action plan, basic marketplace functionalities have to be provided. We propose four measures:

- Increased standardization
- Enhanced transparency
- Improved security
- Integrated transaction process management

Standardization means data and service standardization. The latter focuses on communication and data exchange standardization. ETMs need standardized IT-interfaces to enhance compatibility, interoperability and repeatability between the user and the ETM. This leads to time reductions in the users’ procurement process. Service standardization affects the product offering, contracts and documentation. In order to achieve data standardization, ETMs have to provide, for example, checklists, standard contracts and terms of business for their users. The positive effects of those standard forms are improved transaction processes and facilitated monitoring and complaint management.

Transparency can be increased by offering consistent product, user and pricing information. All information, in accordance with the owner, is saved and reported by the ETM and released to the parties concerned. With secure and consistent presentation of the relevant information (product, customer, price), trust is built.

Another measure to increase trust is security. Enhancing security requires a stable Internet platform and data encryption. Users need to be sure that there is no unauthorized use of their information. The increasing number of closed user groups in ETMs is an indicator of the need of security. Finally integrated transaction process management should be provided, in order to maximize the users’ benefit.

In the second step of the action plan, extended functions should be integrated into the ETMs. We focus on CRM and value-added services. In network industries, like the transportation market, a good CRM is essential, due to observed lock-in and positive network effects. CRM implies identifying and targeting the best customers, providing a consistent customer approach, including hotlines and other contact forms. It attempts to increase customer satisfaction and involvement.

Consequently, ETMs suffer from low liquidity, because they do not reach a critical mass of users. The ETMs with the best position in the SPM feature a set of measures that is capable to improve their position. These measures can be regarded as critical factors that are able to reduce the hurdles for the participation in ETMs in the sense of research question 1.2. They should be integrated into the design considerations of future ETMs:

- Reduction of distrust and fear by introducing a security and reputation management
- Offering of value-added services in order to integrate enhanced functionality into ETMs
- Increasing customer loyalty by means of customer relationship management (CRM) methods
- Enhanced transparency
- Increased standardization
- Integrated transaction process management

The full implementation of these factors should bring a rise in attractiveness for ETMs and thus a more successful business model.

IV. SUSTAINABLE ENVIRONMENTAL DECISION SUPPORT SYSTEMS FOR ADVANCED ETMs

To achieve a successful business model for ETMs and green logistics management by the participants, the design of ETMs has to be changed. The above-mentioned shortcomings have to be overcome using the success factors identified. In a first step, we therefore propose some measures concerning the design of ETMs which should lead to more successful e-fulfillment systems based on Green-IS. In a second step, we sketch an integrated EDSS for ETMs based on combinatorial route optimization.

<table>
<thead>
<tr>
<th>Shipment tracing</th>
<th>Status of shipment is available to shippers and freight forwarders. The status is reported to the ETM by the carrier via his onboard unit or phone.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time slot management</td>
<td>Reduces the waiting time in the loading and unloading process, by providing detailed site information and scheduling features.</td>
</tr>
<tr>
<td>Statistics</td>
<td>A software program to evaluate key figures such as figures for order placement criteria, length of time involved in placing orders, or up to-date carrier prices.</td>
</tr>
<tr>
<td>Route planer</td>
<td>Determines travel times, distances, tolls and displays routes and maps.</td>
</tr>
<tr>
<td>Company directory</td>
<td>A directory for participants, where they post their own company information, look up other companies, and quickly find details of bookmarked contacts.</td>
</tr>
<tr>
<td>Consulting</td>
<td>Provides help in implementing ETM in the course of business.</td>
</tr>
<tr>
<td>Debt collection</td>
<td>Guarantees payment of invoices.</td>
</tr>
<tr>
<td>IT security</td>
<td>A high-security IT environment is provided, in which all payment transactions and communications are encrypted and password-protected without compromising user’s experience and speed.</td>
</tr>
<tr>
<td>Storage exchange</td>
<td>Supports search and offer of storage.</td>
</tr>
<tr>
<td>Debt mediation</td>
<td>Helps facilitate the collection of overdue invoices but does not guarantee payment.</td>
</tr>
</tbody>
</table>

TABLE II

LIST AND DESCRIPTION OF VALUE-ADDED SERVICES
The latter can be achieved in particular by providing incentives, such as discounts and beneficial long-term membership programs.

Finally, the introduction of various value-added services might increase the attractiveness of ETMs. In this context, innovative value-added services are a unique selling proposition, which can help to attract new participants. This might be integrated extra services such as integrated route planning, tracking-and-tracing functionalities, and route pricing functions including toll calculation. Another interesting feature is a fleet management function including a map that shows the current position and destination of the trucks of the actual ETM user and locations of potential additional transportation service contracts that could be integrated into the current route of the user’s truck. At the end, there is an integrated route planning process that looks for suitable transportation tasks and integrates them in a proposed tour for the carriers. Based on this idea, we sketch an EDSS for advanced ETMs in the following.

B. Environmental Decision Support for Advanced ETMs

The highest synergies in collaborative transportation planning using ETMs can be reached by using combinatorial optimization strategies. As mentioned above combinatorial auctions are a suitable instrument to achieve the integration of the exchange of transportation tasks and route planning [16].

Fig. 4 shows the process of environmental decision support for advanced ETMs.

![Diagram of Environmental Decision Support Process](image)

- In a first step, shippers and carriers provide their preliminary transportation plans and open delivery tasks. Based on this information, potential in- and outsourcing candidates are identified. This is done by calculating suitable ask and bid prices for route sections that do not fit in the current route planning of the ETM participants.

In order to price the in- and outsourcing candidates the cost of a tour is calculated including and excluding the candidates. The difference is the value of the candidate point (differential cost pricing).

- In a second step the decision system is looking for suitable combination of transportation tasks with respect to delivery and time constraints of other existing preliminary transportation plans. This implies the clustering delivery points.

- The main step of the transportation decision support process is the matchmaking by exchanging these bundles via a combinatorial auction mechanism [16] or alternatively by using a tour re-construction mechanism e.g. via a prize-collecting vehicle routing system.

- A crucial question in the EDSS process is how to partition the resulting surplus fairly, such that all participants have the incentive to stick to the exchange mechanism in the future. This problem has not been resolved yet, but there should be an IT-based solution for it in connection with an advanced game theoretic distribution mechanism. Research question 2 of section III-A.3 is strongly associated with this part of the EDSS.

- In the last step the resulting routing is determined by the EDSS based on the new transportation task allocation. The new allocation has to be acknowledged by the affected market participants before.

The EDSS and the action plan proposed here should lead to high and essential liquidity. ETMs currently suffer from low liquidity and have not reached the critical mass to fully exploit positive network effects. However, only with a sufficient choice of partners and posted offers, ETMs can provide advantages such as increased business opportunities and better performance for the user, resulting in green logistics management.

V. CONCLUSION

Green IS can help to promote innovation in the logistics market, which is still facing high inefficiencies, such as empty haulage. Intelligent IS solutions are able to reduce kilometers driven by optimizing route planning and supporting collaboration among competitors. In this context, ETMs are one of the most promising inter-organizational information systems aimed at achieving the goal of green logistics management. However, in spite of their positive prospects, ETMs have not shown the expected success yet. In this paper, we provide a literature review and a survey of the success factors and shortcomings of ETMs. We identify the lack of e-fulfillment and the customers’ lack of trust as the major problems. Current ETMs only operate as simple information blackboards and do not offer the advantages of a fully integrated platform. The benefits of ETMs are not fully exploited and platforms are not able to achieve the critical mass of users needed to operate efficiently. In order to achieve e-fulfillment and

2Due to its complexity this question is important enough to build the foundation of a own research thread.
sustainable business operations, we propose a two step action. In the first step, we recommend to provide basic marketplace functionalities, as seen in other B2B marketplaces. In a second step, the integration of an elaborated CRM and some value-added services are proposed to increase attractiveness. These functionalities should be integrated in the ETMs by designing an EDSS which has then to be tested in experimental environments. From the theoretical point of view, our research can generally help to better understand how IS-based collaboration mechanisms can be made more attractive to the users in environments where the participants are not open to innovations due to strong competition and latent distrust. In this context, further extended services for ETMs have to be developed and tested empirically in real-world environments. However, their integration into current ETMs only makes sense if the users’ perception of the ease of use of current ETM-EDSS increases significantly and the distrust concerning the new technologies’ risk diminishes.

REFERENCES