Port Community System Design for Emerging Economies: Case Study Barranquilla, Colombia

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Abstract

Port community systems (PCS), as platforms for connecting the actors of a port community, build a basis for improving information exchange. These systems support automation and visibility, thereby helping to enhance the overall port community performance. However, for a successful development of a PCS, it is necessary to use an appropriate design methodology. In the literature, it is common to find different methodologies for the design of electronic tools. However, this is not the case for products and services related to port communities. Therefore, this study analyzes and identifies a suitable design methodology for PCS, supported by a case study in Barranquilla, Colombia. One of the main findings is that the context, the geographical environment, the technological development and the cultural factor were key factors for the development and implementation of PCS. Taking the above into account, we propose in this research a new methodology for the design of PCS.

Keywords

Design methodologies, port communities, port community system, case study.

1. Introduction

A Port Community System (PCS) can be defined as an inter-organizational system for promoting commercial services and information exchange between the port and its customers and a variety of stakeholders, such as forwarders, carriers, importers, exporters, and customs, among others (EPCSA 2015). This way, a PCS is a tool that can enhance the information flow between all of them by electronically integrating heterogeneous compositions of public and private stakeholders, technologies, systems, processes, and standards within a port community (Heilig et al. 2017).

According to recent studies (Atkinson and McKay 2007; Carlan et al. 2016) the benefits of a PCS, from a digital economic perspective, is to provide employees with a tool to help them increase their productivity, allowing companies to drastically improve their internal operations efficiency and automation of daily works. Magutu et al. (2010) assured that electronic exchange of communications produces a faster and more efficient exchange of information, reduces the number of errors and reduces the lead time of processes. Also, Gustafsson (2007) exposed that, in terms of visibility, having an operational PCS makes the port much less opaque since the information that is crucial for each stakeholder of the chain can be individually valued by others as well.

Over the years it has been proven how a PCS implementation has allowed ports to improve and stand out in terms of productivity, competitiveness, innovation and customer service. In the Netherlands, the implementation of a PCS made it possible to completely eliminate the use of paper in foreign trade operations (Čišić et al. 2009). According to Čišić et al. (2009) the monetary savings obtained by the use of e-documents (compared to the traditional, paper documents) can reach the amount of 38.79%, the savings in time up to 39.64% and the use of electronic communication can save 39% of the flow of documents and affect the profitability of the entire port community. But how can be designed and developed a PCS? Are PCS the same for each port community?

In the literature, it is common to find different methodologies for the design of electronic tools (Cooley 2000; Dreyfuss 1955; García López and Cuevas Salazar 2009; Norman and Draper 1986). However, this is not the case for products and services related to port communities. Port communities are part of a very specific and complex market, with needs that cannot be fulfilled with the current methodologies (Moros-Daza et al. 2018). Also, a previous study (Moros-Daza et al. 2020) exposed that factors like context (market development), geographical environment, technological maturity and culture were key factors for the development and successful adoption of electronic tools for port communities. Considering the previous discussion, this work aims to evaluate the most used design methodologies and propose a new match methodology specific for PCS developments, taking as a case study the port community of the Colombian Caribbean Coast.

Currently, the Colombian port community does not have a platform that integrates and manages the information of all foreign trade operations (Amaya et al. 2018). All forecasts and planning are developed in Excel and many of the controls and supervisions are carried out through physical inspections, therefore the duration of the document preparation activities is very extensive, in comparison to international standards, like the Doing Business[1] standards (World Bank 2014). In fact, in Colombia it takes one additional document more than for the upper middle-income countries of the OECD[2] to perform a foreign trade transaction, according to the studies carried out by the World Bank (World Bank 2014). In addition, import and export processes in the Colombian Caribbean Coast, last three days longer than in any OECD country and almost doubles the costs associated with them (Amaya et al. 2018). In order to improve the coordination of import and export processes, the design and development of a Port Community System prototype is proposed.

The paper is composed of the following sections: Section 2 provides a description of the current design methodology for port related services and product for underdeveloped countries. Section 3 proposes a new specific methodology for the design and development of PCS. Section 4 exposes the experience, results and analysis of the implementation of the methodology in the port community of Barranquilla, Colombia. Finally, section 5 concludes the study with a summary description of the research.

2. Related Work

In this section, the most used methodologies are presented, with a definition of the main stages of each, highlighting their advantages and disadvantages for a PCS design and development. The purpose is to extract their most suitable features to make a "match" of them with the specifics of PCS design, and be able to propose, validate and apply the development and design of a PCS prototype that would be suitable for emerging economies countries, as well.

2.1 Knowledge Management methodology applied to electronic tools

The design of electronic tools was considered as one of the most notable boosters of the Knowledge Management model, due to the growing explosion of technologies for the management of information and communication (Cooley 2000; Dreyfuss 1955; García López and Cuevas Salazar 2009; Norman and Draper 1986). The value provided by this methodology has led to a wide variety of electronic tools to support the necessary structures for the collection of pieces of knowledge, which must serve as a basis for the knowledge life cycle, as well as to facilitate the flow of knowledge among the individuals that interact in them (Cooley 2000; Dreyfuss 1955; García López and Cuevas Salazar 2009; Norman and Draper 1986). In particular, this methodology allows to detect areas of improvement on the development of an electronic tool, i. e. by supporting the technological structure. This can lead to better functionality by improvements made by the philosophy of the knowledge management model.

2.2 Concurrent engineering methodology

Concurrent engineering makes reference to techniques for process optimization and of integration of design teams, such as "Quality function development QFD (From the 70's)" and "SED, implemented by Honda (From the 80's)" (Ciateq 2016). According to the IDA (Institute for Defense Analysis) concurrent engineering is a systematic effort for an integrated, concurrent design of products and its corresponding manufacturing and service process (Hoffman 1998; Sprague et al. 1991). This methodology pretends from the beginning to take into account all elements of the Product Life Cycle, from the conceptual design to its availability, including quality, cost and user needs. The concurrent engineering methodology has different advantages, which are associated in particular with the lower costs of development and production (Hoffman 1998). In addition, the methodology has condensed cycles of product development, faster project execution, and quick implementation time. However, its biggest disadvantage is that it is not applicable for all companies; small and medium-sized companies do not fit well, according to (Ciateq 2016) SMEs are not the most appropriate to benefit from concurrent engineering. In addition,

[1] Doing Business provides a set of indicators from the World Bank that measure aspects of business regulation for domestic firms through an objective lens. Based on standardized case studies around the world, Doing Business presents quantitative indicators on the regulations that apply to firms at different stages of their life cycle. The results for each economy can be compared with those for 189 other economies and over time.

[2] Organization for Economic Co-operation and Development (OECD) is an organization that promotes policies that will improve the economic and social well-being of people around the world

it does not take into account cultural barriers and conflicts of interest. If the appropriate conditions for such methodology are not given, it is not applicable.

2.3 Human-centered design methodologies

Recently, there is an increase of studies based on the development of methodologies associated with human-centered design (Cooley 2000; Dreyfuss 1955; Norman and Draper 1986). The term human-centered design became popular in the 80's based on work from the Donald Norman's research laboratory at the University of California San Diego (Norman and Draper 1986). Mainly, because there was a need based on the design of processes, which were not always intuitive and at times left the user frustrated and unable to complete a simple task. The objective of this methodology was to create a link between the users and the technological developments and eliminate with it their frustration (Abras et al. 2004).

This section presents two human centered design methodologies, the Design Thinking methodology and the Needs and Aspirations for application in a Design and Innovation process (NADI) methodology. In addition, like the above methodologies, a brief description of the methodology, the advantages, and the disadvantages of each is exposed.

Design thinking methodology: Design thinking is a discipline that uses the methods and sensitivity of designers to match the needs of people with what is technologically feasible and what a viable business strategy can turn into value for the client and in an opportunity for the market (Brown 2009). This methodology is used more for the development of products (Brown 2009; Martin 2009) and consists of seven stages. Design thinking exposes a methodology with four macro-phases: *i.* User experience, *ii.* Creativity, *iii.* Selection, and *iv.* Design and execution. Each macro-phase is composed of specific stages, for example: Understand, Observe and Define are part of the User Experience learning process. Define, Ideate and Prototype are part of the creativity phase. Ideate, Prototype and Test are part of the selection phase and finally, the design and execution phase is composed of the stages Test and Implement.

NADI methodology: The design of products and services has been changing since 1955 (Dreyfuss 1955). Van der Bijl-Brouwer and Dorst (2017) explain that this was mostly a consequence of the war and the need to design and develop products and services appropriately to the need of the people after a big tragedy and their interaction with the new environment. After that, in the 80's changes related with the concept of human-centered design started coming and new triggers created the perfect opportunity to change the design process (Norman and Draper 1986). The study depicts five important triggers like democracy in the workplace, need for insight into user-product interaction, need for externally valid insight, need for better connection with the design process and market competitiveness and widespread interest in emotion. One of the last model based in this methodology is named NADI (Van der Bijl-Brouwer and Dorst 2017). The model is centered in four layers: themes, goals, scenarios and solutions. This scheme is to answer questions like: What people want? How they want it? What they need? and with whom they want to interact?

In summary, as exposed above, there are different approaches of methodologies to develop electronic tools. However, none are focused on electronic tools for port communities. However, is it necessary to have a specific design methodology for these tools? Taking into account previous studies (Moros-Daza et al. 2019b; Moros-Daza et al. 2019d; Moros-Daza et al. 2018) it could be found that four key factors are needed to be considered in order to design and develop a PCS or a port community electronic tool. The factors are context, geographical environment, technological maturity, and culture. Considering our discussion about the most common design methodologies, it is apparent that none of the design methodologies considers the four factors; mainly all of them considers the context, but in a general way; and in some cases, also the culture or the technological maturity (see Table 1).

Table 1 Key factors for PCS design VS design Methodologies

	Context (market development)	Geographical environment	Technological maturity	Culture	References
Knowledge Management			x	x	(Cooley 2000; Dreyfuss 1955; García López and Cuevas Salazar 2009; Norman and Draper 1986)
Concurrent Engineering	x				(Ciateq 2016)
Design Thinking	x			x	(Brown 2009; Martin 2009)
NADI	x				(Van der Bijl-Brouwer and Dorst 2017)

Taking into account the mentioned above, it is possible to conclude that for the design and development of a PCS it is necessary to create a new design methodology that considers all of the key factors. Because of this, we propose on the following section a "match" methodology focused on the development of PCS.

2.4 "Match" Methodology proposal

The purpose is to develop a platform tailored to the needs of each of the stakeholders of the Colombian Caribbean port community. Taking as a reference the previous methodologies used for the development of products and/or services, a new methodology is proposed that rescues the most important aspects of each of them, and that poses a direct relationship with the development of Port Community Systems. It must be taken into consideration that all of these methodologies have their advantages as well as their gaps in the context of port communities' electronic tools. Therefore, the objective of the "match" is to try to fulfill those gaps.

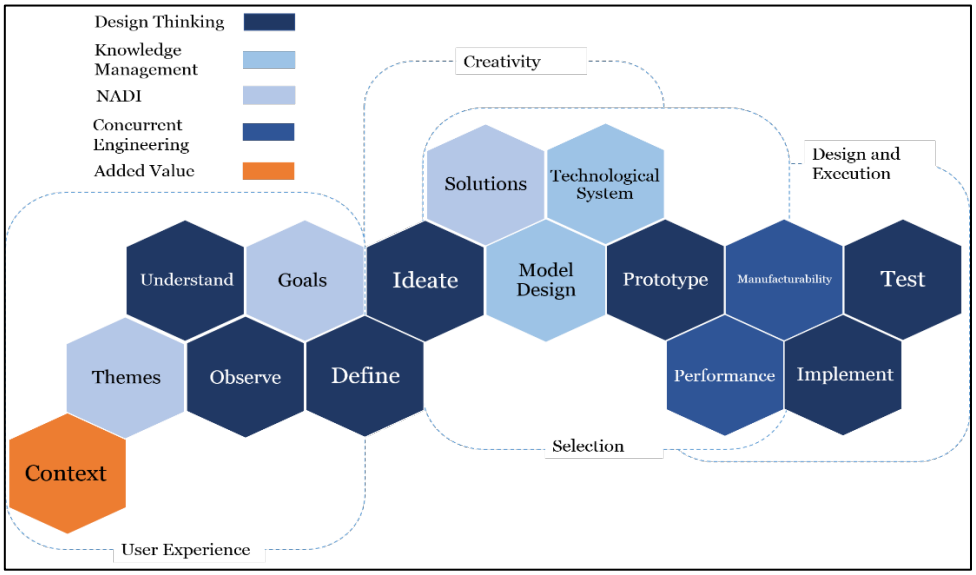

Figure 1. Match Methodology

Figure 1 exposes four main phases: user experience, creativity, selection, and design and execution. The first phase is now based on the match between the basic design thinking proposal and the NADI methodology. But, taking into account that this methodology is for development and implementation of a PCS, a previous step is proposed: to involve as the beginning of the methodology the analysis of the environment (Abras et al. 2004). In this phase the following questions should be answered:

- Where is the product and service developed? Who will be using it?

As mentioned before, this will lead to the analysis of an important factor for a PCS development, the cultural factor. Taking into account that the PCS will be custom-made to cope with emergent economies features, the analysis of the culture that surrounds the environment/context will determine specific characteristics of the PCS and will affect future aspects of the product/service like its business model. This creates new questions to answer and analyze like: What are the main cultural characteristics in emerging countries that affect the development and implementation of a PCS in them? Is the business model of a PCS related with the environment where it will be functioning?

- What is the underlying structure of the experience? What are their meanings and values outside the direct context of the problem?
- Why do people want to interact or behave in a certain way? What do they want to achieve within the context of the problem?
- What do people want or need? Which products, services, or interventions do people want or need?

Taking into account the research made in a previous study (Moros-Daza et al. 2019d; Moros-Daza et al. 2018), the answers to those questions are as follows:

- Where is the product and service developed? Who will be using it? = Colombia and The port community of Colombia.
- What is the underlying structure of the experience? What are their meanings and values outside the direct context of the problem? = Efficiency, Control, and Security.
- Why do people want to interact or behave in a certain way? What do they want to achieve within the context of the problem? = Allow the interaction between the stakeholders of the port community and the exchange of information through the foreign trade supply chain.

The second phase presented in Figure 1, which is named creativity, involves six steps: define, ideate, solutions, model design, technological system and prototype. In this phase, questions like the following should be asked:

- How do people want or need to interact with the solution in the context of use?

- What happens if the government takes a strategic part on the development of the PCS?

It was found that the answers to those questions are:

- Stakeholders should always be able to follow the foreign trade processes in real time
- Stakeholders should be able to detect and react to any disruption
- The government should be able to control and follow the foreign trade activities
- A figure of Port Authority should be created

The third big phase is the Selection phase; a match of all the previous methodologies made this phase. The steps composing this phase are: ideate, solutions, model design, technological system, prototype, performance and manufacturability.

Finally, phase four is design and execution. This phase is made by the match between the design thinking and the concurrent engineering methodologies, where steps like performance, manufacturability, implement and test should be analyzed and took into account in order to make a proper development and implementation of a PCS.

3. Prototype design of a PCS: case study Barranquilla, Colombia

3.1 User Experience

Context: Based on a previous study (Moros-Daza et al. 2018), it was possible to identify specific characteristics about the Barranquilla port community. As a summary, each one of them is below listed:

- Most of the companies in Barranquilla, Colombia (62%) that are involved in foreign trade activities do not have an information system such as platforms or electronic tools that facilitate the flow of information within the same entity and with the other stakeholders of the port community.
- 69% of the companies answered that they are open to the use PCS.
- Most of the respondents who have IT platforms exposed that their systems do not allow them to communicate with the rest of the supply chain stakeholders.
- In an emerging economy like Barranquilla, Colombia, 78% of the respondents did not know or were familiar with the PCS tool.
- The main barrier was that 90% of the respondents have insufficient of prior knowledge about PCS.
- 89% of the respondents believe that there is no local leadership when it comes to regulating the operations performed by the stakeholders of the port community.
- 73% of the respondents do not know any type of study or redesign for standardization of information and documents.

The above characteristics indicate that a first step towards a PCS is to build a system based on the specific needs of the users, which are mostly focused on aspects like processes optimization, alarms and warnings in any situation and summary reports. The fact that most of the stakeholders do not have information systems and are willing to adopt one opens the possibility of a successful adoption of a PCS in an emerging economy such as Barranquilla, Colombia.

Theme: Nowadays, the interactions between all the stakeholders of the port community are a big black box (Amaya et al. 2018) making the traceability of the cargo become almost impossible to follow and therefore this becomes another important and priority aspect of investment.

Another previous research (Moros-Daza et al. 2018) showed that the import users' needs are related to decision making in the import operations. In contrast, exporters have a high affinity for variables related to decision-making that are focused on administration and document management, among which the number of procedures, type of business, area of origin, port type used, SCM management and cost problems associated with equipment are mentioned. Therefore, in developing a PCS it is important to focus and customize the platform considering those differences.

Goals: Colombia's goal for 2032 is to be one of the three most competitive countries in Latin America (Consejo Privado de Competitividad 2016). In order to achieve this goal, Colombia presented some actions for the next years, in which the first step is the need to make the telecommunications, foreign trade and transportation sectors the main drivers of economic growth and social development of the country and, in turn, these contribute to an informed, connected and integrated society to the global environment (Consejo Privado de Competitividad 2016; Montenegro Trujillo and Goldenberg 2010). However, this will only be achieved with the efficient provision of information system services for both sectors. This is why within the 2019-2032 Development Plan five fundamental principles of action are proposed (Montenegro Trujillo and Goldenberg 2010):

- Convergence: both sectors must constantly incorporate the latest technological trends. In particular, it must be adapted to the convergence of networks, terminals, and services.
- Globalization: conditions must be created for community actors to take advantage of the

opportunities that arise from the increasing globalization of logistics services.

- Competition: competition must continue to be promoted so that companies have access to better and better-equipped telecommunications services.
- Adequate coverage and universal access: telecommunications services should be available to the entire population, as support for the use of information and communication technologies (ICT), and the incorporation of the country into the knowledge society.
- Adequate institutional framework: a modern institutional and normative framework is needed that fosters competition, encourages innovation and creativity of companies and recognizes convergence and markets.

Also, through the study (Amaya et al. 2018) made in the Colombian Caribbean Coast, could be highlighted the need expressed by 33 different importers and exporters of the region to have visibility and coordination through all the foreign trade chains. It was found that the 28% of the sample requires visibility across the entire chains, but also the rest of the sample expressed the need of visibility through minimum 2 echelons of the chain.

Scenarios: Figure 2 shows four different scenarios for the design of a PCS in Barranquilla. The first scenario involves a full PCS, which means an expected integration and collaboration of all the stakeholders of the port community, including all the terminals and ports. This scenario can be divided in two, a scenario where is only considered the current PCS services or a scenario where the current plus added value services are considered.

Moreover, Figure 2 presents the possibility of a scenario where only a selected sample of port and terminals are taken into account for the design of the PCS. This scenario, like the above mentioned can be also divided in two based on the offer of services.

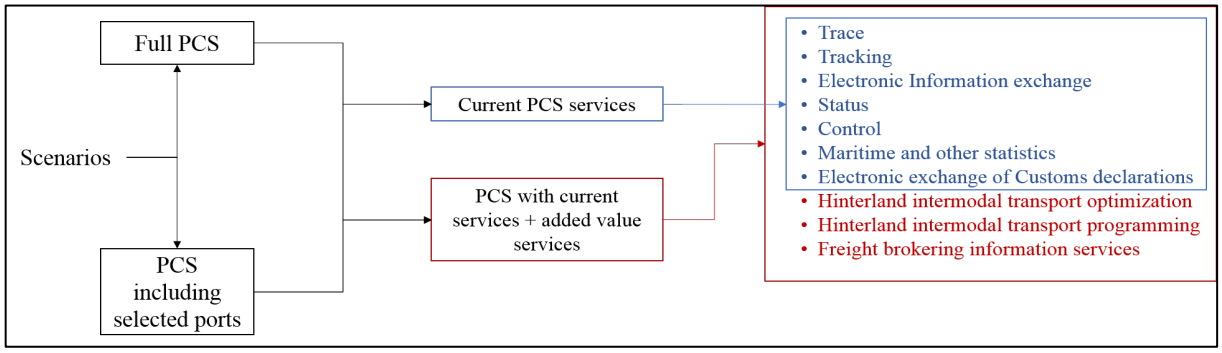

Figure 2 Port Community System Scenarios

3.2 Creativity

Solutions: Figure 3 proposes a solutions' scheme for the expected design of a PCS. This scheme shows the possibility of including the different PCS scenarios mentioned above and a general flow of the PCS.

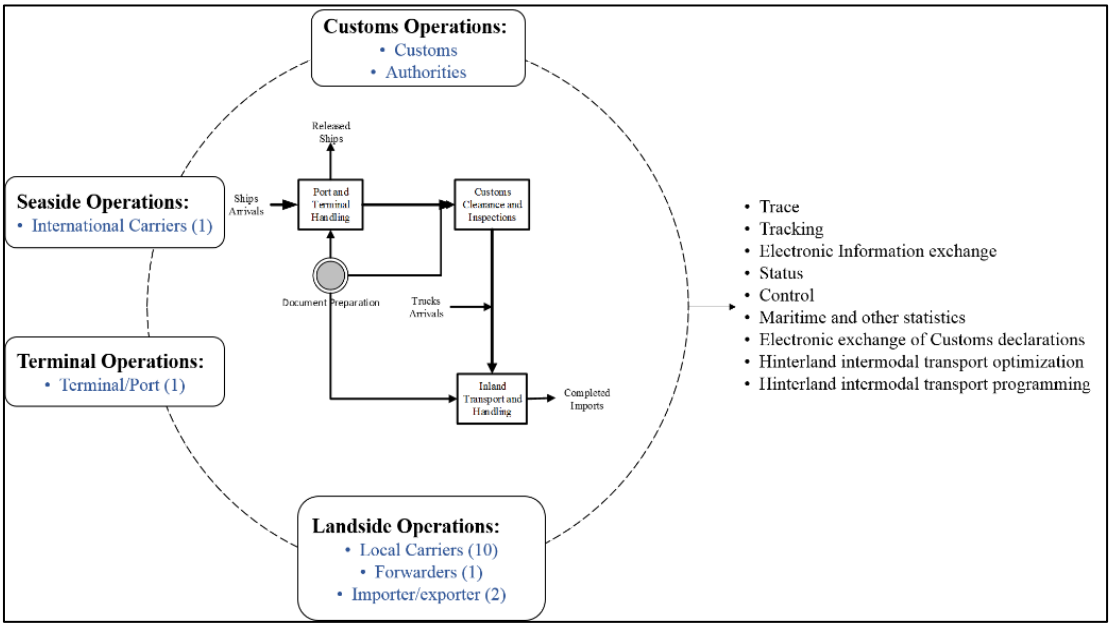

Figure 3. Port Community System Solutions

Conceptual development of the proposed design: Taking into account Figure 3 we will focus on one foreign trade activity for illustrating the example of the proposed design. The selected foreign trade activity is an import activity. An import consists in bringing or carrying in goods or materials from an outside source, especially to bring in from a foreign country for trade or sale. The process is in general standardized worldwide (World Bank 2017) with differences from country to country and from port community to port community.

In general, the import process begins once an importer buys goods or materials from an international supplier and coordinates them to be sent to the destination country. In a port, the import process begins once the shipping company sends the request for confirmation of the vessel arrival to the facilities. Once the port confirms the vessel, the port staff starts coordinating the necessary resources for the unloading of the vessel. Once the vessel arrives at the port and the goods are unloaded, a series of inspections by government organizations start. After the nationalization of the goods, the coordination of the hinterland transportation begins. Finally, the goods are picked up by a local carrier and delivered to their final destination.

Selection: The selected scenario for the prototypical design of a PCS in Barranquilla was the scenario where we considered only a selected sample of ports. Figure 3 shows that we will be using only one port as reference point. In addition, Figure 3 exposes that the selected scenario takes into account the current and added value services, mainly to fulfill the need of the users mentioned in previous sections.

3.3 Design and evolution:

Conceptual design: This process focuses on the activities carried out since the shipping company confirms the vessel arrival with the port until the cargo is delivered to the importer by a local carrier. It is assumed that the client has outsourced some services or activities, like hiring a local carrier company to accommodate the hinterland transportation of the goods and also a forwarder to coordinate some documents. With this, the involvement of the following stakeholders is assured:

- Importer
- International carrier (shipping company)
- Terminal / port
- Forwarder
- Custom
- Governmental organisms and authorities
- Local carrier (Truck - Barge)

The modeled process does not cover all possible scenarios of an import. However, it models scenarios in which all the possible stakeholders of a foreign trade activity are included. This happens, in order to demonstrate a global gain and a more forceful improvement.

A scheme of the proposed Colombian PCS is presented in Figure 4. Figure 4 exposes the proposed services that a PCS can provide, categorized into 4 types of operations: *i.* customs operations, *ii.* seaside operations, *iii.* terminal operations, and *iv.* landside operations.

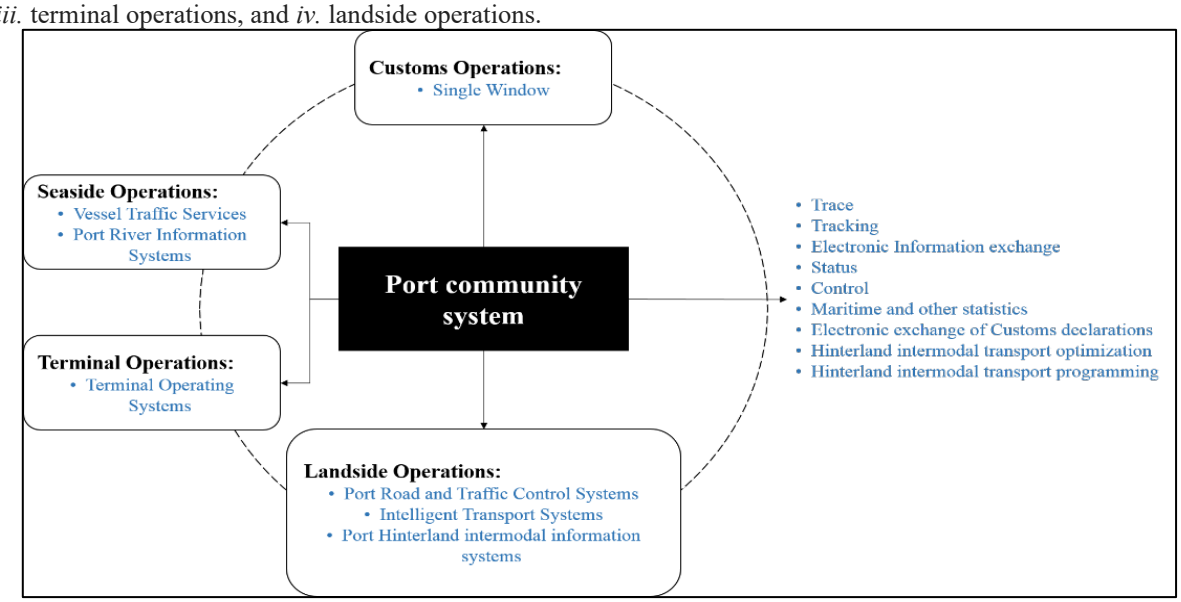

Figure 4 PCS services scheme

Process flow: Taking into account the problems of the Colombian port community analyzed in previous studies (Moros-Daza et al. 2017) and the need to re-engineer operations associated with the foreign trade activity, a PCS flow scheme is proposed. Is important to highlight that this scheme is based in restructuring the interaction of the stakeholders of the port community and the implementation of different technologies associated with each of the processes. The following technological means are assumed:

- Process automation through BPM (Business Process Management)
- RFID (Radio Frequency)
- Digital Biometrics
- Integration of all existing IT services (MUISCA-SIIS-VUCE-SI de PUERTOS - SYGA)
- Electronic "Tarja" (Weighting) System in the Ports
- Hinterland optimization through intermodality (an added value service for routing with intermodality option (Moros-Daza et al. 2019a))

Service oriented architecture (SOA): Figure 5 represents a PCS platform for facilitating the data integration of each stakeholder of a port community (users of the PCS). Figure 5 is a schematic diagram based on a service-oriented architecture (SOA), which includes several different computer applications and the integration of a plurality of data sources. SOA has been defined by the World Wide Web Consortium as a set of components which can be invoked, and whose interface descriptions can be published and discovered (Sprott and Wilkes 2004). It is expected that the data source includes systems from providers such as Microsoft and Java, among others. The data sources are expected to include files created or used by applications such as Microsoft Outlook, Microsoft Word, Microsoft Excel, Microsoft Access, as well as files in standard formats such as PNG and PDF, and so forth. In addition, Figure 5 shows that the PCS platform includes a data integration system to facilitate the collection of data from the different data sources (supported on a SOAP - service-oriented architecture platform). In addition, the PCS will have access to different data sources like: road and river data (for hinterland optimization), customs data (single window (SW) data) and different stakeholders IT systems.

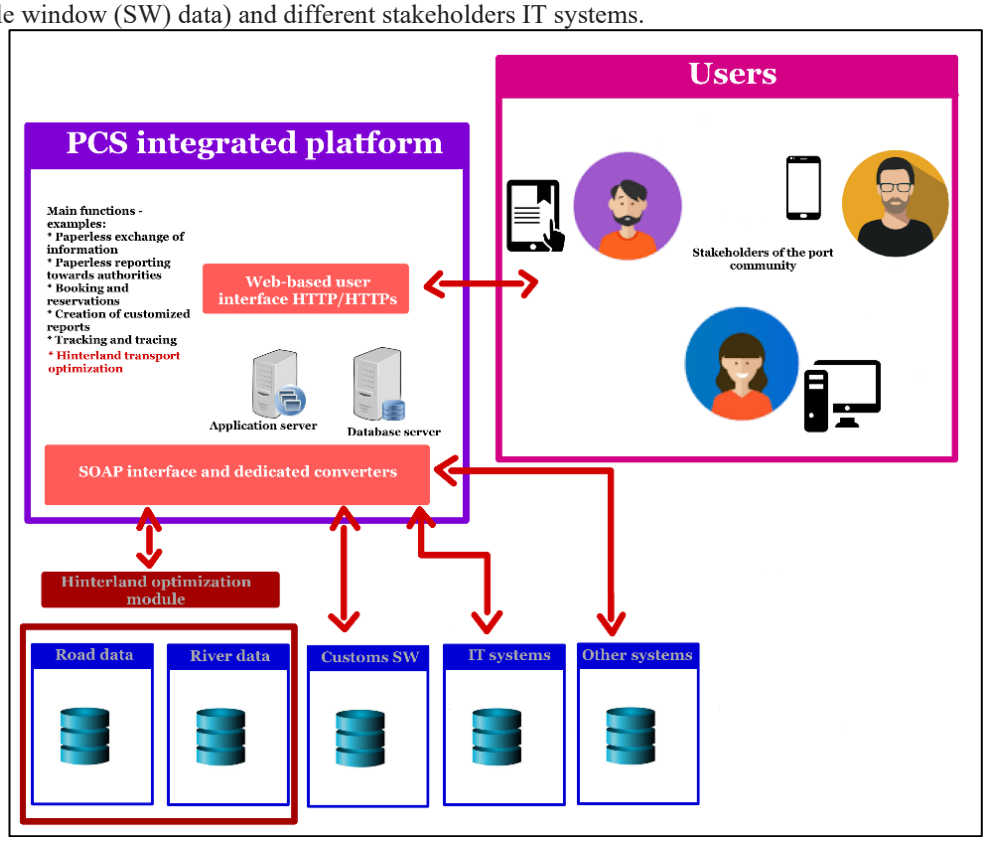

Figure 5. PCS architecture

Prototype of a PCS: For the development of the PCS prototype, the software Bizagi (Bizagi 2015) was used, which is based on the Business Process Management nomenclature. Figure 6 shows an example of the user interface of the PCS for the app version.

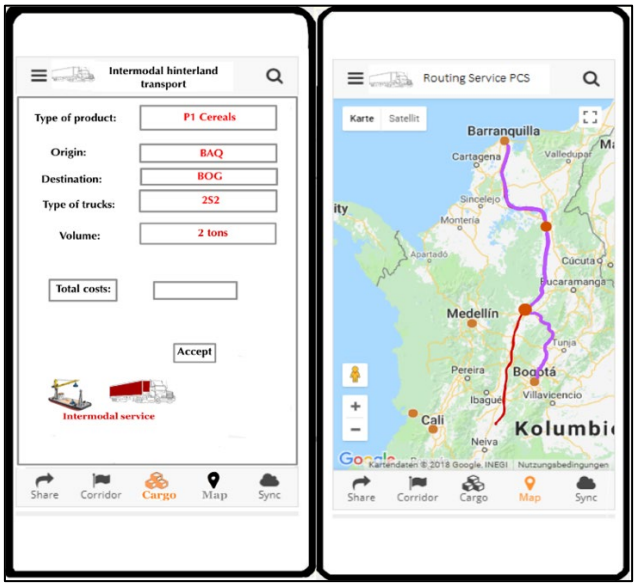

Figure 6. Example of the prototyped interface of the PCS for Barranquilla

4. Prototype testing

For the validation of the PCS prototype, it is necessary to test it with its expected users. The prototype was presented to the Information Technology staff of the selected port, in which the design of the prototype was evaluated satisfactorily. However, several feedbacks were received, each recommendation is listed below:

- Include the option in the model that the client or the forwarder could create import cases, since only the shipping company could start and/or open the case of an import.
- In the initial part of the import process, when the shipping company requests the confirmation of terminal available docks, a specialized capacity restriction must be included and taken into account based on the characteristics of the vessel in question, and not generalize this restriction of capacity for all the vessels of the case.
- In the confirmation activity of the vessel, the Bill of Lading, and the other required documents must be requested.
- The different stakeholders must be notified when the freight is in the warehouse, in order to start making the preparations to dispatching the products from the port.
- Parameterize the activity of the event in which the confirmation of receiving the vessel is rejected.
- In the content of the Bill of Lading, the location of the container ID with the type of cargo must be changed ("one switch") in order to improve the presentation of this and generate greater coherence.
- In the activity of notifying the state of the cargo, the options for the types of deterioration of the cargo must be expanded, to be able to choose several options from it, and to be able to attach photos associated with the deterioration of the merchandise. In addition, a field should be placed where the quantity of the cargo that presents deterioration is specified.
- In the section of filling in the “tarja” (weighting the cargo after downloaded it from the vessels), the information of the amount of the load should not be placed, in order to avoid manipulation of the quantities, risks and/or misunderstandings from the staff.
- In the tax payment activity, a receipt or proof of payment must be attached.

Taking into account the above recommendation, a new interaction of the prototype was made; which was re-presented and finally accepted by personnel of the area of technologies of the selected port.

5. Conclusions

Moros-Daza et al. (Moros-Daza et al. 2017) asserts that a port community system is a great option to apply and develop in the Colombian port community. However, to achieve this, it is necessary to first evaluate some aspects such as feasibility, design, validation and limitations of a prototype.

In the literature, it is common to find different methodologies for the design of electronic tools (Cooley 2000; Dreyfuss 1955; García López and Cuevas Salazar 2009; Norman and Draper 1986). However, none of them is focused on port communities. Port communities are part of a very specific and complex market, with needs that cannot be fulfilled with the current methodologies (Moros-Daza et al. 2020). Also, it was found on a previous study (Moros-Daza et al. 2018), that in order to design and develop a PCS, key factors needed to be taken into

account, i.e.: the context, the geographical environment, the technological development, and the culture. Considering the above, this research aimed to evaluate the most used design methodologies based on the key factors and to propose a new match methodology specific for PCS developments, taking as a case study the port community of the Colombian Caribbean Coast.

We proposed a new design methodology for the development of electronic tools for port communities. This methodology takes into account four phases: user experience, creativity, selection, and design and execution. The first phase was based on the match between the basic design thinking proposal and the NADI methodology. But, taking into account that this methodology is for the development and implementation of PCS, a proposed opening step for the methodology now involves an initial analysis of the environment (Abras et al. 2004).

The second phase was named creativity, which involves six steps: define, ideate, solutions, model design, technological system and prototype. The third phase was the selection phase, which was made by a match of all the previous methodologies. This phase is composed by the following steps: ideate, solutions, model design, technological system, prototype, performance and manufacturability. Finally, phase four is design and execution. This phase features the intersection between the design thinking and the concurrent engineering methodologies, where steps like performance, manufacturability, implement and test should be analyzed and taking into account in order to make a proper development and implementation of a PCS. As a case study, we portrayed a platform tailored to the needs of each of the stakeholders of the Colombian Caribbean port community.

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