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A Simulation Study of the Electronic Waybill Service

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Abstract—We present results from a simulation study, which was designed for investigating the potential positive impacts, i.e., the invoicing and processing time, and financial savings, when using an electronic waybill instead of paper waybills for road-based freight transportation. The simulation model is implemented in an experiment for three different scenarios, where the processing time for waybills at the freight loading and unloading locations in a particular scenario differs from other scenarios. The results indicate that a saving of 65%–99% in the invoicing time can be achieved when using an electronic waybill instead of paper waybills. Our study can be helpful to decision makers, e.g., managers and staff dealing with paper waybills, to estimate the potential benefits when making decisions concerning the implementation of an electronic waybill solution for replacing paper waybills.

Keywords–waybill; simulation; invoicing time; freight transportation;

I. INTRODUCTION

In this paper, our aim is to design and perform a simulation experiment for investigating the impact on process time for a potential electronic waybill (e-Waybill) application compared to a paper waybill as mostly used today. Different processes that occur during freight transport, such as verification and validation of freight's status, or handover of responsibility, utilize different lengths of time depending on several factors, such as resource availability, load level (e.g., queue or no queue), type of network and products. The waybill is at the center of some of these processes and weather they are handled electronically or physically with pen and paper could have an impact on the resources utilization, in particular the time taken by the different processes for completion. One way to understand how resources are utilized is by simulating the different processes. An e-Waybill is an electronic version of the paper waybill, which can be used for different purposes during and after the transport, e.g., a receiver signed waybill may also be used by the transport company as a proof that the order has been completed successfully. In an earlier study [1], five different e-Waybill solutions were proposed. The solutions differ in where the e-Waybill information can be stored and updated. It was found that the e-Waybill solution where the information is stored, read, and updated both the back-office and in the vehicle can support greater number of intelligent transport systems (ITS) services when compared to the other e-Waybill solutions [1]. Therefore, in this paper, our focus is on the particular e-Waybill solution where both the copies of the e-Waybill, i.e., at the back-office and in the vehicle, are synchronized and hence a change in the e-Waybill at the back-office will be visible at the vehicle and vice versa.

A simulation experiment, if properly designed, is a cost-effective way of testing a model of the real world without losing too many details of the real world object under investigation. It should be noted here that, for the rest of this paper, we use the term waybill to represent both electronic and paper waybills. However, in certain situations, we use the terms paper waybill and e-Waybill whenever the focus is on those particular types of waybills. In particular, we use modeling and simulation to investigate:

- The processing time taken by a waybill at different nodes (processing time)
- The total time taken by a receiver signed waybill to reach back the transport company (i.e., invoicing time)

The focus of our model is on the waybill-centric processes that occur at the Transport Service Provider (TSP), and at the freight loading and unloading locations, which we refer to as nodes. In particular, our focus is on the waybill creation process at the TSP facility, and the waybill processing at different loading and unloading nodes. Traditionally, the waybill processing at nodes include the time taken to transfer a waybill from one actor to another, checking the waybill for any inconsistency, verifying that the freight and its conditions are similar to the specifications mentioned in the corresponding waybill, and updating the waybill, e.g., signature or comments.

The remainder of the article is organized as follows. In Section II, we describe related work similar to our study. Next, In Section III, we discuss the important steps in a real world transportation process. Based on Section III, we present our simulation model in Section IV. In the next Section, i.e., Section V, we implement our simulation model in an experiment involving a road network used by a medium-sized Swedish transportation company. Next, in Section VI, we present analysis of the results from our experiment. Finally, in Section VII, we summarize our main

conclusions and highlight directions for future research.

II. RELATED WORKS

In the literature, there are several studies that investigate the effects of information sharing in the supply chain; see, [2], [3], [8], [13], for overviews. There also exist studies whose focus is on assessing the benefits of using e-Waybill solution in place of paper waybills. In a study [9], it is found that a savings of $125 per document-set can be achieved when using electronic bill of ladings (eBoL) instead of a paper based bill of lading (BoL), which is a type of waybill [9]. The study [9] found that different problems related to the use of BoLs are: delays in information gathering, typing errors, excessive paperwork, increased waiting time for authorization, high turnaround time, cost, and fraud factors. Additionally, the study found that the key benefits concerning eBOLs are: quick documentation processes, better management of information, and postal savings.

In another study [4], the effects of using different technologies for information flow (including creation and exchange of BoLs) in a retail supply chain are assessed. It is found that, using RFID (Radio-Frequency Identification) and EPC (Electronic Product Code) network, a saving of 355 seconds in process time can be achieved in different processes, such as data entry, generating document, and verifying data, performed on a BoL [4]. The study that is most closely related to our work is [10]. In this study, the authors perform a simulation experiment for two scenarios; one for paper documents, and one using electronic documents in a supply chain. The study [10] is aimed at identifying the value of e-commerce technologies in the supply chain. It is found that electronic documents reduces the transaction costs as it reduces the time required to create and obtain such documents as compared to paper documents. Additionally, the study has shown that, for a total of 103 documents in a supply chain, the electronic documents are 39% less expensive than the paper documents [10].

The main difference between the focus of this paper and the related research discussed above is that none of the studies focus specifically on e-Waybill solutions for road transport. The study [10] focuses on all the documents (103 in total) that are used in a typical shipment. Further, the study focuses on maritime transport comprising of almost all the actors involved with handling the 103 shipment documents. We design and perform a simulation experiment to assess the resource utilization when using an e-Waybill instead of the traditional paper waybills in a road transport scenario. We believe that the results from our study will provide an evidence of the time saving effects when using an e-Waybill, which is currently missing in the existing studies on e-Waybill solutions for road transportation.

III. REAL WORLD PROCESS

In executing a freight transport service, several interdependent activities need to be coordinated in order to maximize the efficiency of the service. Such activities are proceeded by; instantiation activities that are initiated by orders arrival, which are then followed by control and assurance activities that are aimed at managing the chain of control and responsibility assuring the transport operations and a feedback loop reaffirming the results of various undertakings.

Initialization-In most transport companies, when an order arrive, via email, phone, fax, word of mouth or other communication facilities, the following activities are performed.

1) The consignor may contact one or more transport service providers (TSPs) to negotiate the terms (usually the price) of the transport service and the type of services needed, e.g., origin, destination, lot size and so on.

2) Once an agreement between the consignor and a TSP is reached, a waybill (with 4 copies) is created by the TSP. The waybill has essential information about the consignment, such as freight specifications, origin, and destination.

Control and assurance:

3) Three copies of the waybill are then forwarded to a transport planner (TP), who maintains a record of all the trucks and the drivers, and one copy is transferred to the concerned department (usually a record keeping department). At this point, the waybill is ready to be assigned to a truck.

4) A truck may be assigned multiple waybills (i.e., a batch of waybills) by the TP for different reasons, e.g., the freight volume and weight may be low and there might be multiple consignee or consignors on the route that is to be traveled by the particular truck. A single waybill consist of three identical copies, i.e., one copy each for the driver, consignor, and the consignee. In the rest of this paper, we refer to this step as the batching process.

5) The truck (after the batch has been assigned to it) travels on a particular route, which consists of all the freight loading and unloading locations (nodes) specified in assigned waybills.

6) At the freight loading node (i.e., the consignor facility), the driver reports to the gate. Clearance operations, such as drivers license, vehicle id and type, are performed and copies of the waybill are transferred to a representative of the consignor.

7) The representative may inspect waybill information and the driver may inspect the freight. Once inspections are over, the freight is loaded and all the copies

of the waybill are signed by the representative. The driver may enter additional remarks to the waybill, e.g., on the physical condition of the freight. A copy of the waybill is left to the representative and the driver drives to the next loading or unloading location.

8) The driver follows instructions from the back-office for the next nearest location to visit. In case of no instructions from the back-office, we assume that the driver checks the waybills for the next nearest location to visit. If the next location is a loading point then step 6 is repeated, otherwise step 9 is performed.

9) On reaching a consignee location (i.e., unloading node), different checks, such as driver id, license, vehicle id and type, are performed and copies of the waybill are transferred to a representative of the consignee. The freight is unloaded and checked against the waybill by the representative. All the copies of the waybill are signed and any remarks may be written on it. A copy of the waybill is left to the consignee and the driver drives to the next loading or unloading location.

10) Steps 6-9 are repeated until the last order is completed by the truck. The driver then drives back to the TSP facility, i.e., the TSP node, along with the signed waybills for the completed orders.

Feedback and confirmation:

11) Upon reaching the TSP node, the signed waybills are handed over to the concerned department (usually the invoicing department).

12) The invoicing department sends a copy of the consignee signed waybill to the consignor via fax, email, or post in order to claim payment for the transport services.

13) Upon receiving of the payment, the order is considered to be completed.

IV. The Model

In order to design a simulation model reflecting the scenario described above, the main activities relevant to a waybill have been considered thus; the initialization, control and assurance, and the feedback and confirmation components. In order to simulate the processes affecting waybill related operations in the identified components, different simulation entities have been considered: 1) the waybill itself shall be treated as a meta-entity on which several operations can be performed, such as *create*, and *update*. These entities are updated at different nodes, i.e., their values changes depending on the current node; 2) resources for processing waybill are also considered as important entities in the simulation since it is important in this study to generate information about time utilization for both e-Waybill and paper waybill.

The activities that are considered in our model are focused on the operations that can be performed on a waybill. These include: creation, batching, and assigning of a waybill at the TSP location, and the processing of the waybill at the freight loading and unloading locations. It should be noted that these activities are performed on a waybill by the resource. Upon completion of an activity, an event is generated, which changes the state of the system. The events are based on the activities, e.g., upon successful completion of the waybill creation activity, an event is generated to initiate the batching activity. In our model, the events are: waybill created, waybill batched, waybill assigned, and waybill reached loading location, waybill reached unloading location, and waybill reached TSP. In Table I, we present the notations that we have used in our simulation model, which we illustrate using Algorithm 1.

TABLE I
PROCESSES AND NOTATIONS IN OUR MODEL.

Notations	Description
n	Total number of waybills/orders
$i \in O = \{1, 2, 3...n\}$	A set of orders arriving at the TSP
$j \in W = \{1, 2, 3...n\}$	A set of waybills
k	No. of nodes
W_{ij}	Represents a waybill j for each corresponding order i, $\forall\ i \in O, j \in W\ W_{ij} = 1$ otherwise 0
B	Represents a batch of waybills
BT	Time taken to create a batch of waybills
M	Maximum number of waybills in a batch
Q	Waybill waiting time in queue
R	Represents staff (resources) for processing waybills
S	Waybill processing time at TSP
$\hat{S}$	Waybill processing time at nodes
process(W_{ij})	A function to calculate processing and queue time of a waybill W_{ij} for $i \in O$ and $j \in W$
size(B)	A function to calculate no. of waybills in a batch
S(W_{ij})	Waybill service and queue time at TSP for $i \in O$ and $j \in W$
Ŝ(W_{ij})	Waybill service and queue time at nodes for $i \in O$ and $j \in W$
current(R)	Function to check status of Staff
TT(W_{ij})	Travel time of waybills, which is calculated by a function f(B) for $i \in O$ and $j \in W$
$\bar{T}(W_{ij})$	Travel time of electronic waybills (Equation 3) for $i \in O$ and $j \in W$
T(W_{ij})	Travel time of paper waybills (Equation 2) for $i \in O$ and $j \in W$
f(B)	Function to calculate travel time of waybills

For a waybill W_{ij}, the total processing time (PT) is a sum of the processing time at the TSP and the processing at the loading and unloading nodes. It can be represented as:

$$PT = S + Q + BT + \hat{S}(W_{ij}) \tag{1}$$

For the total travel time of a waybill, we assume that the nodes are statically located. Hence, the total travel time for a paper waybill consists of the travel time from node 1 to k and back to node 1. Therefore, the total travel time for a paper waybill can be represented as twice the travel time between node *1–k*.

Algorithm 1 Our Model.

```
1:  procedure WAYBILL (W)
2:      W_ij = 1 : i ∈ O ∧ j ∈ W
3:      size(B) = null
4:      process(Wij) = null : i ∈ O ∧ j ∈ W
5:      f(B) = null
6:      current(R) = false
7:      IT(Wij) = BT(Wij) = S(Wij) = 0 : i ∈ O ∧ j ∈ W
8:      Q(Wij) = Ŝ(Wij) = 0 : i ∈ O ∧ j ∈ W
9:      S = Q = 0
10:     for i ∈ O do
11:         while W_ij > 0 do    ∀j ∈ W
12:             Call ⇒ process(Wij)
13:             process(Wij)
14:             {
15:             if current(R) = false then
16:                 current(R) = true
17:                 S = τ(Wij)
18:                 Increment i
19:                 current(R) = false
20:                 Return S, Q
21:             else
22:                 if current(R) = true then
23:                     Q = τ(Wij)
24:                     GOTO 15
25:                 end if
26:             end if
27:             }
28:             S(Wij) = S + Q :    j ∈ W, i ∈ O
29:             BT = Σ_j W_ij :    i ∈ O
30:             if size(B) = M then
31:                 TT(Wij) = f(B)
32:                 Ŝ(Wij) = process(Wij)
33:             end if
34:             IT(Wij) = S(Wij) + Ŝ(Wij) + BT + TT(Wij)
35:         end while
36:     end for
37: end procedure
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$$T(W_{ij}) = 2 \times \sum_{l=1}^{k} T_l \tag{2}$$

In the case of e-Waybill, the total travel time will be the total travel time from node 1 to k without the factor of 2. This is because the e-Waybills are synchronized and a change of status to the e-Waybill at node k will result in updating the e-Waybill copy at the node 1.

$$\bar{T}(W_{ij}) = \sum_{l=1}^{k} T_l \tag{3}$$

The invoicing time for a waybill, i.e., $IT(W_{ij})$, is a sum of the total processing time at TSP, processing at different nodes, i.e., at freight loading, and freight unloading nodes, and the total travel time, which we calculate using Equation 2 in case of paper waybills and Equation 3 for e-Waybills. The total invoicing time for a paper waybill $IT(W_{ij})$ can be calculated using Equation 4, while for e-Waybill Equation 5 is used.

$$IT(W_{ij}) = S(W_{ij}) + \hat{S}(W_{ij}) + BT + T(W_{ij}) \tag{4}$$

$$\bar{IT}(W_{ij}) = S(W_{ij}) + \hat{S}(W_{ij}) + BT + \bar{T}(W_{ij}) \tag{5}$$

V. EXPERIMENT SETUP

We implemented our model using the *AnyLogic* simulation tool for a network of 12 nodes, which is served by a medium-sized Swedish transportation company. The travel time between every pair of nodes was provided as an input to the model. In the customer orders database of the company, we observed that for a period of 10 days a total of 170 orders arrived. These orders were transported using one truck on a daily basis. Therefore, in our simulation setup we assumed the maximum batch size to be 17, i.e., a batch comprises of 17 waybills.

In Table II, we summarize the above discussion and we present the parameters of our simulation experiment. We created three different scenarios based on different values of $\hat{S}$.

TABLE II
SIMULATION SETUP VALUES.

Parameters	Paper Waybill	e-Waybill	Applicable Scenario
nodes (k)	12	12	All
Simulation run-time	2160 hours	2160 hours	All
Inter-arrival rate	30 min	30 min	All
S	uniform discrete [6, 100] minutes	uniform discrete [0.083, 50] minutes	All
Ŝ	uniform discrete [30, 90] minutes	5 minutes	Scenario 1
Ŝ	uniform discrete [240, 2880] minutes	1 minute	Scenario 2
Ŝ	uniform discrete [1440, 4320] minutes	15 minutes	Scenario 3

In all of the three scenarios, for *S*, we used the time values for creating waybills based on the studies [4] and [7]. For the time needed to process the waybills at different nodes, i.e., $\hat{S}$, the time values are based on different studies. The values of $\hat{S}$ are based on [14] for scenario 1, and [12] for scenario 2 and 3. The study [12] suggest two different values for $\hat{S}$ due to which we consider both the values in two different scenarios. Furthermore, it should be noted here that for the customer orders, we used an inter-arrival rate of 30 minutes (i.e., the orders arrive in to the customer ordering database of the transport company after every 30 minutes). After a pilot run of the simulation experiment, we found that the there is an infinite increase in the queue size if the upper bound for *S* is set to be 170 minutes. We executed different iteration of the experiment for different values of *S* and found 100 minutes to be an appropriate value for the upper bound of *S*. Therefore, we used 100 minutes instead of 170 minutes for *S* in the case of paper waybills.

In our simulation setup, we know the minimum and maximum values for *S* and $\hat{S}$, but we have no knowledge about the likelihood of any value between the minimum and maximum. Therefore, for both *S* and $\hat{S}$, we used a discrete uniform distribution consisting of the maximum and minimum values presented in Table II. In the *AnyLogic* tool, a discrete uniform distribution is used whenever the likelihood of any outcome between a range of values is unknown.

VI. Results and Analysis

We used the Welch method, as illustrated in [6], for calculating warm-up period of our simulation experiment. The method is based on executing several iterations and calculating the mean across the different iterations. The averages are then plotted and the truncation point is selected to be the point where the graphs flattens out [11]. The simulation experiment was initially executed for all the scenarios with different time periods of 24, 168, 336, and 1440 hours in order to verify the true stable state of the simulation. We found that different scenarios had a slight different warm up period, e.g., in scenario 1 the simulation generated stable results after 5 batches (i.e., 85 waybills) were processed, while in scenario 3 the stable results were generated after processing batch 9 (153 waybills). Therefore, for our analysis, we collected results for all the scenarios after the processing of batch number 10. For each of the scenarios, the experiment was executed for a period of 90 days, i.e., 2160 hours.

In Table III, for the initial 255 processed waybills in each of the scenario, we present the mean invoicing time (for waybills) with a confidence interval (CI) of 95%. It can be seen that the difference between the minimum mean invoicing time for paper and electronic waybills is approximately 19 hours, while the maximum mean invoicing time can be as high as 1635 hours. In scenario 1, the difference between the mean invoicing time for paper and electronic waybills is 1161 minutes. Hence, a total of 65%, i.e., ((1161/1796)*100), savings in invoicing time can be achieved when using e-Waybills in place of paper waybills. Similarly, a saving of 99% in the invoicing time can be achieved for each scenarios 2 and 3.

TABLE III
MEAN INVOICING TIME FOR WAYBILLS.

Waybill Type	Scenario	No. of Waybills processed	Mean invoicing time with 95% CI
Paper	1	4267	1796.79 ±22.29 minutes
	2	1326	52700.53 ±747.59 minutes
	3	442	98872.29 ±2020.80 minutes
Electronic	1	4284	635.69 ±30.00 minutes
	2	4284	585.75 ±27.69 minutes
	3	4284	792.53 ±34.34 minutes

For illustration purposes, consider Fig.1, which represent the mean invoicing time (of 15 batches) for paper and electronic waybills in scenario 1. It can be seen in Fig.1 that, in addition to the high difference in the mean invoicing time, the mean invoicing time of paper waybills fluctuates more often when compared to the invoicing time of e-Waybills, which is more stable. The mean invoicing time for paper waybills is between 1581–1984 minutes, while for e-Waybills it is between 532–745 minutes in scenario 1.

Additionally, we observed that in all the scenarios a total of 4320 orders arrived. In our simulation experiment, a waybill was created for every order received, therefore, in total 4320 waybills entered the system. Similarly, a waybill is ready for invoicing when the order has been fulfilled, i.e., the freight is loaded and unloaded at different nodes and the respective waybill for the freight is processed at the particular nodes. We found, for paper waybills, the number of orders fulfilled was different in the three scenarios, i.e., 4267 in scenarios 1, 1326 in scenario 2, and 442 in scenario 3. In contrast to the paper waybills, 4284 orders were fulfilled in each of the scenarios for electronic waybills. The efficiency of the system, i.e., percentage of the ratio between orders received and fulfilled, is 99.17% for electronic waybills; whereas, the systems efficiency for paper waybills is 98.87%, 30.69%, and 10.23% in scenario 1, 2, and 3 respectively.

Furthermore, in Table IV, we present the monetary savings when using electronic waybills instead of paper waybills. The saving figure of US $0.4 per document is used in the table from a study by Hewlett Packard [5]. In scenario 1, difference between the total number of processed paper and electronic waybills is significantly low, which leads to low savings. However, when comparing the number of paper and electronic waybills processed in scenarios 2 and 3, the number of electronic waybills processed is 3-10 times higher than paper waybills, which can lead to potential direct savings of US $1194 and $1536 respectively.

TABLE IV
SAVINGS WHEN USING ELECTRONIC WAYBILLS.

Scenario	Paper Waybill	Electronic Waybill	Difference	Savings (US $)
1	4267	4284	17	6.8
2	1326	4284	2985	1194
3	442	4284	3842	1536.8

VII. Conclusion

We have presented a simulation model for estimating the invoicing and processing time of waybills in road-based freight transportation. The model is implemented using the simulation tool *AnyLogic* for three different scenarios having different processing time for waybills at the nodes. We have analyzed the results from the simulation experiment, which was executed for a period of 90 days. The results indicate that a saving of 65–99% in invoicing time can be achieved using e-Waybills instead of paper waybills. However, for e-Waybills, the difference in invoicing time and the number of processed e-Waybills in the three scenarios is not significantly different even though the processing time increases 3–15 times. Similar to the number of waybills processed, the savings on electronic waybills is low in scenario 1 when compared to scenario 2 and 3. The overall systems efficiency is high for e-Waybills even when the
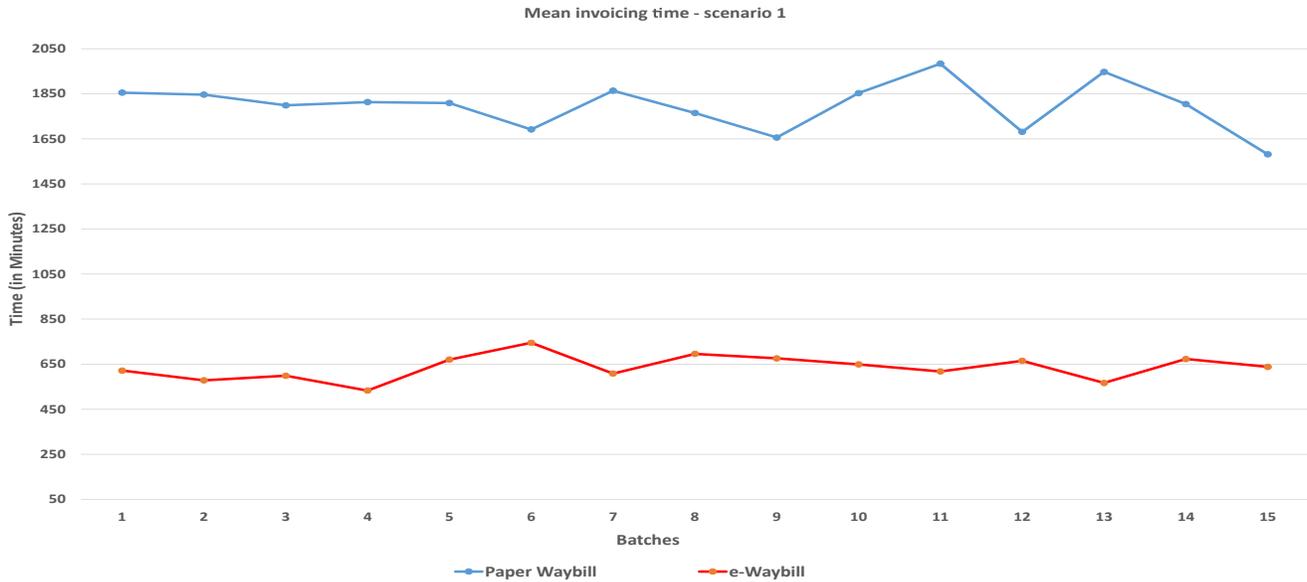
Figure 1. Mean invoicing time for paper and electronic waybills in scenario 1.

processing time of waybills is increased 5-15 times in the three scenarios.

A possible limitation of our study is number of nodes, where the waybills are processed. We have considered 12 nodes with only one TSP. Due to this limitation, the number of waybills processed at loading and unloading nodes are low in number as compared to the total number of waybills processed at the TSP. Therefore, a possible future work can be to consider more than one TSP for a particular number of loading and unloading nodes. Additionally, the process of batching needs to automatic in order to get a better estimate of the invoicing and processing time for electronic waybills.

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REFERENCES

[1] S. Bakhtyar, J. Holmgren, and J. A. Persson, "Analysis of information synergy between e-waybill solutions and intelligent transport system services," *World Review of Intermodal Transportation Research*, vol. 4, no. 2, pp. 123–139, 2013.

[2] S. Croom, S. E. Fawcett, P. Osterhaus, G. M. Magnan, J. C. Brau, and M. W. McCarter, "Information sharing and supply chain performance: the role of connectivity and willingness," *Supply Chain Management: An International Journal*, vol. 12, no. 5, pp. 358–368, 2007.

[3] S. E. Fawcett, C. Wallin, C. Allred, and G. Magnan, "Supply chain information-sharing: benchmarking a proven path," *Benchmarking: An International Journal*, vol. 16, no. 2, pp. 222–246, 2009.

[4] S. Fosso Wamba and H. Boeck, "Enhancing information flow in a retail supply chain using rfid and the epc network: A proof-of-concept approach," *Journal of Theoretical and Applied Electronic Commerce Research*, vol. 3, no. 1, pp. 92–105, 2008.

[5] R. Hill, "Hps experiences electronic data interchange (edi)," in *The international HP users conference*, Brussels, 1989.

[6] A. M. Law and W. D. Kelton, *Simulation Modeling and Analysis*, 3rd ed. McGraw-Hill, 2000.

[7] A. Lertkitcha, "Changing to electronic bill of lading by a freight forwarder in bangkok," *The Journal of Risk Management and Insurance*, vol. 16 (2012), pp. 55–67, 2012.

[8] R. Liu and A. Kumar, "Leveraging information sharing to configure supply chains," *Information Systems Frontiers*, vol. 13, no. 1, pp. 139–151, 2011.

[9] Z. Mei and J. Dinwoodie, "Electronic shipping documentation in china's international supply chains," *Supply Chain Management: An International Journal*, vol. 10, no. 3, pp. 198–205, 2005.

[10] M. Pocuca, D. Cisic, P. Komadina *et al.*, "Modelling the documentation flow in transport supply chain-results from the simulation experiments," *International Trade*, vol. 4004, 2000.

[11] B. Sandkçi and I. Sabuncuoğlu, "Analysis of the behavior of the transient period in non-terminating simulations," *European Journal of Operational Research*, vol. 173, no. 1, pp. 252–267, 2006.

[12] K. Sathasivam, "The single electronic window singapores tradenet scope of services and pricing model," presented at the CAREC Workshop on Single Electronic Window Development, July 15 2009.

[13] B. Sezen, "Relative effects of design, integration and information sharing on supply chain performance," *Supply Chain Management: An International Journal*, vol. 13, no. 3, pp. 233–240, 2008.

[14] D. Zec, D. Čišić, and A. Perić, "Facing up the challenges of port operations in digital world," *Pomorski zbornik*, vol. 39, no. 1, pp. 237–248, 2001.