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Horizontal cooperation architecture used in development of mobile applications: logistics processes at textile sector case

Arquitectura de cooperación horizontal en desarrollo de aplicaciones móviles: procesos logísticos en el caso del sector textil

Daniela Alejandra Pacheco[1], Néstor Fernando Álvarez[2], Giovanny Mauricio Tarazona[3]

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RESUMEN

El presente artículo describe los procesos de diseño y creación de prototipos llevados a cabo para desarrollar una aplicación móvil utilizando la arquitectura de colaboración horizontal para el comercio electrónico. Dicha aplicación está destinada a ser utilizada por las PYME en el sector textil con el fin de facilitar la logística relacionada con el transporte mediante la recopilación de información. En consecuencia, los costos se reducen para el cliente final al entregar productos a través de un proveedor de logística unificado.

ABSTRACT:

The present article describes the design and prototyping processes carried out to develop a mobile application using horizontal collaboration architecture for e-commerce. Said application is meant to be used by SMEs in the textile sector in order to facilitate transportation-related logistics by collecting information. Hence, costs are reduced for the end customer by delivering goods via a unified logistics provider.

1 BSc. In Industrial engineering, Universidad Distrital Francisco José de Caldas, Colombia; member of GICOGECOL research group. E-mail: dapachecor@correo.udistrital.edu.co. ORCID: https://orcid.org/0000-0001-9729-8234
2 MSc. In Industrial engineering, Universidad Distrital Francisco José de Caldas, Colombia; member of GICOGECOL research group. Current position: Globant, Colombia. E-mail: nfalvarezg@correo.udistrital.edu.co. ORCID: https://orcid.org/0000-0002-8579-4297
3 Ph.D. In Informatics Systems for Internet. Universidad de Oviedo. España. Current position: Professor at Universidad Distrital Francisco José de Caldas, Colombia, member of GICOGECOL research group. E-mail: gtarazona@udistrital.edu.co. ORCID: https://orcid.org/0000-0001-5012-1466
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1. Introduction

Currently, the electronic commerce has granted opportunities and advantages on a commercial level since it diminishes communication, transportation and distribution costs. Hence, commercial alliances can be established between investors and partners with a "win to win" mindset, [1]. In the era of the Internet of Things (IoT), businesses are constantly seeking to implement internet tools to facilitate to carry out processes involving supply, inventory management, human resource control, sales and post-sale service. Thus, a better experience is offered to the client and his loyalty is improved while keeping updated on regulations and thoroughly complying with them, [2].
The traditional commercial process lacks in data manipulation standards, which translates in the need to recollect, identify and analyze important information at the moment of negotiation. This need has been progressively satisfied with the implementation of e-commerce, which offers the following advantages: 24/7 availability of the product, reduce staff costs, Favor customer interaction, Reduce inventories, Speed business processes, Better product advertising, Greater access to global markets, Low investment risk, [3].

After stating the advantages of electronic commerce regarding traditional processes, different problem areas faced by the textile sector are detailed as well as their relationship with e-commerce processes, specifically: 1. geographic, economic and social problems of e-commerce in Colombia; 2. problems in the textile sector and their incursion in electronic commerce.

First, Colombia needs an improvement in the logistical network, in terms of distribution processes to satisfy the national and international demand of native textile products. It is also important to drive change in legislations to allow their optimal integration with the policies focused on current economic models [4].

Another hardship in Colombia is the inadequate infrastructure in ports and airports, which leads to an inability to mobilize a moderate merchandise flow. Hence, the state should commit to attracting more private investment in port activities so that Cartagena can position itself as one of the most important ports of Latin America and overcome such capacity-related gap [5].
At the second problem, the Colombian textile sector is characterized by traditional inefficient production processes and it has no technological innovation management methods to increase its competitiveness in the market. Large companies and SMEs are not willing to change and innovation processes are required to survive the market evolution [6]. Furthermore, Colombia faces a deficiency in terms of regulations and policies aimed at the commercialization of textile products through an e-commerce platform. The latter "consists in the distribution, sale, purchase, marketing and supply of information of products and services through the internet" [7]. This leads to insecurity in potential customers regarding web-based commercial transactions [8].

Considering the problem areas of the textile sector and the advantages of the electronic commerce for the links of the production chain, in this paper a cooperative architecture of logistical e-commerce operators is proposed which is fundamental in textile companies, especially SMEs. Currently, said enterprises have no methodologies in place for the transportation of merchandises [9]. Thus, there is a need to unify data referring to said process by developing e-commerce platforms, which optimizes their costs and delivery times.

2. Background

The research discussed in the thesis "Modelling and simulation of a multinational focused in logistical distribution" analyzes different logistical processes with the purpose of reduce them at maximum level, thereby improving interoperability in military operations and optimizing resources [10]. Another study from Tarazona, Diaz, Rojas and Pablo [11] approaches the development of a model based on electronic commerce, whose purpose is to facilitate the control and interaction of the electronic platform that carries out commercial and productive transactions throughout the supply chain of the textile and clothing industry.

The research stated in Jiang, Y., Zhang. Z., Wang, Z, & Sun, H. [12], analyzes various sectors of Asian e-commerce, where improvements are made regarding

security and credibility for customers. Thus, the speeds of merchandise delivery and logistical processes are maximized and client needs are identified. The study from Carlos Danilo Diaz Rojas and Pablo Vergara Gomez [11], e-commerce models were established for the interaction of the links of the supply chain in the textile and clothing sectors in Bogotá.

The present research -followed for this paper- for is carried out with the goal of developing a cooperative architecture based on meta-models for e-commerce platforms, in terms of conditions, interaction strategies and processes, so that SMEs in the textile sector of Bogotá can develop and ease their logistical system in favor of e-commerce business model.

3. The textile sector in Colombia

The textile industry is one the most dynamic and important sectors in Colombian economy. Currently, Colombia has approximately 450 textile companies and 10.000 clothing manufacturers, most of which are catalogued as SMEs. 50% of them has between 20 and 60 sowing machines [13-16]. This sector approximately employs 20% of the national workforce, including more than 130.000 direct jobs and 200.000 indirect jobs, and represents 5% of total exportations.

Textile production in Bogotá is distributed as follows: 42% is located in Puente Aranda, Engativá, Kennedy, Santafé and Los Mártires; where Puente Aranda and Fontibón amass 77% of large companies and 44% of medium-sized companies of the chain. Usme, Bosa, San Cristóbal, Rafael Uribe and Antonio Nariño are localities with an existing precedence of micro-businesses and small companies. In Bogotá, there 5958 clothing transformation companies, which represent 42% of the supply chain of clothing and textile industries, [17].

4. The logistics sector in Colombia

According to the international logistic performing index, Colombia takes the 97th spot with a score of 2.64 (in a scale of 1 to 5). Colombia takes the 64th spot with a score of 2.87 [18], [19] [20], as seen in Table 1.

One of the shortcomings of the country regarding logistical growth is related with its infrastructure: "In order to face commercial agreements, it is paramount to guarantee the movement of merchandises in the shortest time possible, with higher efficacy and cost reduction", [22].

Country	Year	LPI Rank	LPI Score	Customs2	Infrastructure3	International shipments4	Logistics competence5	Tracking & tracing6	Timelin
Algeria	2014	96	2.65	2.71	2.54	2.54	2.54	2.54	3.04
Colombia	**2014**	**97**	**2.64**	**2.59**	**2.44**	**2.72**	**2.64**	**2.55**	**2.87**
Burkina Faso	2014	98	2.64	2.50	2.35	2.63	2.63	2.49	3.21
Belarus	2014	99	2.64	2.50	2.55	2.74	2.46	2.51	3.05
Ghana	2014	100	2.63	2.22	2.67	2.73	2.37	2.90	2.86
Senegal	2014	101	2.62	2.61	2.30	3.03	2.53	2.65	2.53
Liberia	2014	102	2.62	2.57	2.57	2.57	2.86	2.57	2.57
Honduras	2014	103	2.61	2.70	2.24	2.79	2.47	2.61	2.79
Ethiopia	2014	104	2.59	2.42	2.17	2.50	2.62	2.67	3.17
Nepal	2014	105	2.59	2.31	2.26	2.64	2.50	2.72	3.06
Solomon Islands	2014	106	2.59	2.49	2.46	2.22	2.72	2.72	2.96

Table 1. Score of the Logistic Performance Index, [21].

5. Horizontal collaboration

Horizontal collaboration focused on logistical processes is a useful tool when the distribution and transportation needs of two or more companies can be unified since it lowers costs and offers clients lower prices. Furthermore, competitiveness in the market is increased. The savings in terms of costs using horizontal collaboration have significant impact in SMEs, since these are based on economies of scale, which means more affordable fees with increased bargaining power and usage of wider fleets as well as a better design of the shipment logistics [23].

6. Legal framework

Legal framework of horizontal collaboration and e-commerce

In 1998, Law 79 of the Colombian Congress [24] established parameters for the collaboration between companies in the country, including 162 articles, focused in the creation of companies with legal representatives and registration. The law was modified by Act 2150 of 1995. In the same year, Law 454 of August was stated as a solidary economy, in which the Fund of Warranties was consolidated for financial, savings and credit cooperatives [25].

In Colombia, Law 1266 of 2008 regulates the fundamental right to habeas data, stipulated in Article 15 of the political constitution. This article is related with the protection of data regarding financial, loaning, commercial information, among others [26].
In 1999, Law 527 was created to determine the bases of legal and evidentiary validity focused in data management, by establishing specific requirements. The regulation focused in digital processes generates parameters and conditions that must be fulfilled by open and closed certification entities, for the authorization, vigilance and control of activities within the purview of the digital market, [27].

7. Horizontal collaboration architecture based in e-commerce metamodels

General overview of the architecture

The horizontal collaboration architecture to be developed comprises: Establishment of the semantics of the e-commerce process, Extraction of the taxonomy focused on electronic commerce logistics, Establishment of the ontology based on the obtained semantics and taxonomy, Extraction of a specific-domain language to manipulate data referring to logistical processes, Transformation of said language into data that can be easily accessed by the end user. Figure 1 shows the development of the previously described process:

Figure 1. Objects obtained in each process. Source: own.

8. Description of common modules in e-commerce platforms

Opencart

Opencart is an online store developed under the GNU general public license and launched in the year 2000. The store comprises two modules: the catalogue (Front-end) where clients navigate to search and purchase products and a management tool (back-end) where the administrator can establish different options related with the operation and identity of the store [28]. The catalogue in the Opencart platform comprises: Inventory management, Image configuration, List of products and Categories.

Magento

It is an open source system of online stores that grants access to stores from mobile devices. It gives to possibility to advance to commercial versions and increase expansion power compared to other electronic stores. The paid version offers many functionalities such as the capacity of scaling the system or develop apps for tablets and mobile devices [29]. The catalogue for this platform offers the following services: Category management, Revisions and assessments, Google content, and Search terms.

Prestashop

Prestashop was created in 2007 in France by Igor Schumberger and Bruno Lévêque. Its purpose is to

render e-commerce sales more accessible. It has a solid back-office, which can manage components such as catalogues, order histories, shipping expenses and customers, [30]. The components of the Prestashop catalog are: Attributes and values, Image mapping, Adjuncts, Labels, Characteristics, and Categories.

Comparative analysis of the platforms

Table 2 shows some of the influential factors to perform a correct distinction between platforms, since this is essential to develop a proper semantic model.

Criterion	Magento	Prestashop	Opencart
Version for tablets and mobile devices			
Interface management	Yes	Yes	Yes
Mobile	Yes (limited)	Yes	No
Mobile applications	Yes (limited)	Yes	No
HTML5	Yes (limited)	Yes	Yes
Complexity	Source	Average	Average
Information of products and services			
Detailed description of marketing	Yes	Yes	Yes
Portability	No	No	No
Social	Yes	Yes	No
List of stores	No	Yes	No
Extranet stores	No	No	No
Geolocation	No	Yes	No
Existence in stores	No	No	No

Table 2. Comparative analysis between e-commerce platforms. Source: own.

The platforms with more time on the market have an advantage over recent ones. In this case, it is concluded that Opencart has more options available for management from mobile devices. In terms of the information of products and stores, Prestashop is the leading software since it has more detailed information on customers, products and stores.

9. Common taxonomy in e-commerce platforms

In order to build a domain taxonomy, it is necessary to have expert knowledge on the different e-commerce platforms. In order to properly carry out the process, knowledge maps are created seeking to define a common taxonomy based on the data obtained, [31], [32].

In order to identify a common taxonomy, the information of the platforms must be classified according to similar characteristics and data must be organized depending on hierarchy [33] [34]. The relations between the attributes and the similarities of Prestashop, Opencart and Magento must be recognized in all the logistical processes such as sales, products, merchandise transportation, customers and catalogues. A detailed description is carried out of the taxonomies of each platform to proceed with the generation of the taxonomy common to all platforms.

Taxonomy for the catalogue

Table 3 exhibits the data corresponding to the catalogue category of the respective stores.

Catalogue		
Opencart	Magento	Prestashop
Monitoring	Revision of attributes	Inventory
Product	Images	Categories
Manufacturer	List of products	Products
Attachments	Categories	Search terms
Characteristics		Google content
Labels		Labels

Table 3. Content of the catalogue in e-commerce platforms. Source: own.

The taxonomy corresponding to the catalogue is comprised of category, image configuration, inventory and list of products.

Taxonomy for clients

The customer data in the platforms is exposed in Table 4.

Client		
Opencart	Magento	Prestashop
Transactions	Customer attributes	Contact data
Contact data	Client management	Client attributes
Personal data	Groups of clients	Address attributes
Location	Direction attribution	Fees
Groups of clients	Fees	
Blocked users		

Table 4. Composition of clients in the e-commerce platforms. Source: own.

The taxonomy corresponding to customers is comprised of: companies, contact information, personal information, location and news related with purchases made by clients and his preferences.

Taxonomy for the product

The information corresponding to the product in the

platforms refers to prices, description, name, existing units and status. Table 5 exposes said information keeping in mind each platform.

Product		
Opencart	**Magento**	**Prestashop**
Categories	Attributes	Images
List of products	Revisions and assessments	Categories
Description	Category management	List of products
Inventory	Product management	Inventory
Prices	Search terms	
Suppliers	Google content	
	Labels	

Table 5. Composition of products in e-commerce platforms. Source: own.

In the identification of the product taxonomy, it was established that it comprises Categories, subcategories, image configuration, inventory and list of products.

Taxonomy for transportation

The transportation data comprised in the analyzed platforms is detailed in Table 6.

Transportation		
Opencart	**Magento**	**Prestashop**
Shipping costs	Table of cots	Clients
Rates	Rates	Payment methods
Billing	Transportation	Delivery address
Zones	Operators	Status
Logos		Comments
URLs		Billing address

Table 6. Composition of merchandise transportation in e-commerce platforms. Source: own.

The taxonomy common for transportation is comprised of billing data, shipping expenses, rates, shipping reports and payment reports.

Taxonomy for sales

The data comprising sales in said platforms is listed in Table 7.

Sales		
Opencart	**Magento**	**Prestashop**
Billing	Bills	Clients
Name	Terms and conditions	Sold products
Coins	Orders	Viewed products
Prices	Reports	Total sold
Suppliers	Shipments	
Attributes	Taxes	
Characteristics		

Table 7. Composition of sales in e-commerce platforms. Source: own.

Finally, the components of the taxonomy of sales are: information on the customer that purchase a product, purchase mode, type of purchase, bought products and a report with the taxes paid for the products sold. Based on the presentation of the e-commerce platforms, a knowledge map (Figure 2) is created resulting from the identification process of the taxonomy common to all platforms.

10. Semantics of logistical processes in e-commerce

To identify the semantics of the logistical elements in e-commerce, concepts were gathered coming from knowledge maps of several platforms. A common taxonomy was established in order to finally use the algorithm proposed by (Dietz, Vandic & Frasincar) [35], which proposes a series of information filters, which are mentioned in this section to avoid data redundancy.

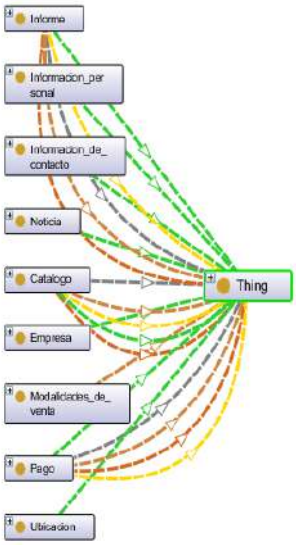

Figure 2. Taxonomy map, needed for the generation of the ontology. Source: own.

The information filters are: Pertinence of the domain, Domain consensus, Lexicon of cohesion, Structural pertinence, and Various.

Considering that the previous algorithm and the information obtained from the e-commerce platforms, a series of "data groups" is established: Classes, Object properties, Data properties, Notes properties and Individuals.

11. Ontology for the semantic model of e-commerce

For the creation of the ontology, the methodology proposed by Noy & McGuiness [36] is the official guide provided Protégé (Stanford Center for Biomedical Informatics Research, 2010), which defines an ontology and proposes the following steps in its construction: Determine the domain and scope of the ontology, Consider the reuse of existing ontologies, Enumerate important terms for the ontology, Define the classes and their hierarchy, Define the properties of the classes (slots), Define the facets of the slots (or data) and Create instances or individuals. Figure 3 shows a fragment of the project ontology and a class created with the developed ontology and its respective objects.

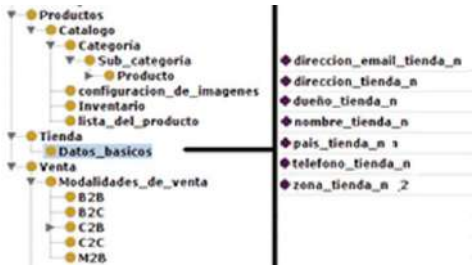

Figure 3. General overview of a class created with the obtained ontology with its respective objects. Source: own.

After creating the ontology, it is concluded that the studied e-commerce platforms use different standards in their databases as well as user interfaces and programming languages yet the main modules are similar. The main problem involves the technological implementation carried out in each platform. Hence, the possible solution to facilitate the creation of independent modules is the application of Model-Driven Engineering (MDE).

12. E-commerce meta-models

The meta-models come from the abstraction of the real world. In order to perform proper modelling, an identification of the elements is required. Said identification creates an ontology in which the concepts, languages and components are established, thereby setting the foundations of the data abstraction process, divided into various levels: Object level: Objects of the real world, Object software, Model level: Domain of ontologies, Models, Meta-model level: Concept description, Concept language and Meta meta-model level: Domain analysis, Design of specifications. [37] Based on a pre-established architecture, the specific e-commerce ontology can be created in order to generate the correct meta-model. The Horicoop meta-model shown in Figure 4 was developed in Eclipse, whose nomenclature sets some writing rules. The first vocal or consonant must be written in capital letters, the other components of the word must be written in lower case and the words are separated by using a connecting line depending on the data type. The string or numeric type must have an 'E' preceding them.

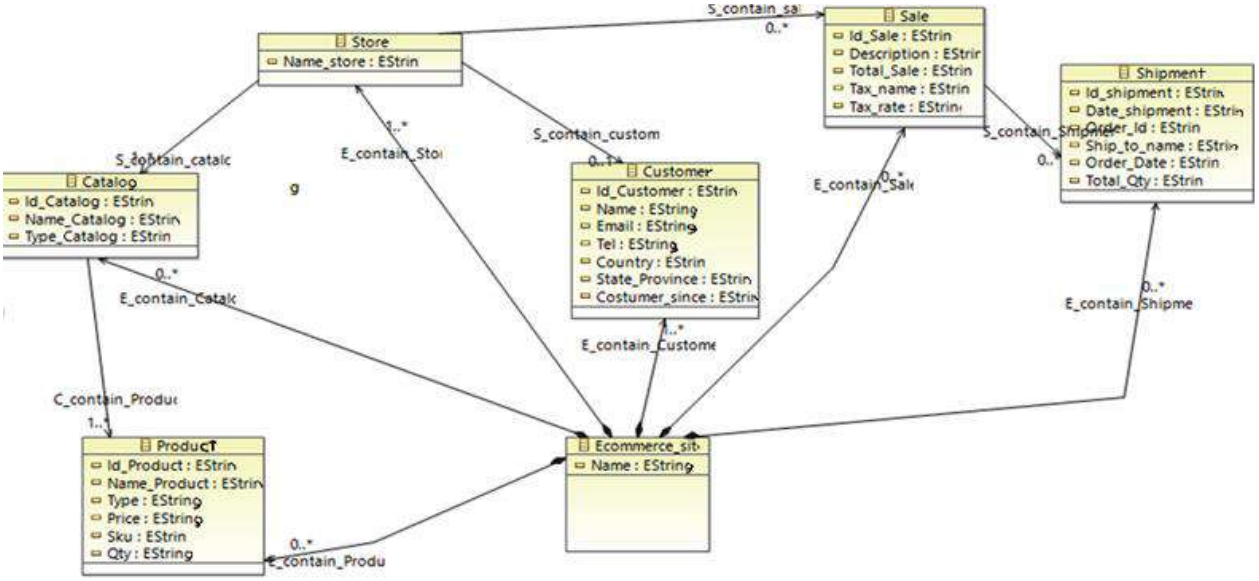

Figure 4. Base meta-model for Horicoop. Source: own.

Figure 5 describes the "Ecore" base for the prototype and for the respective transformations in the meta-model applied to the e-commerce in the textile industry of Bogotá.

Figure 5. Ecore of the meta-model of Horicoop. Source: own.

13. DSL tool for e-commerce platforms, HORICOOP

To establish the DSL, Helios Eclipse was used, which includes the components Eclipse Modeling Framework and the Graphical Modeling Framework. The EMF was used to define and detail the meta-model for the Horicoop application. The Graphical Modeling Framework is used to establish a process to transform the meta-model into a domain-specific language. "The GMF has a more natural disposition of these data in order to create personalized interfaces depending on the definition of the business" [38].

In order to predict the solution to the real world problem, it is necessary to have certain levels of abstraction. Hence, the behavior of the processes can be adequately transformed into a model to subsequently give origin to a meta-model and finally develop a meta meta-model. The creation process of the model begins with the elaboration of the Domain Model, which is used to generate the Domain Generator Model. Then, the "Graphical Definition Model", the "Tooling Definition Model" and the "Mapping Model" are developed. The last step for the creation of models using the GMF is called the "Genmodel Diagram editor" which is comprised of the last three models. The "meta-model" and the "GMF" can generate XMI files (XML Metadata Interchange) which are a specification for the exchange of diagrams. In the case of this project, the Ecore Model of the EMF is used to generate the XML by transforming the data corresponding to the electronic logistics of real world components into the data of a meta-model.

The meta-model developed in this research project focuses on the data types with more information traffic in the electronic logistics of the e-commerce platforms: Products, Sales, Merchandise Transportation, Catalogues, and Clients.

14. Transformation BETWEEN MODELS

The transformation process between models converts an input model, described as a specific origin meta-model, into another model described by a destination meta-model. The "Ecore" (based on EMF) from Eclipse manages a transformation language between models called "ATL". This model is the highest specification of the model pyramid (M3). The ATL is a language that offers a series of standard development tools (syntax highlighting, depurator, etc.) which has the purpose of facilitating the development of transformations between models. "The 'ATL transformation' process is comprised of rules that define over which elements of the origin model they are used, as well as which elements of the destination model are constructed" [39].

15. HORICOOP meta-model

The creation process of GMF establishes a series of steps. The first one is the creation of the Domain model, which copies the code obtained from the meta-model and uses transformation patterns to generate the Java code which is used in subsequent parts of the process.

The construction of a GMF defines a specific order for the creation of the components coming from the meta-model, detailed in Eclipse in these steps: Create a new GMF Project, Create a new Graphical definition model, Create a new Tooling definition model, Create a new

Mapping definition model, Create a new Generator model, Check problems of the generator model, and finally Generate the Java code.

The meta-model experiments data transformation processes with the help of the "ATL from Eclipse EMF" which facilitates the creation of a specific model, following the steps given by the GMF. Keeping in mind the creation process for the creation of the GMF, the artifacts (store, sale, catalog, customer, product, and shipment) coming from the generation of the meta-model were obtained as well as the prototype derived from the Horicoop project.

16. XML format delivered by the meta-model

After the data modelling with Horicoop, a file in XML format is obtained which is used as a base for the mobile app visualized by the user. Horicoop transforms the data coming from the XML file into a structure easily accessed by the users and the logistical operator. The latter can transversally visualize the SHIPMENT of the e-commerce platforms discussed in this article. The data are altered through the ATL algorithm, being transformed from raw data of each platform into an XML file that is then displayed in the mobile app in the form of a table.

The design and development of the Horicoop mobile app was carried out with the purpose of facilitating and optimizing the logistical processes, especially in transportation times and costs of the merchandises offered by the three e-commerce platforms Magento, Prestashop and Opencart.

17. Conclusions

Horicoop is a mobile app that seeks to improve costs and delivery times allowing organizations to become more competitive in the market and break frontiers through digital tools that are adopted internationally and give more satisfaction to the customer with excellent quality products at good prices.

Within the development of this research, it is necessary that the Ministry of ICTs promotes the use of electronic commerce platforms so that the SMEs located in Bogotá can increase their potential client base, widen their market segment and reduce costs and expenses related to inadequate logistic design.

In the framework of collaborative commerce, the management and exchange of knowledge is crucial both inside and outside of the company. It can improve the development of processes, methodologies and tools and thereby mitigate or remove possible flaws and adapt to the ever-changing environment, increasing competitiveness and quality in the market.

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