

# Assessing the effect of implementing a port community system platform in the response time of an international terminal: the case of a multi-cargo facility at the Colombian Caribbean coast

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**Abstract** - This paper shows the expected impact of the implementation of a Port Community System (PCS) Platform, in the time of different foreign trade operations, such as document preparation, port and terminal handling, customs clearance and inspection and inland transport and handling, in an emerging economy such as the Colombian, more specifically in the Atlántico Department. We develop two different discrete event simulation models, one of the current situation (AS-IS) without the Platform, and the other considering a business process enhanced with the PCS Platform (TO-BE), to illustrate the reduction in time of foreign trades activities such as imports. The basis of such time reduction lies in the improved rate of service of a number of bottlenecks provided by the automation granted via the PCS. The paper considers as well an analysis of 3 different prospective scenarios, based on the expected situation but with the possibility of increasing the number of imports in the region. The major conclusion is that an implementation of a PCS platform will reduce the time of the foreign trade activities (in these case Imports) in the amount of 35%. At the same time, Imports can be increased in 10% without changing the operation process, only by allowing communication and visibility through the whole supply chain using one single- window platform.

**Keywords** - Port Community System platform; simulation model; foreign trade activities; single window; visibility; communication.

## I. INTRODUCTION

Nowadays, the logistics is a key factor to every business process, because it improves the competitiveness of any firm in the global markets [1]. Such improvement is reinforced by collaboration efforts between the different stakeholders of the supply chains, reducing with this the cost through the chain and maximizing the profit for the companies involved in the import and export processes. This is especially true for Colombian companies, which currently face major challenges in terms of logistics performance, and is the driving force behind the present investigation. Results show that Colombia is far from the logistics performance leaders in Latin America, as shown in the Logistics Performance Index (LPI) of the World Bank [1]. In Latin America, the logistics costs can represent up to 30% percent of the cost of a product, according to research by Amar Ramudhin, expert from Georgia Tech Institute in Atlanta GA, USA. In the recent years was estimated that in Colombia, 23% of logistics costs is absorbed by the GDP [2]. In the case of Colombia, the latest measurements showed alarming figures obtained in terms of this indicator, situating Colombia in 108<sup>th</sup> place among 144 countries in the period of 2014 - 2015 [3].

In addition, a previous diagnosis on the Colombian Caribbean international trade supply chains (Amaya et al, pending publication) reports that by looking closely to the stakeholders of the supply chains, there is scarce collaboration between them in all the processes associated with operation of imports or exports; each

process is typically associated with numerous transactions, which are necessary and oftentimes enforced by law. Plus, are not available nor properly informed to many other parties, which makes it a complex and disintegrated process. In addition, overzealous controls exercised by customs and drug enforcement police further complicates and lengthens the trade process. Among several key findings, lack of adequate infrastructure is reported to fail the needs of users, from technology tools to staff training at each stakeholder in the supply chain; it is also reported the existence of corruption and inefficient practices within government agencies, hampering processes while creating delays that result in higher costs for businesses. Because of the former, we propose the implementation of a Port Community System Platform in the International Trade Logistics Cluster of the Atlántico Department.

A Port Community Systems (PCS) is an One Single Window electronic platform that enables intelligent and secure exchange of data between public and private stakeholders of a foreign trade supply chain, to enhance the efficiency and competitiveness of the port communities and in many cases also airports [4]. Also a PCS automates the different processes associated with the foreign trades' activities. It handles electronic communication in ports between the private transport operators, the private hinterland, the importers and exporters, the port authorities, Customs and other authorities. The most important services are: Information Exchange, Electronic Exchange, Electronic Handling of all Information, and other [4].

We propose as main objectives of this initiative the following: 1. Show the impact of increasing the visibility of the foreign trade processes, which is expected to improve coordination between the actors; 2. Show the impact of automating the management of document related to foreign trade processes. This enables the possibility of monitoring the process of imports and exports with emphasis on detection of bottlenecks and security breaches, making explicit the participation and responsibility of multiple stakeholders in the process. Also, the main element of contribution is the reduction of time of imports approximately to 35%, also accompanied by a significant reduction in foreign trades' transaction costs. Additionally, the visibility provided and the possibility of traceability naturally discards out of the logistics ecosystem inefficient players and corrupt practices to streamline the cargo flow.

## II. PROBLEM DESCRIPTION

Internationally, logistics has been widely reckoned as one of the variables that define the competitiveness of a country, since reduces time and landed costs for the gross domestic product. Analyses of the national competitiveness show [3] that improving logistics performance is significantly associated with gains in competitiveness, productivity and increased sophistication of exports and imports activities, which is essential to incorporate the Colombian emerging economy in global value chains [5].

For 2008 Colombian imports required an average of 8 documents, 20 days and around 1160 USD , since the goods arrives at sea/river ports until delivered to the final destination [6]. By this time, the document that required the most time was the letter of credit, which took about half the time to export their production and about a third of the time of importation. In 2010 the Colombian ports were competitive at a regional level, in reference to the time to export and import products, but this measurement could still improve, because in that year was shown as the main bottleneck document processing, taking between 35% and 40 % of the total time required for export operations, and 54% for imports from Barranquilla [6].

From 2008 to 2012, progress was made on a reduction of up to 60% of the time required for Document Preparation for exports and 40% for imports. Still, the component of cross-border trade was still taking more time in preparing documents (including the letter of credit) with 34% of the time to export and 44% for imports. Currently the number of required documents is the same in all three ports on the Atlantic coast, 5 for export and 6 for the import, with time of 5 and 6 days respectively.

In regard to the time used to perform an import and/or export, the lapse for foreign trade operations in Colombia shows that Santa Marta, Cartagena, Barranquilla for 2008 had the minimum times in the nation for foreign trade activities [1]. This factor is influenced by the fact that the goods make smaller inland transit, because these cities have their own ports, meanwhile for the other cities in the rest of the country the delays of the inland transport is a determining factor in the end of the days waiting the load.

It can be said that the currently leadership is from the ports of Barranquilla and Santa Marta with a total time of 13 days, followed closely by Cartagena with 14 days for imports and in much cases exports. In the ports of the Caribbean region, technical control and customs clearance takes two days for exports. While in port management takes up to 3 days for the same operation. In contrast to import all these procedures take two days. Unlike previous years (2010), where the port management represented a 25% of the exports time and customs and inspections accounted for 15%, the handling time in port and terminal represent 22% and the approval of the customs and other inspections is 14%; meanwhile, for imports these is 15% and 16% respectively of the total time of the foreign trade activities.

According to previous research in the region like the last project: LogPort, it was found that there ten extended times and a series of bottlenecks in different stages of the foreign trade process, such as in the Port Handling stage, the Customs Clearance and Inspections stage and the Inland Transport stage, because the all the processes are quite complex and extensive (Amaya et al, pending publication). It has potential errors because the same information is repeatedly re-introduced in multiple systems and there is a clear lack of visibility into the entire chain. The actors are disconnected, each using its own internal system and within an internal scope exclusively regarding their organizations. It can be seen that the times in various port terminals of the region are affected considerably by a disconnected land transport, causing multiple bottlenecks in the trucks coming in and out of these terminals. Note that the problems in the Colombian process of foreign trades are not only operational or documentary type. Another major issue is the deficiency in information and communications technologies, leading to incur in cost, time and paperwork unnecessarily added to the supply chains.

The access and adoption of technologies have become prerequisites in global markets, since the use of technologies tools can increase productivity and social development of a country, increasing the volume and speed of transmission information [5]. Because of this it is necessary to promote and implement information technology supporting logistics operations, such as transport and control of goods, with the aim of operational integration that allows fluency in handling cargo without delays or high costs [7].

Studies have shown that the application of information and communication technologies in transport and logistics processes has been successful [8] if the proposed solution has not replaced but supplemented and improved legacy information systems; also, when there are clear rules set on the use of information and neutral forms of managing the platforms [7].

### III. THE MODEL

Colombia's goal for 2032 to be one of the three most competitive countries in Latin America motivates the need to venture into solutions for problems such as the above. At the same time, it is significant the fact that a Port Community Systems has never been implemented so far in the country [5]. Also through previous study the need expressed by 33 different cargo owners in the region to have visibility between the various links of the companies is rescued, showing that 28% of the sample requires visibility of all the links that form the chains (Amaya et al, pending publication).

One of the ways to solve these problems is implementing collaborative policies in the supply chains of the Atlántico Department. Normally companies do not have the time or resources to implement and evaluate these policies before permanently execute those [9]. This is why we develop a discrete simulation model to show the impact of the implementation of an electronic collaboration tool based on the performance of foreign trade processes of supply chains in Barranquilla, based on the concept of Port Communities Systems (PCS), a virtual single-window platform type that integrates different supply chain actors. All this in order to contribute with proposals that help to improve the logistic processes of the local supply chains, projecting high-impact scenarios for the region.

For the model we use a specific foreign trade process: Imports. The objective is to minimize the total time of the service system, in addition to obtaining the impact in increasing the number of imports in the region and the economic effect in an emerging economy.

#### IV. DISCRETE EVENT SIMULATION MODEL

For this section we introduce a model as means of carrying out a detailed performance assessment of the service system based on the current situation of the import process in Barranquilla. We present a validation of the model and conclude the section with the analysis of the different scenarios.

The model includes all the element of a foreign trade supply chain: from the arrival of the ships with the goods to the port in Barranquilla, followed by mooring the ships and unloading of goods, storage, regulatory inspections, to the arrival of the trucks and subsequent delivery of the goods to the load generator. A detailed structure is presented in the following section. Processing flow of the simulation model of an import supply chain is summarized in Fig. 1.

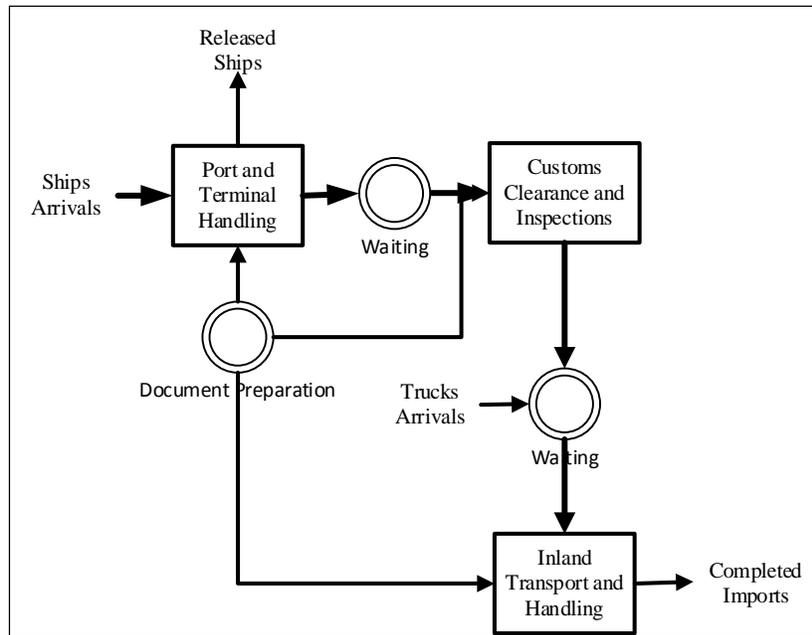


Fig.1. Pseudo-code of the Imports process for the discrete simulation model

##### A. Validation

One of the first steps to prove whether the model simulation model is accurate is to check that it all represent the real system. We fed the model with historical data and make statistical tests to validate simulation outcomes against the corresponding real response measures.

For model such a complex systems using discrete simulation, like a complete supply chain of foreign trade, is important to have a lot of historical data for achieve the capture of the entire system. Given the complexity of the system, it is essential to emphasize that it is impossible to record each and every one of the historical data. So our validation is mainly based on the system queues, associated resources and the time of the import macro processes. The following tables show the validation of the simulation model, based on the confidence intervals (CI) method. The average of our model are associated with the columns (AS -IS: current state) and the intervals are associated with historical data collected in one of the most important ports in Barranquilla, Colombia. The historical records are from January 2014 until mid-September 2015.

TABLE I. QUEUES' VALIDATION

Queues	AS IS		Intervals		
	Average	Half Width	Minimum	$\mu$ (Average) Case Study	Maximum
Number of Trucks (Loading)	18,77	5,25	13,52	13,92	24,02
Time (Loading Trucks) (minutes)	19,31	3,63	15,68	21,68	22,94

The **table 1** shows the validation of the queues, for this case we use the average time (in minutes) of a truck in queue for loading the cargo for it further delivery to the customer and the number of trucks in queue to load the cargo in the port. TABLE I. shows that with a 95% of confidence the model simulate the behavior of the trucks in the port, but there also shows that our model has a service rate faster than the real one.

TABLE II. MACRO OPERATIONS TIME VALIDATION (DAYS)

Macro-Processes	AS IS		Intervals		
	Average	Half Width	Minimum	$\mu$ (Average) Case Study	Maximum
Import Average Time (Total)	13,47	2,17	11,30	13	15,65
Port and terminal handling Shifts >5000 TEUS	5,71	0,93	4,78	5	6,65
Inland transport and handling	3,23	2,03	1,20	2	5,26
Customs clearance and inspections	1,79	0,09	1,70	2	1,89
Port and terminal handling Shifts < 5000 TEUS	2,09	0,25	1,85	2	2,35

TABLE III. RESOURCES' VALIDATION

Utilization %	AS IS		Intervals		
	Average	Half Width	Minimum	$\mu$ (Average) Case Study	Maximum
Bays	54,43	7	47,43	52,03	61,43

In a similar way TABLE II and III show that the model represent with a 95% of confidence the behavior of the macro-process of imports operation in Barranquilla and the resources involved in it. Also TABLE II shows that the only event with small variation is the Customs clearance and inspection; that is because the operations associated to this process are in nature different in every import. TABLE II indicated that our model is 0,47 day slower in the total time of an import process than the real one, this can be because the only type of cargo simulated in the model is General Cargo, and in reality the average of the total time is the average of different types of cargo, e.g. containers, bulks, liquids, general cargo, and others.

Another significant validation is to find the perfect number of replications to run the model (r), for this step we used an alpha of 0,05 and also assuming a normal distribution we found that the perfect number of replication was  $r = 21$ .

*B. Analysis of Scenarios*

For the analysis of scenarios we made a second model based on the implementation of a Port Community System in the Region that represent the changes of the system if there were a paperless port and automation processes like the automations of communication between all the actors of the chain. The changes are represented in the Fig. 2.

Using this model we represent 3 different scenarios, Scenario 1 TO-BE: represent the impact in time of the implementation of the PCS in the region with the same conditions. Scenario 2 TO-BE 10% GC: shows the execution of the PCS and impact of increase the general cargo imports in 10%. Scenario 3 TO-BE 20% GC: is like scenario 2 but the general cargo import is increased by 20%. Scenario 4 TO-BE 10% C: illustrated the impact of the PCS in time with a 10% of container increase. The next table shows the results in the different scenarios:

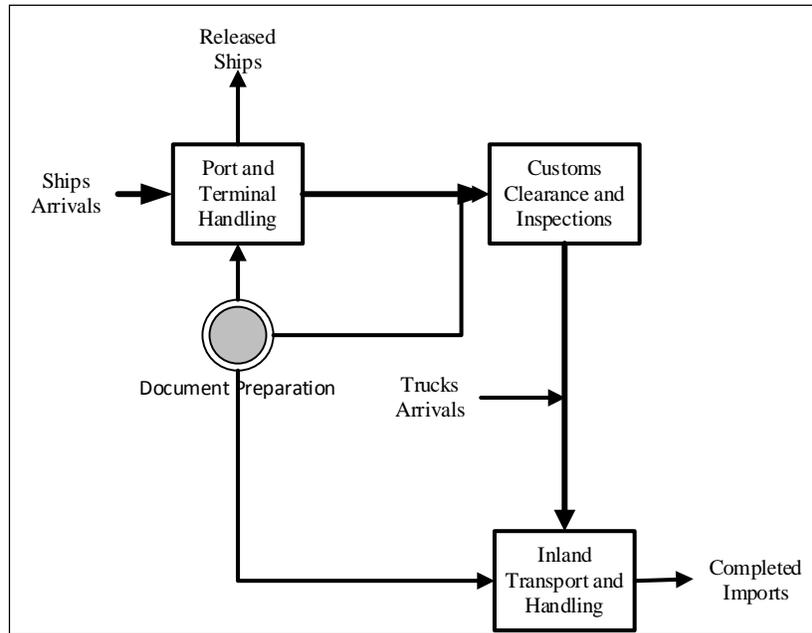


Fig.2. Pseudo-code of the process with the implementation of a PCS.

TABLE IV. DIFFERENT SCENARIOS (DAYS)

Scenarios	Time Of Processes Or Stages				
	Document Preparation	Port and Terminal Handling	Customs Clearance and Inspections	Inland Transport and Handling	Total Time
AS IS	5	4	2	3	13
TO BE	4	3	1	0,5	8,5
TO BE + 10% General Cargo	4	3	1	0,5	8,5
TO BE + 20% General Cargo	4	3	1	1	9
TO BE + 10% Containers	4	3	1	2	10

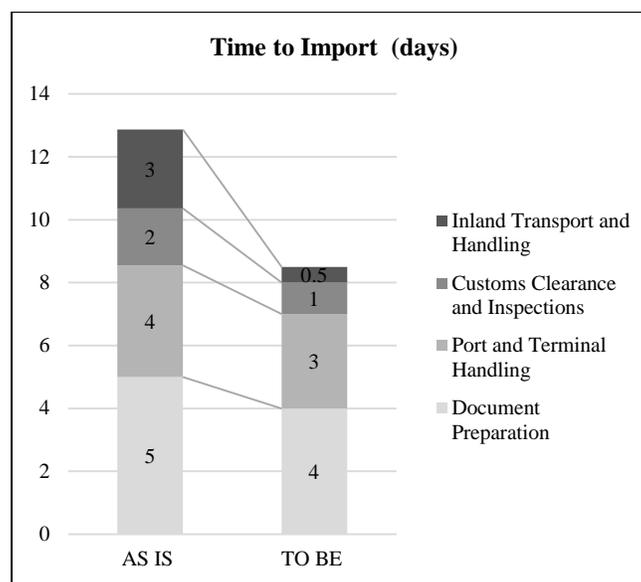


Fig.3 Import Time with and without the PCS.

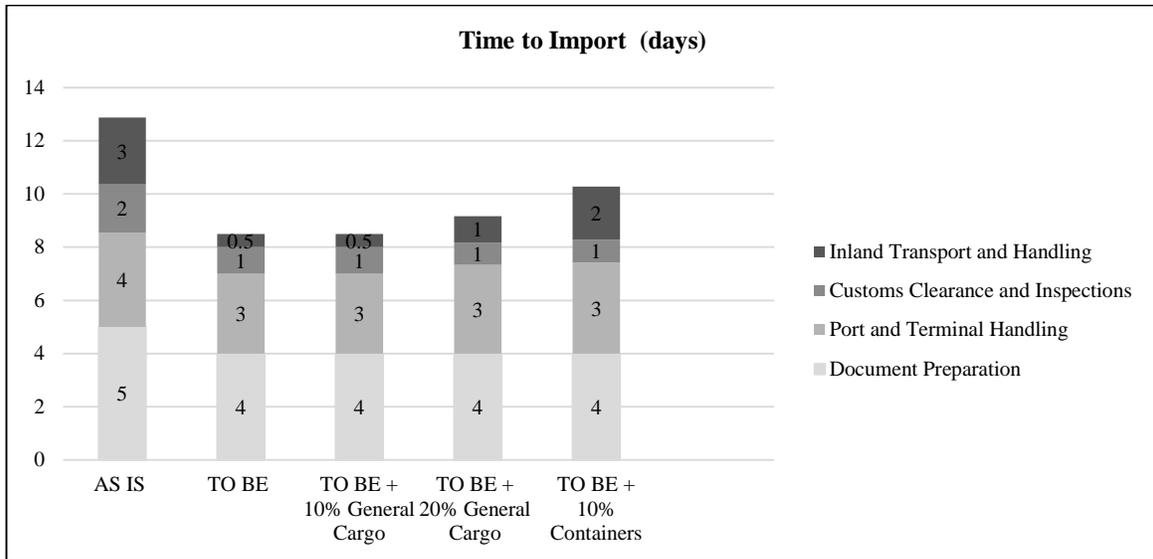


Fig. 4 Import Time with and without the PCS in the different Scenarios.

The TABLE IV and the figures 3 and 4 show that the total time of the import process can be reduced by 35% with a PCS and also increasing by 10% the imports of general cargo. Is important to clarify that the port of the case study is specialized in general cargo, because of that with an increase of 10% of container the total time can be only reduced by 23%. However there is a time improvement and, because of that is a possibility for open new markets in the region.

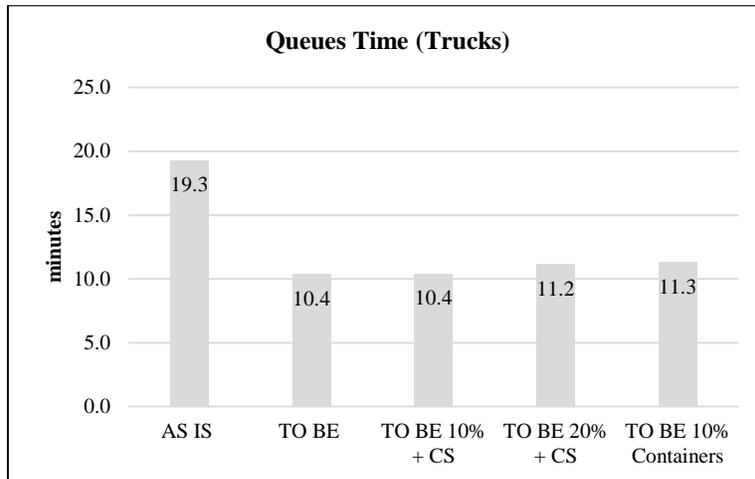


Fig. 5 Queues Time of trucks in the port with and without the PCS in the different Scenarios.

Another relevant finding is that the queue time of trucks in port is reduced by 46% in the best-case scenario (Fig 5). However there is a significant reduction in any scenario compared with the initial one.

In conclusion the best case scenario is the scenario 3 (TO-BE + 10% General Cargo), this one has a time reduction of 35%, which means that the total time of an import process can be in average 8,5 days and also the market of General Cargo in the port can be increased in 10%. This is because with the implementation of a PCS the bottlenecks associated to the Inland Transport Process and the Document Preparation Process are reduced in 46% and 20% respectively. Also one of the most important results is that a PCS can improve the collaboration between the stakeholders with the efficient exchange of all the document through every associated process in an import, this represent a reduction of 1 day in the total time of the process of Document Preparation.

## V. RELATED Work

Every day we can see that business partnerships are created to improve the supply chain [10]. This is because in reality the demands are irregular, so it is common to see more and more collaborative scenarios within supply chains, which tend to be significantly more competitive than non-cooperation scenarios [11, 12]. It is important to keep in mind that you can give a partial or full cooperation within the chain, but it has been shown that the benefit is greater in implementing full cooperation [13].

Collaboration in the supply chain is based on different practices of planning, coordination and integration processes between two or more links in the chain [14]. The implementation of these collaborative practices can have different purposes based on the effectiveness of the same, but in general the implementation of the partnership have a common goal: to create a pattern of visible and transparent throughout the supply chain demand [15].

Recent studies have shown that collaboration improves the performance of the supply chain in different ways: increasing the sales, improving forecasting, giving more accurate and timely information, reducing costs and inventory and improving customer service [16].

### A. *Electronic Collaboration*

Undoubtedly we are in the era of e-commerce, so it is necessary to go ahead, creating some kind of differentiation that makes competitive businesses. This is where electronic collaboration, as a key alternative, comes to create competitive and productive advantages [17]. Perhaps the most significant benefit when using electronic collaboration rather than the other types collaboration is the high reduction of costs arising from this alternative [18]. All this is proven by the case of the German automotive industry, which has implemented electronic collaboration and thus has shown that this is the most influential when it comes to impact on costs and performance of the supply chain [19].

### B. *Types of electronic collaboration tools for supply chains*

There are two types of tools for managing supply chains, the SCP (planning) and SCE (execution) [20]. Both have different objectives, but are complementary. The SCP will focus on the provision of end-user demand and production capacity; also, these tools usually offer capabilities for demand management, sales planning, production scheduling and distribution planning schemes. The SCE meanwhile focus on operational aspects of managing supply chains. Usually they involve inventory management, transportation and storage.

### C. *Platforms PCS Port community systems*

According to the European association a Port Community Systems PCS is characterized as an open and neutral electronic platform that enables intelligent and secure exchange of information between public and private stakeholders in order to enhance the efficiency and competitiveness of the port communities and airports. This optimizes, automates and manages ports and logistics processes through a single submission of data and by connecting the transport chains and logistics [4].

### D. *Using Discrete Event Simulation for represent the impact of a PCS*

In the literature we can find little about how to measure the impact of PCS platforms in a country or region. We found that a great possibility to do it, is to use discrete event simulation [21]. However, that study [21] has a lack of real data information and is only focus in one type of load, containers. Meanwhile we worked with historical data for each operation of the model (about the last 18 months of operation in the port) and with the help of one of the most important ports in the region, we were able to reproduce a realistic model adapted to our region.

## VI. CONCLUSIONS

This paper considered the situation of an emerging economy such as the Colombian in the foreign trade logistics activities (especially imports), taking into account the 4 main global activities like: document preparation, port and terminal handling, customs clearance and inspections and inland transport and handling.

We create a discrete simulation model that represents the entire system and also we alter the system with the addition of a Port Community System, to prove that a single window platform can help to increase the competitiveness in an emerging economy such as the Colombian. One of the most outstanding results is that this tool can provide a reduction of 35% in the best-case scenario of the total time of import in Barranquilla, improving with this the logistics activities related to these specific supply chains. Also the PCS can increase in 10% the general cargo imports keeping the same reduction in time. Because of that we strongly recommend the investment in a Port Community System for the region.

This case study provides more substantial information about the quantification of the benefits related to the time of each macro process of imports activities in Barranquilla, Colombia for a future development of a Port Community System in the region, so investment evaluation could be easier for the future decision-makers.

The major limitation of this study is that a PCS has not been developed ever in Colombia. The simulation model is based on the hypothetical implementation of a PCS in Barranquilla, proposed in a previous study (Amaya et al, pending publication). Any difference between the proposed discrete event simulation model and the real implementation of a Port Community System in the region could change the amount of the quantified time benefit. Another limitation is that our model only contemplates the import process, and maybe the simulation of export activities can change the results.

For future research we propose the incorporation of a financial study with quantification of economical results. Also we propose a future research using different ports of Barranquilla and other cities in Colombian (horizontal and vertical collaboration) with greater participation of the different types of cargo.

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