Available online at www.jlls.org

JOURNAL OF LANGUAGE AND LINGUISTIC STUDIES

ISSN: 1305-578X

Journal of Language and Linguistic Studies, 18(4), 896-917; 2022

Conceptual Design Of A Decision Support Model For Production Planning In The Tailoring Companies Located In The City Of Ibagué

Carolina Suárez Roldan[1], Fredys A. Simanca H.[1], Germán Andrés Méndez[2], Marco Fidel Suárez Góngora[3]

[1]Universidad Cooperativa de Colombia

[2]Universidad Distrital Francisco José de Caldas

[3]Servicio Nacional de Aprendizaje SENA

APA Citation:

Roldan, C.S.R., Simanca H, F.A., Méndez, G.A., Góngora, M.F.M. , Conceptual Design Of A Decision Support Model For Production Planning In The Tailoring Companies Located In The City Of Ibagué ,*Journal of Language and Linguistic Studies, 18*(4), 896-917

Submission Date: 07/10/2022

Acceptance Date: 06/12/2022

Abstract: Challenges faced by companies are increasingly greater, which is why decision making in production planning is a key factor for their continuity and competitiveness. One of the most affected sectors due to the increase of imports is the clothing industry, for this reason, we proposed a model of decision making in the production area. For its development, we applied the phases of acquisition, knowledge representation and decision making that determine an organizational Intelligence Model. In the acquisition phase, characteristics of the production systems were identified, highlighting the role that the machine has in the system survival, the decrease of the region's own product and the absence of knowledge and/or tools for production planning. In the next phase, the main components of the model are determined, in the last phase, the complete model is developed, and the computational tool applied for analysis, as well as related validation. A model focused on production planning was designed, which contemplates the needs of the companies in the region, generates information and projects future situations for decision-making.

Key Words: Intelligence Model, Decision Making, Production Planning, SME´s, Clothing sector.

1 Introduction

In Colombia, 96.4% of the productive sector is composed by Micro, Small and Medium-size enterprises (MSMEs), 92.6% of which are microenterprises and 3.7% are small and medium-sized enterprises [1]; for this reason, MSMEs have become pillars of the local and national economy, since they provide 85% of total employment in most Latin American countries [2]. It is also evident that MSMEs face great challenges and adversities, such as, the economic situation of the nation that affects the purchasing level of consumers, access to markets due to unfair competition, smuggling and informality, lack of technology, lack of leadership, difficulty in accessing financing due to the number of requirements and guarantees requested by financial institutions and lack of innovation, among others. Therefore, MSMEs require a rapid response capacity to the increasing demands and projections in the environment [3] [4], access to and analysis of information is a critical and key resource for the survival and competitiveness of organizations.

Another challenge related to the permanence and coverage of markets is the increase in imports of products arriving from the east, with a very low price offer, which discourages domestic production. Among the business sectors that have been most affected is the clothing industry, involving major regions such as Bogota, Antioquia, Tolima and Valle [5] . Based on the above, the Department of Tolima is committed to reactivating the primary and secondary sectors, which include cotton, textile and clothing manufacturing production. Since the participation of these economic activities is representative in the economic development of the region, which in recent years has shown a decrease [6]. Likewise, decision making is usually based on the experience and intuition of SME managers, without integrating other types of knowledge and tools that help to analyze the complexity of environmental changes and their implications in decision making that determine the competitiveness and productivity of companies [7] [3] [8].

In other words, the value of information in decision-making is recognized as a key factor in the survival and growth of SMEs [9]. For example, the lack of costing systems and price estimation to determine a profit margin is a symptom of the lack of organizational structure and information [4].

Similarly, it is identified that the access and formalization of accurate technology is another obstacle for SMEs in Colombia [10], due to the limitation of financial resources and the type of robust solutions found in the market, since it does not fully respond to the needs and dynamics of the operation of these organizational units [11]. Therefore, the priority of implementing mechanisms to generate knowledge in these organizations is urgent, in order to guide decision-making and design new competitive strategies in SMEs. It is recognized, therefore, that intelligence models respond to the challenge of creating knowledge, being this, one of the inevitable and urgent challenges that companies require, since the successful implementation leads to the overcoming of barriers that contribute in the first instance to the survival and a significant improvement in the competitiveness of enterprises. Consequently, the term of intelligence is related to three elements, the first "considers information as a valuable asset that brings competitive advantages to the organization". The second "the processes of assimilation, treatment and dissemination of this information transformed into knowledge" and the third "converts information and knowledge into effective actions within the organization such as improved problem solving, efficient decision making or better adaptation to the environment" [12]. Likewise, [13] identifies a direct relationship between the appropriation of Knowledge Management (KM) and organizational culture, in other words, it is necessary to advance in the acquisition and appropriation of KM competencies in

individuals, so that this capability is developed in an organizational culture, which is characterized by strategies and value propositions.

In this sense, Table 1 lists the search chains designed from the possible combinations of key concepts corresponding to: intelligence model(s), SMEs, production, clothing. Then the Scopus database is used for the search process in which the following criteria are defined: two searches, the first is performed on the titles of the articles (T) and the second on the titles, abstract and key words (T - R - PC), all years are reviewed, and the type of access is all. From the results in Table 1, it is identified that the number of articles related to the model words(s) of intelligence and production is low, since the respective searches report only one document (T) and 35 articles (T-R-PC). Therefore, it is recognized that none of the reported documents present a direct relationship with the object of study of this manuscript, which is an indication that the topic has not been sufficiently investigated in this type of literature. Is important to clarify that the original language of this article is Spanish, so was the searching of the key words inside the database.

Table No.1 Results of Key Concepts in Search Chains

Criteria	Model(s) Intelligence	Production	Small and Medium Business	Making	No. Documents
T	X				182
T-R-PC	X				698
T	X	X			1
T-R-PC	X	X			35
T	X	X	X		0
T-R-PC	X	X	X		0
T	X	X	X	X	0
T-R-PC	X	X	X	X	0

Title (T), Review(R), Key words (KW)
Source: The authors– Scopus

In summary, there is a need to strengthen and reactivate the productive systems of the Tolima region, as is the case of the textile apparel industry, which is one of the sectors that significantly increases employment levels and the quality of life of society. For this reason, we propose the design of a decision support model focused on production planning to guide the management functions that are of great importance in the productivity and competitiveness of production systems, in such a way that it contemplates the dynamics, changes and needs of the context in the decision making process of these companies.

The article is presented as follows: the first section presents a contextualization of the components of the study object of the research. The second section relates the methods used in the design of the decision support model for production planning. The third section relates the most relevant results and discussions of the acquisition, representation and decision-making phases and ends with the conclusions.

1.1 Production Planning

Production planning is a function at the management level that allows estimating in advance the needs of physical resources (raw materials, materials, machinery) and human talent required for the manufacture of products. Therefore, Production Planning involves making decisions that affect the policies that guide the actions in the long, medium and short term, which has a scope in each of the organizational levels [14]. It is important to mention that decision making is the result of analyzing the opportunities and threats of the different options, which imply determinations about the goals and courses of action of the organization [15], being this a critical component in SMEs, since the current state of the process is produced by the actions that have been taken in the past and that influence the future.

1.2 Organizational Intelligence Models

The decision support model for production planning in apparel companies located in the city of Ibagué is designed based on the components of an organizational intelligence (OI) model, as it allows the generation of knowledge, which is the critical resource that SMEs do not have, and which is also required for decision making that leads to the survival and competitiveness of these organizations in the region. For the above reasons, [16] develops a review in the field of OI and proposes a new definition that integrates the different ways of understanding OI:

"Organizational intelligence is defined as the systemic capacity of all the intellectual capital of an organization to learn from its history and the present, building day by day a sustained healthy future, through a creative and effective process in the perception of the internal and external environment, in the creation and management of knowledge, and in the decision making process...."[16].

According to the above, the OI allows strengthening and increasing intellectual capital, based on individual and collective changes for the benefit of a common good, such as the transformation of goods and services with greater benefit. Therefore, OI becomes a cornerstone of economic, political and social development [17], since it allows to analyze and evaluate from different approaches. Table 2 shows the main components and principles of the OI, which have generated positive changes in different companies around the world.

Table No.2 OI Components and Principles

Components	**Principles**
How the organization processes information about itself and the environment.	Create a sense of urgency about the need to improve OI.
The memory that retains the experience in a useful and accessible way.	Knowing the current OI profile.
How the organization develops and improves its knowledge (effectiveness of collective thinking and decision-making processes).	Address issues of highest priority and organizational impact.

Components	**Principles**
Organizational culture and communication among members of the organization for the exchange of data, information and knowledge.	Monitoring progress through OI management

Source: Elaborated based on [18] [19]

Other types of intelligence related to the organization are competitive intelligence (CI) and business intelligence (BI), which are very important in strategic decision making through the process of information management, and which are studied in the areas of engineering, computer science and business in greater proportion, since they account for 90% of scientific production [20]. Likewise, [21], establishes a framework that integrates the elements of business intelligence (BI), business analytics (BA) and organizational performance management (OPM) in the public sector, which is why 20 important elements are recognized in the BIAPM implementation process (BI, BA, OPM Integration) that are classified into four main components Process, Governance, People and Capability.

Some of the 20 elements are top management, performance manager, BI implementer, data scientist, work culture, technology, strategic planning, decision maker, performance evaluation, among others. Equally, it is verified that in the implementation process all parties must have the appropriate skills in their respective fields, in addition to having qualified support staff, a positive work culture and data visualization. In summary, intelligence models allow companies to generate knowledge that guides future actions by obtaining, storing and processing information and develops behaviors that deliberately seek to predict or anticipate the consequences of their own and third parties' decisions with the objective of improving the competitiveness of companies, being one of the main challenges faced by managers of intelligent organizations. In accordance with the above, Table 3 shows a conceptual classification of the intelligence models according to the development that has occurred over time.

Table No.3 Intelligence Models Classification

Information Management Models	**Knowledge Management Models**	**Intelligence and learning Models**	**Mixed Intelligence Models**
Based on the processes of recovery, reading, recognition, reinterpretation, revision, issuance and restructuring. They are exclusively oriented to computer resources (technological strengthening) and to the restructuring of	It studies the organizational capacity to generate new knowledge. It mainly contributes to organizational intelligence in the phase of knowledge assimilation or transformation of data and information into knowledge.	Pure models of intelligence are located, since they comply with the three elements (information, knowledge assimilation and decision making).	Characterized by being more complete, newer and innovative models. They are empirical models focused on a specific sector. Explain the concept of intelligence by means of phases with the purpose of clarifying the concept.

Information Management Models	**Knowledge Management Models**	**Intelligence and learning Models**	**Mixed Intelligence Models**
processes due to change.			

Source: The authors based on [12]

1.3 Tailoring Industry

The textile and apparel sector in the Colombian economy was characterized as one of the sectors with the greatest generation of employment, tradition and dynamism, but unfortunately in recent years because of the difficulties that were named above plus smuggling and non-legal practices in trade, have seriously affected the competitiveness and stability of these companies [6]. Of the municipalities in the department of Tolima, the one with the largest number of garment companies is the city of Ibagué with a total of 657 companies as of August 31, 2018, in which there was an increase of 124 companies in the department of Tolima, according to the report [22].

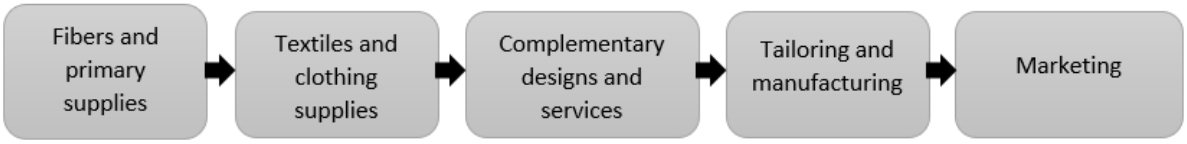
The production chain of the textile and apparel sector is divided into four links: the first is made up of suppliers of primary inputs (natural and/or synthetic materials and fibers such as cotton, wool, nylon and polyester), the second is made up of textile spinning and weaving companies (weavings, embroidery, printing and dyeing). The third link is organized by apparel companies (manufacturing of final and complementary products) and the last is made up of marketing companies that operate through different channels (see Figure No. 1) [5].

Figure No. 1 Production Chain of the Textile and Apparel Sector in Colombia

Source: The authors based on [5].

Moreover, 97.7% of the companies are micro-sized, 2% are small-sized and 0.3% are medium-sized in the textile fiber, apparel, design and fashion chain, which is why there are few large-sized companies in the city of Ibagué. Likewise, the companies that participate in the textile and apparel sector chain are classified into five links (see Figure 2), which are distributed as follows: 2% for companies in primary fibers and inputs, 3% for textile and apparel companies, 22% for design and complementary services organizations, 16% for apparel and manufacturing companies, and 57% for companies in charge of marketing. On the other hand, the information received by the Ibagué Textile and Apparel Cluster from the Cámara de Comercio in 2013 lists a total of 340 companies that are part of the fourth link (Apparel and Manufacturing), in which 96% (325) of these companies are micro-sized, 3% are small-sized (11) and 1% are medium-sized (4) [6].

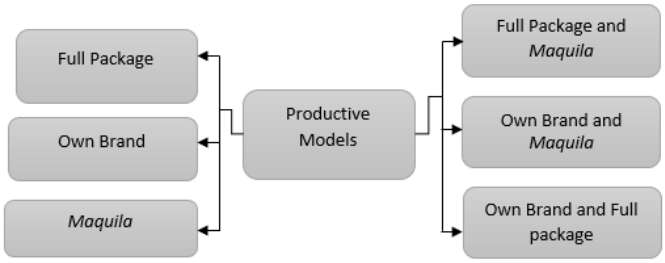
Figure No. 2 Productive Chain of the Textile and Apparel Sector in the city of Ibagué



Source: The authors based on [6]

Another relevant characteristic that has become more pronounced in recent years is the segmentation that corresponds to small units called outsourced maquiladoras, which give rise to the outsourcing (sale of services) of certain sub-processes. In view of the above, Figure 3 shows two blocks of production models, the one on the left refers to traditional production models, and the one on the right is a combination of traditional models with the means of production called maquiladora workshops. Therefore, it has been identified that in medium and small-sized companies in the apparel sector, the maquiladora activity predominates in relation to the complete package and own brand [6].

Figure No. 3 Productive Models of the Apparel Sector in the city of Ibagué



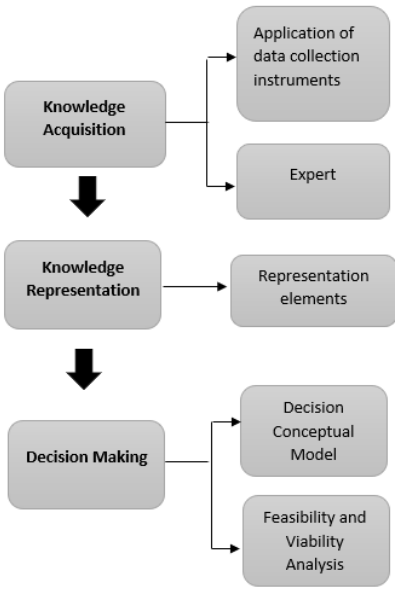
Source: The authors based on [6].

In conclusion, it is relevant to mention that the textile and apparel industry is currently going through a difficult moment that reflects a decreasing demand, high inventories and the permanent entry into the country of products at very low prices. In the month of June 2017, the tailoring sector presented a drop of 13% in relation to the same month of the previous year, being the textile apparel sector the second activity that contributed the most to the generalized drop in manufacturing [23]. For the above, the apparel sector requires strategies that allow it to be more competitive and productive in the local, national and international market.

2 Development of the Conceptual Model from the foundations of an Intelligence Model

Within the framework of the research, a descriptive observational study was developed to characterize production planning in the apparel companies in the city of Ibagué. Figure No. 4 shows the methodology for the design of the conceptual model that specifies attributes of the production systems of the SMEs analyzed.

Figure No. 4 Methodology of the Decision Model for Production Planning

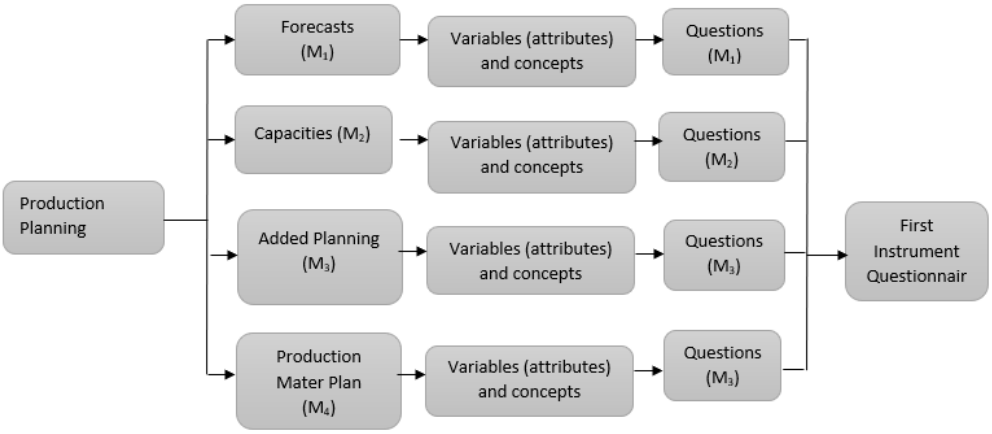


Source: The authors

2.1 Knowledge Acquisition Phase:

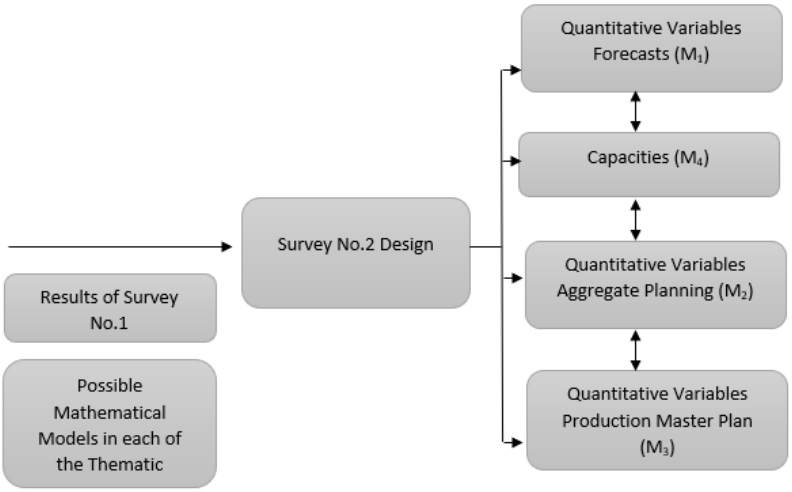
It consists of the design, validation and application of two information-gathering instruments applied at two different times. The first instrument measures the level of appropriation that the companies have with the Production Planning technique, being a more qualitative instrument. On the other hand, the design of the second instrument is of a quantitative type, since it numerically investigates the variables of interest identified in the first one. The technique used is the survey applied by means of a questionnaire based on the variables to be measured. Figures 5 and 6 show the design of the questionnaires, which consist of four modules corresponding to the scope of Production Planning: Forecasting (module 1), Capacities (module 2), Aggregate Plan (module 3) and Master Production Plan (module 4).

Figure No. 5 Design of the First Questionnaire



Source: The authors

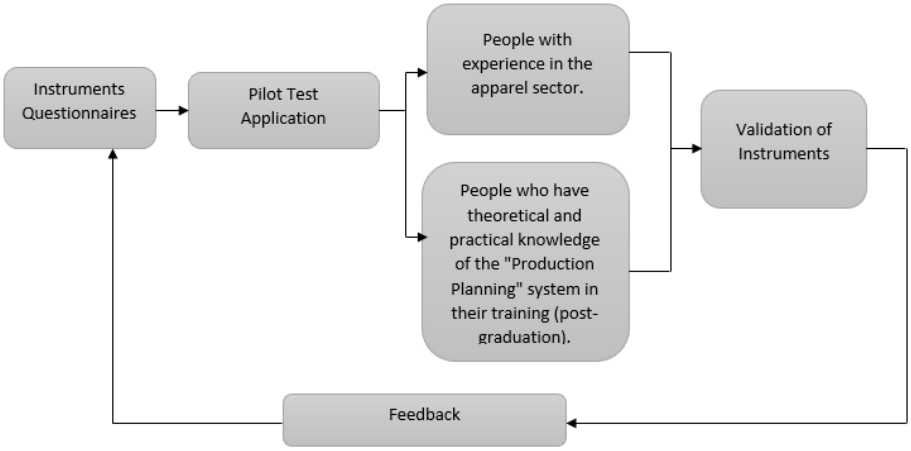
Figure No. 6 Design of the Second Questionnaire



Source: The authors

Next, the reliability and validity of the data collection instruments were reviewed (see Figure 7) to determine the degree to which their repeated application produces the same results and the confidence level with which the instrument represents the variable it is intended to measure. The result of the validation led to change technical concepts to a simpler language for the type of profile of the surveyed and to widen the response options in order not to limit the results.

Figure No.7 Validation of the Information Collection Instruments



Source: The authors

Initially, the sample size for the application of the first instrument is established according to the number of companies linked to the Apparel cluster in the city of Ibagué. Therefore, the first instrument was applied to 13 micro, 11 small and 2 medium-sized companies for 26 economic units. According to the results of the first questionnaire, few organizations have information or traceability of the operation of the production systems, which is why the sample size was smaller in the second instrument.

2.2 Decision Model Representation

In this phase, it is established that the representation of the decision model is designed according to the four components that are part of production planning, these are:

- **Forecasts**: correspond to quantitative modeling that allows projecting the number of units of final products to be manufactured according to market needs.
- **Capacity:** consists of two processes, assignment and leveling, which determine the organization's work potential, which can be expressed in production volume or time.
- **Aggregate Production Plan**: an aggregate unit is defined, which is determined by the product families, and estimates the medium-term needs of the labor force required in the manufacturing system. This component evaluates combinations of labor strategies and whether it is necessary to expand capacity to reduce the total cost.
- **Master Production Plan**: the aggregate unit is disaggregated into specific products, so that the quantities and exact manufacturing dates of the final products are estimated.

2.3 Decision Making

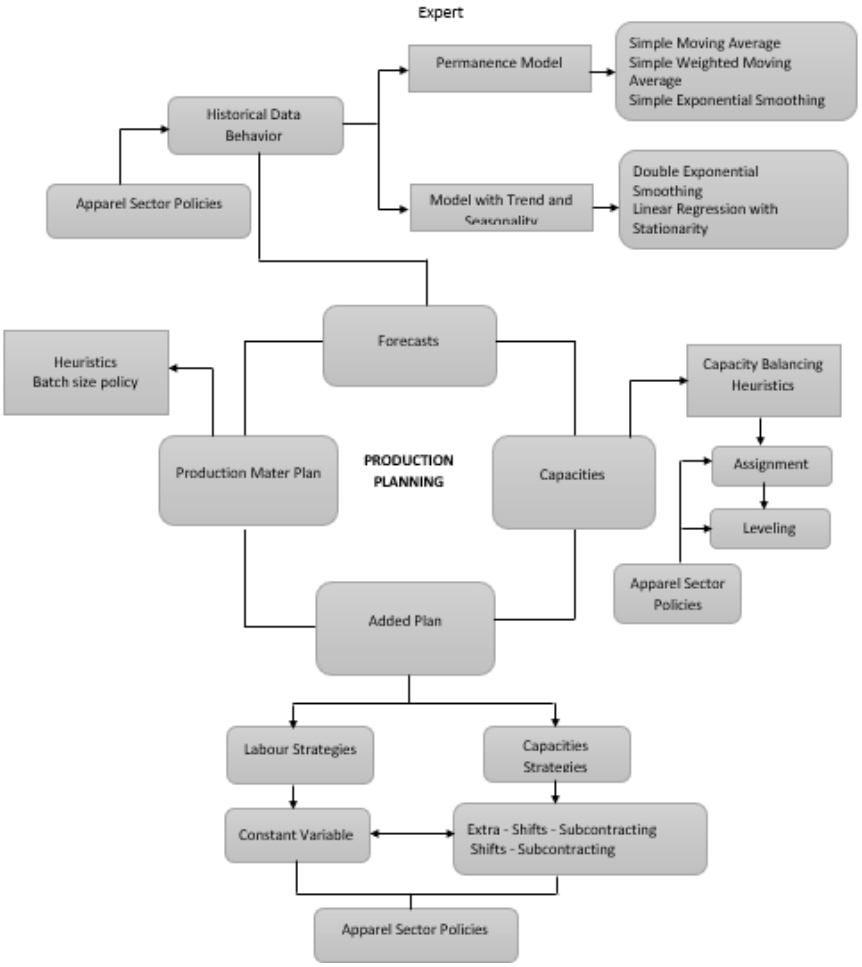
It consists of two stages: the decision support model and the feasibility and viability analysis.

- **Decision Support Model for Production Planning**: Figure No.8 shows the model in which the mathematical models that are part of each of the modules are related in a general way. A brief description of each is given below:
- **Forecasting Module:** establishes two groups that correspond to mathematical models with permanence and models that contemplate trend and seasonality, being behaviors that present the demand for the various products (garments) manufactured in the apparel sector. The output of this module is the quantity of garment units estimated for each of the production lines.
- **Capacity Module:** requires the output of the previous module and the configuration of the manufacturing system related to current policies and resources, such as number of shifts, shift hours, number of work centers, among other conditions. It is important to mention that in this module two heuristics are applied that use the sector's own policies. The first one allows developing the assignment process, in which the feasibility condition must be met, which consists of the available capacity being greater than or equal to the required capacity. The second one models the leveling process, where the production line type attribute (own brand or maquila) defines the type of rule to be used in the process.
- **Aggregate Plan module:** the unit is aggregated by type of family (pants, shirts, blouses, etc.) and a heuristic is developed that considers the inventories and evaluates the different options of labor and capacity expansion strategies. These capacity expansion strategies are applied if there is a time deficit in any planning period, after having performed the leveling in the previous module.
- **Production Master Plan module**: the production unit (product families) is disaggregated by specific references, in other words, the pants family is disaggregated into the different references of pants that the manufacturing system makes. The result of this module is to determine the quantity of specific products that are required to be manufactured in each of the planning periods.

- **Feasibility and Viability Analysis**: to analyze the feasibility and viability, a computer software is developed to represent the scope and functionality of the decision model. Therefore, the software entitled "Confección 1.0" is designed in function of five modules. The first one corresponds to the "Configuration" of the manufacturing system, and the other four modules are oriented to the components of the production planning, but with the difference that this software, compared to others, contemplates the specific needs and requirements of the clothing sector in the city of Ibagué. The four modules are: Forecasts - Capacity Plan - Aggregate Plan - Production Master Plan. In the development and validation of the computer tool, we had the experience and participation of some businessmen of the sector under study and with the expert who accompanied each of the stages of the research.

According to the current conditions, the "Confecciones 1.0" software is registered with the National Copyright Office (see Figure 9) and has a confidentiality agreement, which limits the information and the level of detail of the tool's development. Likewise, the purpose of the manuscript is oriented more towards the decision model than the development of the tool.

Figure No.8 Decision Support Model for Production Planning



Source: The authors

Figure No. 9 "Confecciones 1.0" Software Presentation

Source: The authors

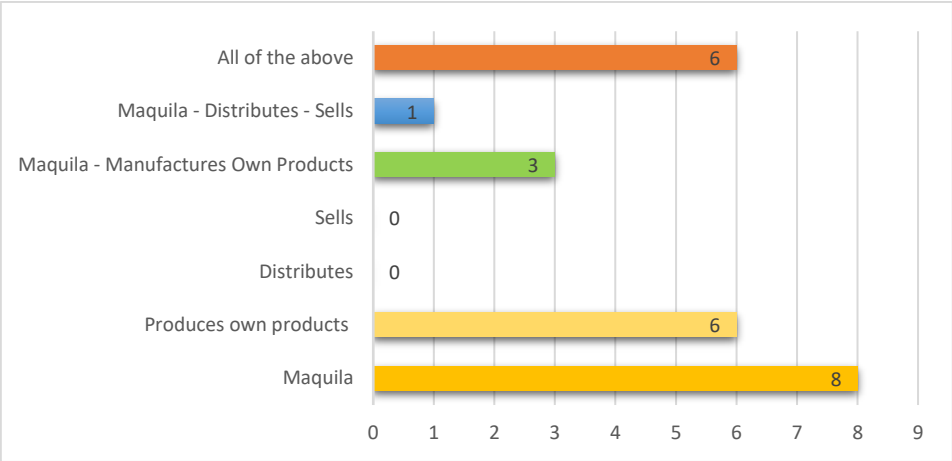
3. Results and Discussion

According to the acquisition of the information, the most representative characteristics of the garment sector in the city of Ibagué are presented.

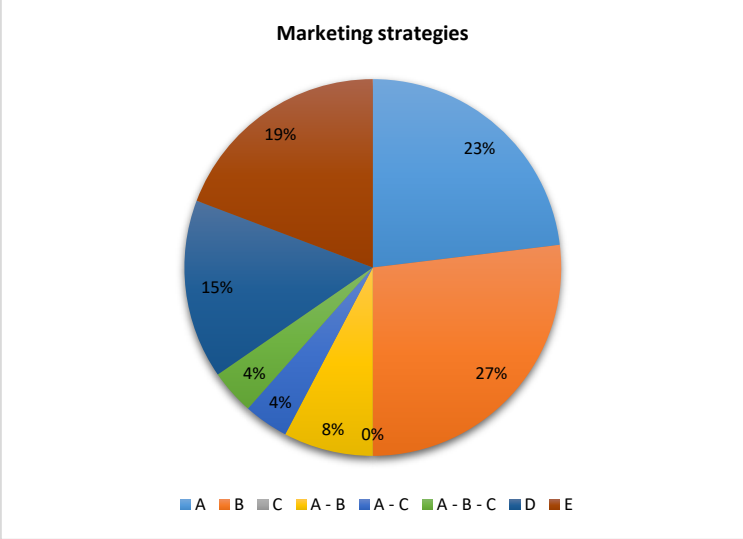
The productive units of the apparel sector in the city of Ibagué in recent years have become suppliers (outsourcing) of medium and large organizations from the same or other cities (Medellin, Bogota), which is why the maquila economic activity is the one with the highest participation with a value of 30.8%. However, in the second place is located the Manufacture of Own Products being this a strong component in those times when the Sector presented a good performance and growth. Likewise, it is identified that in this same place there is a combination of activities carried out by the maquila companies: manufacturing of own products, distributing and selling. According to the above, it is important to mention that the garment sector has shown a reduction in the innovation of new collections, in which the concept of design and fashion is lost, to become maquiladoras of other cities (see Graph No. 1).

Furthermore, the strategies most frequently applied by the companies to have an impact on the market are changing the design of the garments and adding new characteristics to the products (see Graph No. 2). However, 46.15% of the production units do not know and do not respond to the question of whether they know the market and the competition. Which is why it can be deduced that a possible critical factor is marketing, since the productive units manufacture new garments or make changes without fully knowing the needs and expectations of the clients, and also have little or no information on the competition that would allow them to create strategies with greater added value (see Graph No. 3). In addition, there is a representative percentage (46%) of non-compliance with orders (see Graph No. 4).

Graph No. 1 Number of companies according to activity subtype

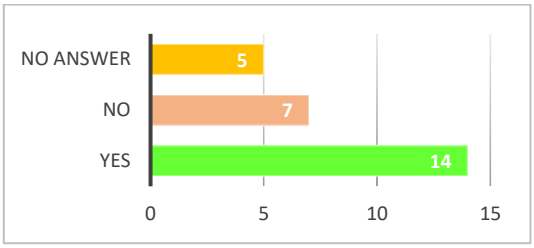


Graph No. 2 Marketing Strategies

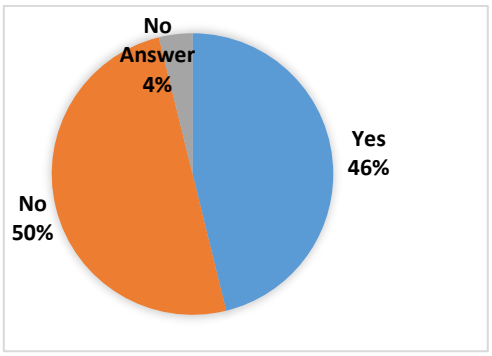


A	New Features of existing Products	B	Change product design	C	Launch New Product Lines	D	No answer	E	Others

Graph No.3 Number of companies that identify market and competition

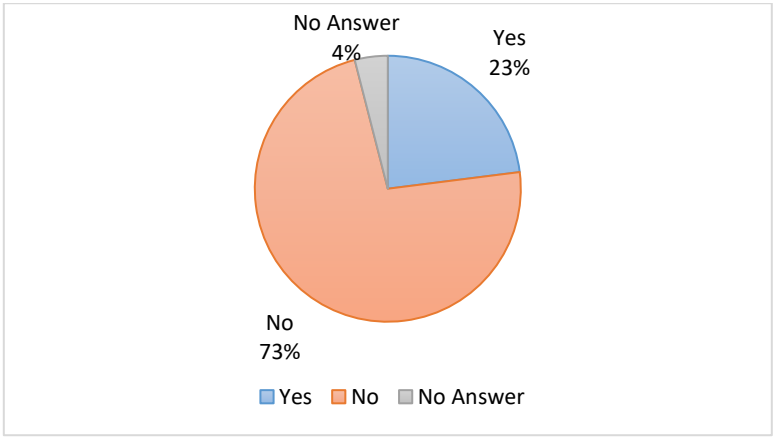


Graph No.4 Percentage of Order Noncompliance

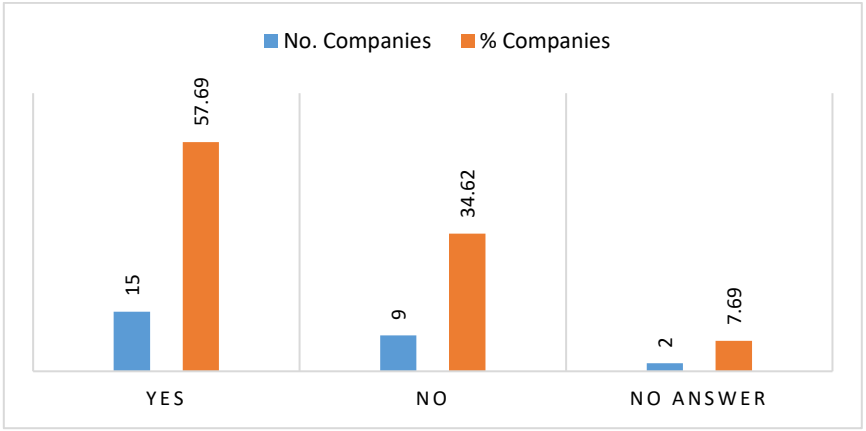


Similarly, Graph No. 5 shows that 73% of the companies do not know the methods for projecting product demand; one reason for this lack of knowledge is the level of training of the businessmen and the limited time they have available to receive short training programs. On the other hand, 23% of the companies state that they do use some method to estimate demand, in which they refer to an average of historical data on quantities sold. Another input that is essential in the development of mathematical models is the availability and quality of historical data, which is a component that needs to be improved since 43% of the organizations do not present historical data and some do not respond (see Graph No. 6).

Graph No.5 Percentage of companies that apply some method for demand projection

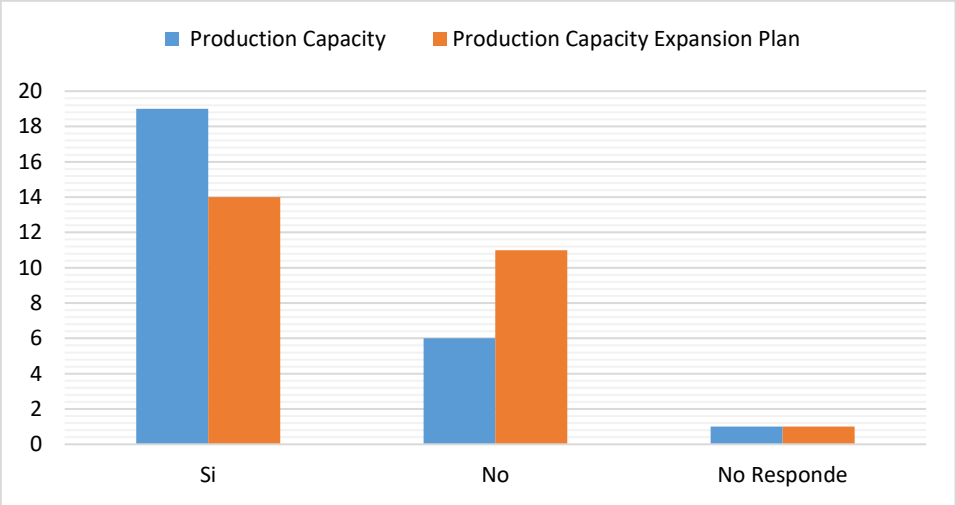


Graph No.6 Availability of Historical Data on Sales Volume

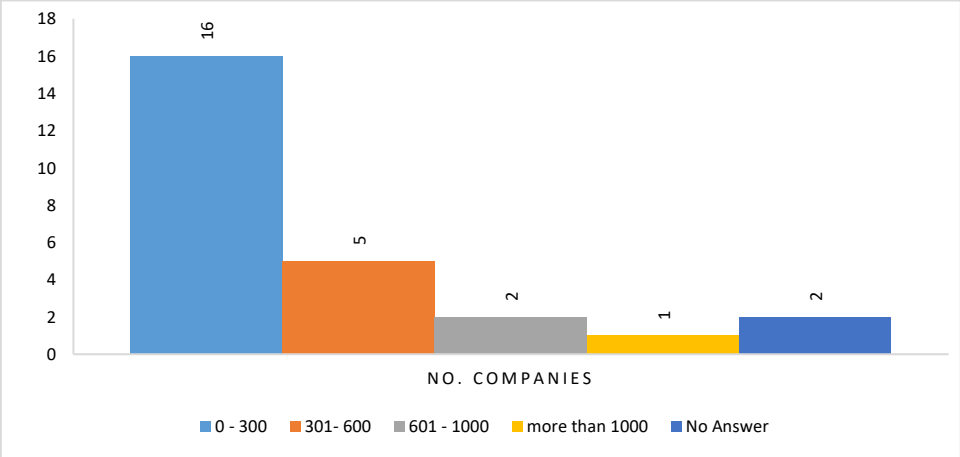


Another component is production capacity, where 73% of the companies do know the capacity of the manufacturing system, which is why they offer their services as maquiladoras, and make manual calculations of the output of garments in a unit of time (see Graph No. 7). In addition, more than half of the production units (16) have a daily capacity of between 0 and 300 units, followed by five companies with outputs of between 301 and 600 garments per day, and finally there is only one company with a daily capacity of more than 1000 units of garments (see Graph No. 8).

Graph No.7 Number of companies that know their production capacity and expansion plan

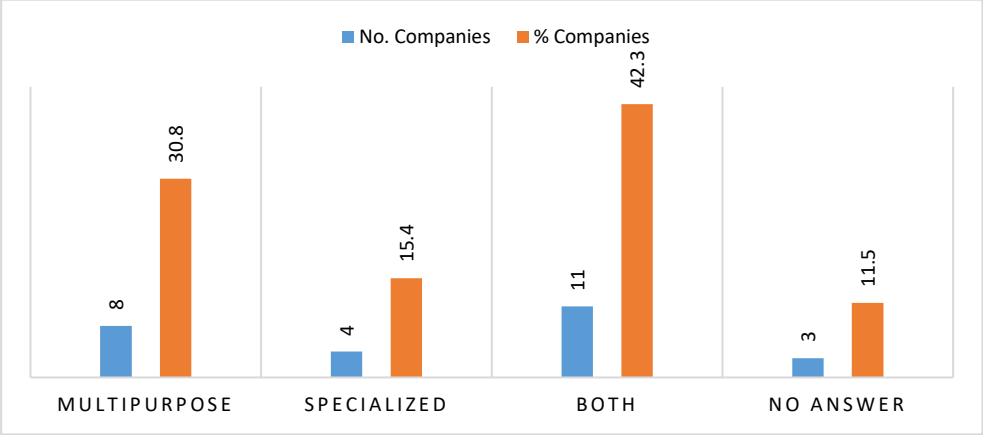


Graph No.8 Average daily quantity of units produced

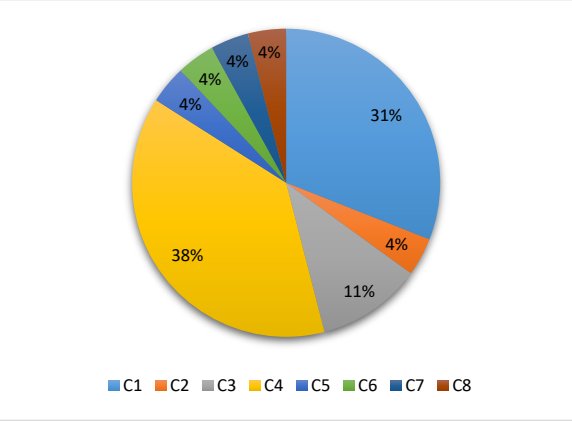


A crucial component in the apparel sector is the labor force, which is why few organizations employ specialized labor in the manufacturing system (see Graph No. 9). This behavior explains that the most common type of employment relationship is still piecework, in which the conditions are not favorable to employees (see Graph No. 10). Likewise, Graph No.11 identifies that the area that concentrates the largest number of workers is the production department, and that 69.23% of the productive units maintain the payroll in this area.

Graph No.9 Classification of employees in production area

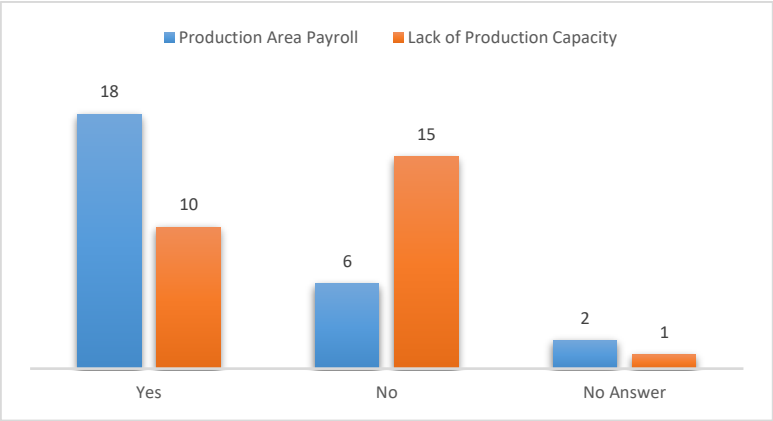


Graph No.10 Employees' labor relationship in the Production area



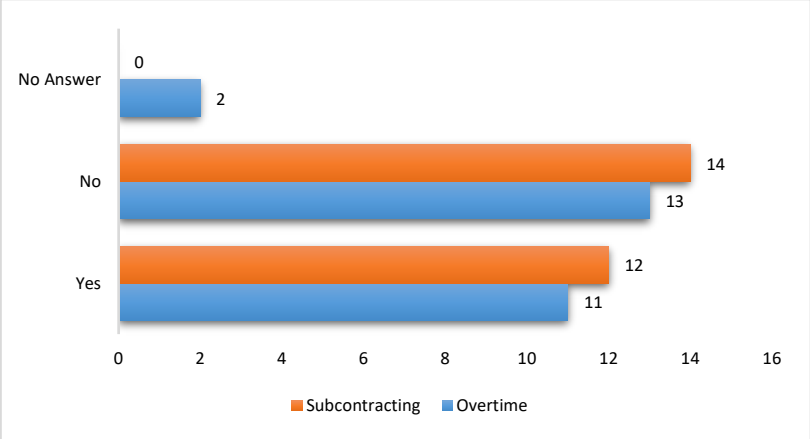
C1	C2	C3	C4	C5	C6	C7	C8
Fixed-term	Indefinite term	Service Provision	Piecework	Fixed Term - Work labor (piecework)	Fixed Term - Indefinite Term	Fixed Term - Labor work (piecework)	Service provision - Work labor (piecework)

Graph No.11 Number of companies that have stable payroll (Production) and know the losses (Sales) due to lack of production capacity

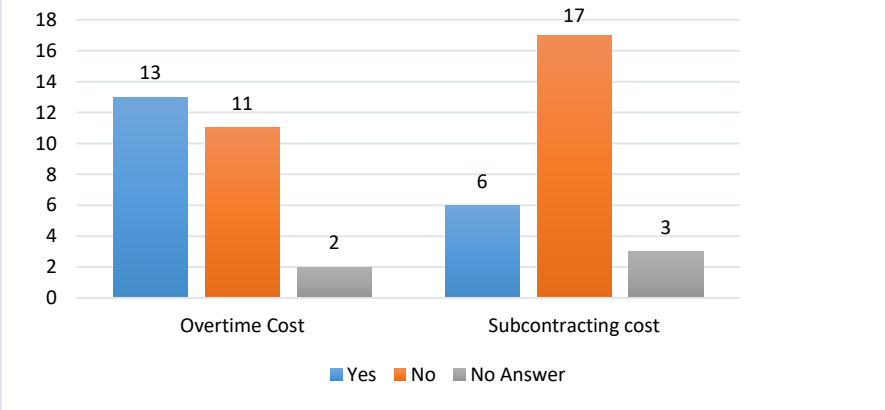


Regarding capacity expansion strategies, there is a minimal difference of 3.84% between subcontracting and overtime, since some production units prefer to subcontract rather than increase overtime because of the quality of work, due to employee fatigue and exhaustion (see Graph No. 12). This is because the cost of overtime is determined according to the organization's policy, while the cost of subcontracting varies depending on the maquila supply market (see Graph No. 13).

Graph No.12 Number of companies that use capacity expansion strategies



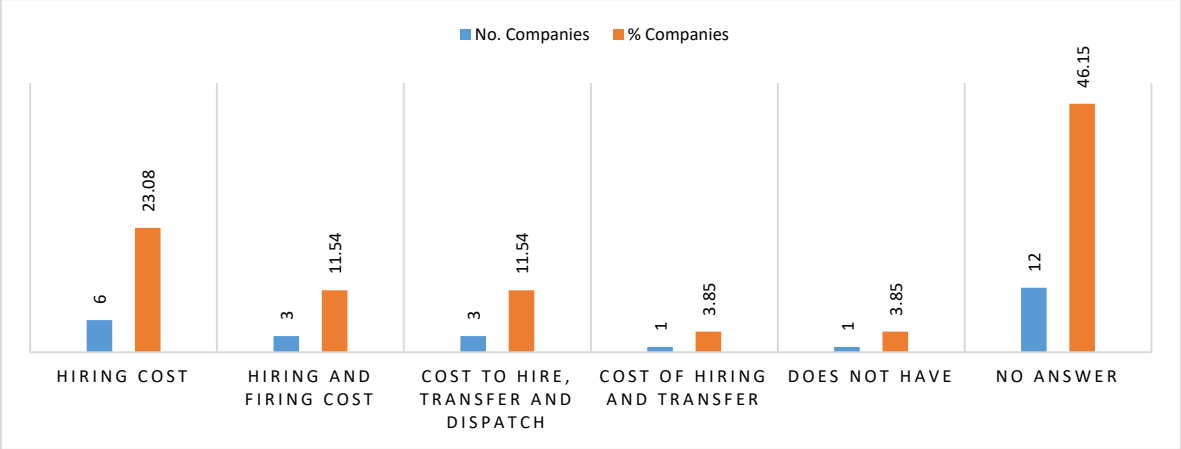
Graph No.13 Number of companies that are aware of the cost of capacity expansion strategies



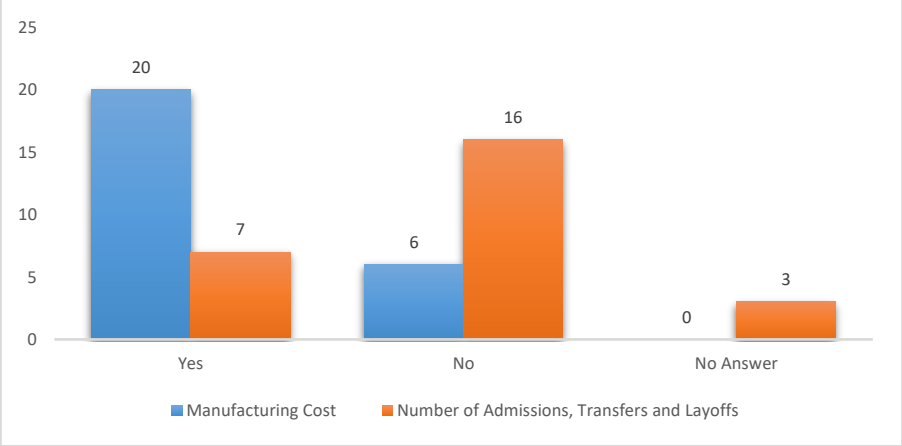
According to Graph No. 14, 46.2% of the companies do not answer the question whether they have established production costs, one of the reasons being the absence of a formal and complete structure of a costing system. Therefore, it is indicated that this factor should be improved in the productive units, as it is a key element that allows the formulation of budgets, when they are executed, and evaluates performance (profits), among other factors. Likewise, 76.9% of the productive units indicate that they do know the manufacturing cost, but it is identified that the process is not carried out adequately most of the time (see Graph No. 15).

On the other hand, 58% of the companies do not have an inventory policy in place that defines how much and when to order (see Graph No. 17), which is a component that provides control and organization of the manufacturing system's inventory, which is why only 46.15% of the production units operate inventories (see Graph No. 16).

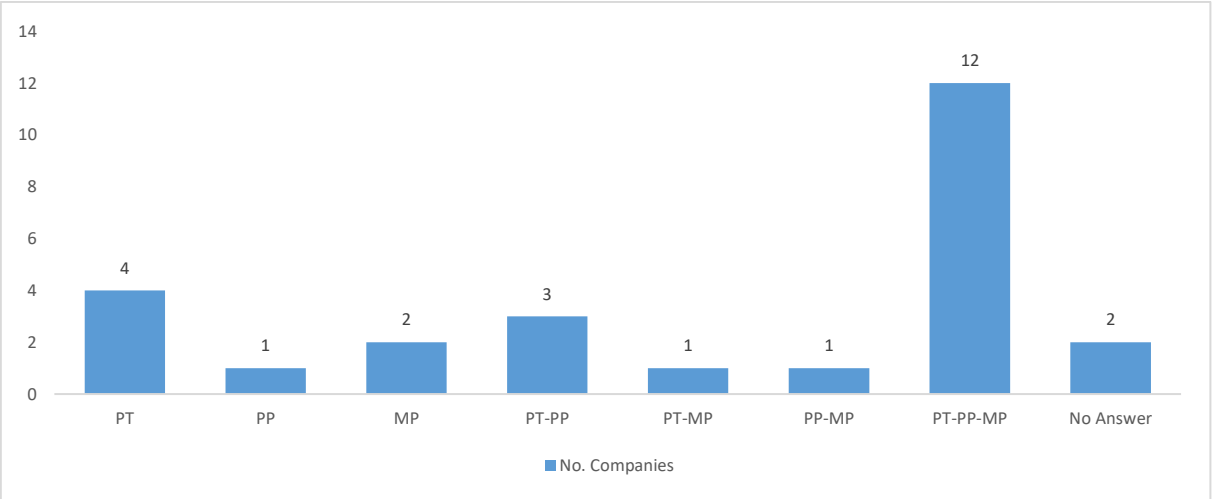
Graph No.14 Number of companies establishing types of costs



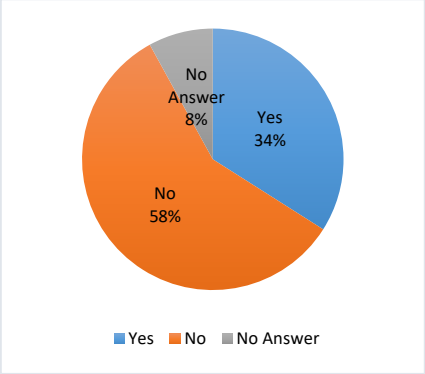
Graph No.15 Number of companies that know the cost of manufacturing, amount of revenues, relocations and layoffs



Graph No.16 Types of inventory in the manufacturing system

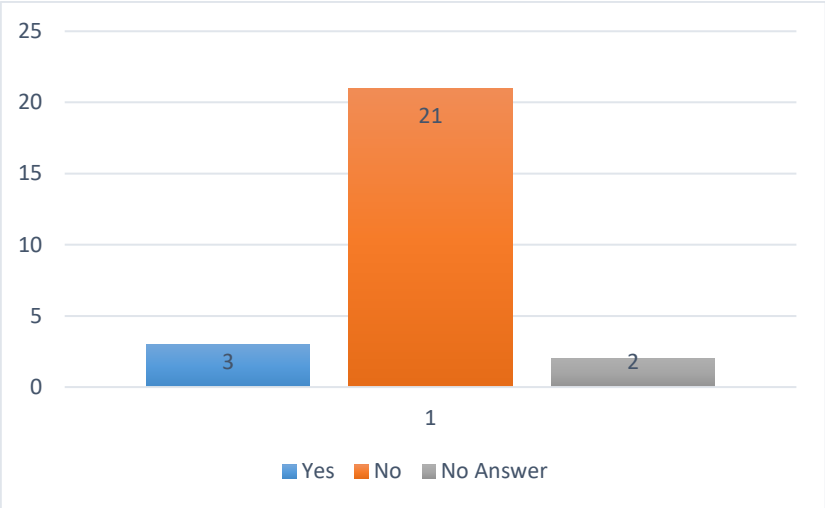


Graph No.17 Percentage of companies that have a defined inventory policy



The technological factor is a critical element, since 81% of the companies do not have a computer application oriented to the development of production planning, being this situation frequent in SMEs in Colombia. Therefore, the result of this research is quite interesting because it provides a decision model that structures and generates information for decision making in manufacturing systems (see Graph No. 18).

Graph No.18 Number of companies that have a computer application



Conclusions

In the knowledge acquisition phase, two information-gathering instruments were applied at different times. The first instrument is more of a qualitative type since it measures the level of appropriation that the companies have with the Production Planning technique, being this an input for the design of the second instrument, which is of a quantitative type, since it investigates in a numerical way the variables of interest. It is important to mention that the availability and quality of the numerical information is a factor of low performance in the organizations, being this the reason why the second instrument was applied to a smaller sample with respect to the sample of the first instrument. According to the knowledge acquired, the characteristics and specific needs of the apparel sector were identified.

In the representation and decision making phase, four modules are defined for the model that correspond to the components that are part of Production Planning. According to the above, mathematical models and heuristics are used in each of the thematic modules, which at a certain level change because policies or decision rules are integrated according to the needs and operation of the production system of the apparel sector. It is important to mention that the model was approved by the Expert and by some companies of the sector under study. Subsequently, the software entitled "Confección 1.0" was designed, which represents the feasibility, viability and functionality.

Referencias

[1] G. Castro, “Supervivencia de las MiPyme: un Problema por Resolver,” 2018.

[2] Banco Interamericano de Desarrollo, “Apoyo a La Pequeña Y Mediana Empresa.” New York Avenue, N.W., p. 74, 2000.

[3] E. E. Zapata Guerrero, “Las Pymes y Su Problemática Empresarial. Análisis de Casos,” Rev. Esc. Adm. Negocios, no. 52, pp. 119–135, 2004.

[4] E. Trujillo, M. Gamba, and L. Arenas, “Las dificultades de las Pymes en América Latina y Colombia para lograr ser competitivas y sostenibles Eduardo,” 2016.

[5] J. P. Moreno Velasquez, "Sector Textil en Colombia: Un Análisis de las Importaciones y Exportaciones entre los Años 2008 a 2014," 2008.

[6] P. de las N. U. para el desarrollo PNUD, "El sector Confección. Condiciones Laborales de la Población que Trabaja en las Confecciones en Ibagué.," 2014.

[7] M. Palomo González, "Los procesos de gestión y la problemática de las PyMEs," Ingenierías, vol. 8, no. 28, pp. 25–31, 2005.

[8] A. G. Martínez Cárdenas, "Acercamiento al Proceso de Toma de Decisiones en las Pymes del Sector Industrial de la Ciudad de Duitama, Boyaca, Colombia," FACE Rev. la Fac. Ciencias Económicas y Empres., vol. 17, no. 2, p. 6, 2016.

[9] W. Niebles, Y. I. Linan, and L. K. Jiménez, "Sistemas de Información para Pyme: Herramientas para Alcanzar Competitividad en Colombia," AGLALA, vol. 10, no. 2, pp. 141–155, 2019.

[10] A. Cabarcas, P. Puello, and R. J. Martelo, "Sistema de información soportado en recuperación XML para Pequeñas y Medianas Empresas (PYME) de Cartagena de Indias, Colombia," Inf. Tecnol., vol. 26, no. 2, pp. 135–144, 2015.

[11] A. L. Quispe, M. P. Padilla, J. A. Telot, and D. Nogueira, "Tecnologías de información y comunicación en la gestión empresarial de pymes comerciales," Ing. Ind., vol. XXXVIII, no. 1, pp. 81–92, 2017.

[12] P. Moro and F. García, "Modelos de Inteligencia Organizativa y Recomendaciones para el Desarrollo de la Inteligencia Organizativa," Dir. y Organ., vol. 60, pp. 24–39, 2016.

[13] C. Marulanda, M. López, and F. López, "La Cultura Organizacional y las Competencias para la Gestión del Conocimiento en las Pequeñas y Medianas Empresas (PYMEs) de Colombia," Inf. Tecnol., vol. 27, no. 6, pp. 3–10, 2016.

[14] J. Silva, C. Díaz, and J. Galindo, "Herramientas Cuantitativas para la Planeación y Programación de la Producción," Ing. Ind. Actual. y Nuevas Tendencias, vol. V, no. 18, pp. 99–114, 2017.

[15] J. Gareth and J. George, Administración Contemporánea. Mc Graw Hill, 2006.

[16] J. L. Oviedo, C. Hernán, and G. Campo, "Una Propuesta para la Definición de la Inteligencia Organizacional," Univ. Empres., vol. 16, no. 26, pp. 155–171, 2014.

[17] J. Quiroz, "Sociedad de la Información y del Conocimiento," Boletín los Sist. Nac. Estadístico y Inf. Geográfica, vol. 1, no. 1, pp. 81–92, 2005.

[18] A. T. Pombert, "El Profesional de la Información en la Inteligencia 0rganizacional," Acimed, vol. 10, no. 5, pp. 1–7, 2002.

[19] H. Mendelson and J. Ziegler, Los 4 principios de la empresa inteligente: reinventar la empresa en la era de la información. 2004.

[20] I. Pinto and C. Malcón, "Inteligencia de negocios e inteligencia competitiva como elementos detonadores para la toma de decisión informada: Un análisis bibliométrico," Rev. Int. Investig. e Innovación Tecnológica, no. 31, pp. 1–9, 2018.

[21] J. Yahaya, N. H. Z. Abai, A. Deraman, and Y. Y. Jusoh, "The Implementation of Business Intelligence and Analytics Integration for Organizational Performance Management: A Case Study in Public Sector," Int. J. Adv. Comput. Sci. Appl., vol. 10, no. 11, pp. 292–299, 2019.

[22] Camara de Comercio de Ibague, "El sistema Moda del Departamento del Tolima," Ibagué, 2018.

[23] Dinero, "Sector textil-confección en jaque, ¿cuál es el futuro?," 2017.