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Journal-Industrial Organization

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Presentation of the content

In the first article we present, *SCOR model Application to identify improvement opportunities in the production system of an SME clothing manufacturing. Case study* by López-Lucas, Ricardo, Sánchez-Galván, Fabiola and Bautista-Santos, Horacio with ascription in the TecNM / ITS de Tantoyuca, as following article we present, *Implementation of the ILUO training system in the San Francisco de los Romo industrial park* by Rivas-Castorena, Britney Daniela, Vázquez-Gutiérrez, Rosa Inés and Núñez-Montalvo, Juan Manuel with adscription in the Universidad Tecnológica del Norte de Aguascalientes as following article we present, *Individual public passenger transportation service for continuous improvement* by Rodríguez-Valencia, Blanca Susana, Castro-De La Cruz, Jucelly, López-Valdiviezo, Leticia and Meneses-Hernández, José Luis, with affiliation at the Tecnológico Nacional de México, Campus Villahermosa. México, as last article we present, *Viability of the open-pit cultivation of bell peppers in Meoqui, Chihuahua* by Pacheco-Meléndez, Brenda Marina, Macías-López, María Guadalupe, Ortega-Montes, Fabiola Iveth and Pérez, Jerónima Antonieta with affiliation at the Universidad Autónoma de Chihuahua.

Content

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Article

SCOR model Application to identify improvement opportunities in the production system of an SME clothing manufacturing. Case study

Modelo SCOR como herramienta para identificar oportunidades de mejora en una PYME del sector textil. Caso de estudio

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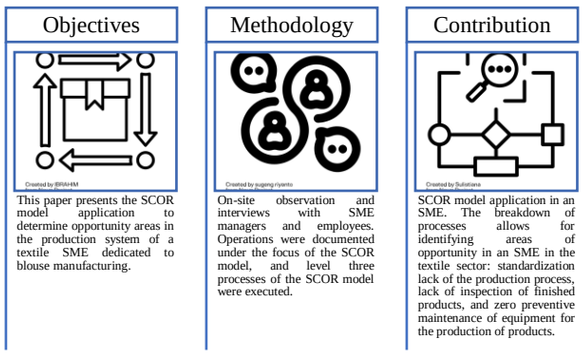
Abstract

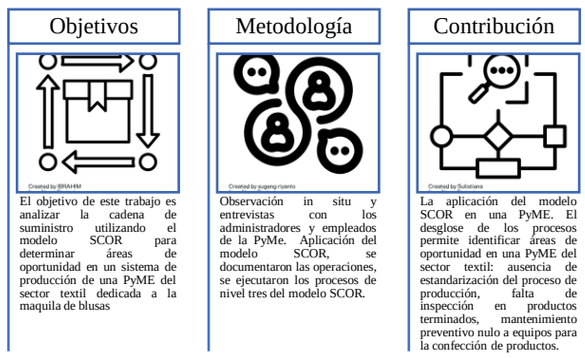
The SCOR model frames a set of processes through a common language. Companies or organizations use the SCOR model as a reference for the diagnosis of their production process. This article presents the SCOR model application to determine opportunity areas in the production system of a blouse manufacturing SME. To carry out this study, information was collected on the production process and the operations were documented under the provisions of the SCOR model. It was identified that the process called "manufacture to order" is the process in which there are opportunities for improvement due to late deliveries in orders and high production costs, with critical processes in scheduling production activities, product manufacturing, and product inspection and testing.



Supply chain, Production system, Textile sector

Resumen

El modelo SCOR enmarca un conjunto de procesos a través de un lenguaje común. Las empresas u organizaciones utilizan el modelo SCOR como referencia para el diagnóstico de procesos y para la optimización de las operaciones. Este artículo presenta la aplicación del modelo SCOR para determinar las áreas de oportunidad en el sistema de producción de una PYME maquiladora de blusas. Para llevar a cabo este estudio se recolectó información del proceso de producción y se documentaron las operaciones acordes a lo establecido en el modelo SCOR. Se identificó que el proceso denominado “fabricación bajo pedido” es el proceso en donde existe oportunidades de mejora debido a entregas tardías en los pedidos y altos costos de producción, con procesos críticos en la programación de actividades de producción, manufactura del producto e inspección y pruebas del producto.



Cadena de suministro, Sistema de producción, Sector textil

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Introduction

The Supply Chain Operations Reference (SCOR) model presents a framework of standard processes that represent the way organizations operate (Chopra et al., 2022). SCOR is a reference model used for managing and improving Supply Chain (SC) efficiency, it involves and synchronizes participants through a common language that encourages communication (Abbaspour, 2019). It is considered as a diagnostic tool that identifies relevant processes, creates a common environment of parameters, terms, language for all constituents for Supply Chain configuration (Chehbi-Gamoura et al., 2020). The application is flexible and can be adapted to increase productivity and meet customer needs (Yuniaristanto et al., 2020).

The SCOR model operates under a systemic approach to manage processes, improve operation strategy and measure performance (Prasetyaningsih et al., 2020). In addition, it links business processes, performance metrics, practices and people skills; it aims to establish a structure of integrated processes to align with functions as well as with the organization's main objectives (Kusrini et al., 2019). It was introduced to measure CS performance and be useful for organizational leaders to make strategic decisions based on the analysis obtained (Ricardianto et al., 2022); performance measurement is achieved through performance metrics that show the state of the chain (Kusrini and Miranda, 2021).

SCOR presents five core processes that most companies execute in their supply chains: (1) Plan, which collects data for market research and supplier selection, obtains information on customer requirements, and seeks to match available resources to meet demand with strategically crafted plans (Alshawabkeh et al., 2022); (2) Source, which is the process of sourcing and sourcing of supply chains, 2022); (2) Sourcing, is the process of acquiring resources for order fulfilment, in this process supplier evaluation and selection is performed (Yuniaristanto et al., 2020). Activities of request, delivery, receipt and movement of materials are executed (Hanh Nguyen et al., 2021); (3) Making, are processes of transformation of materials, for the elaboration of orders and the fulfilment of customer requirements (Sarjono et al., 2021).

It includes production scheduling, production process management and maintenance (Yuniaristanto et al., 2020). (4) Deliver is to provide the manufactured products; it carries out order management, distribution and transportation (Sarjono et al., 2021). It facilitates the flow of products from the manufacturer or supplier to the customer (Kottala and Herbert, 2019); (5) Return, is the process of receiving products returned by customers for any reason (Sooksaksun et al., 2023). For defects, overages, for maintenance, repair or overhaul (Kottala and Herbert, 2019).

The model is applied based on four hierarchical levels, in which the next level precisely details the previous level: Level 1 (Process types) is the top level, consisting of five key processes: plan, procure, manufacture, deliver and return. Here, the scope and definition of the operations of the model is established (Roque et al., 2021); the operation strategy to deliver the products or services to the customers is made (Trueba et al., 2022). Level 2 (Process category) defines by categories each process of the previous level (Ikatrinasari et al., 2020). It shapes the operation strategy given the CS activities by classifying them into categories according to capabilities (Trueba et al., 2022). Level 3 (Process elements) is the lowest level of the CS, detailing each identified process, assigning them performance attributes, metrics and best practices; here the performance level of the processes can be observed (Ikatrinasari et al., 2020). Level 4 (Implementation) applies the previously defined processes, these contain the description of each implementation activity and differs in each organization, for this reason, few consider this level (Roque et al., 2021).

The objective of this paper is to analyse the supply chain using the SCOR model to determine areas of opportunity in a production system of an SME in the textile sector dedicated to the maquila of blouses.

Case study

It is presented an SME located in the northern highlands of the state of Puebla, it operates under the flow of production by order (MTO, Make to order), its economic activity is the manufacture of blouses for wholesale customers, it has a commercial premises to display its product and to sell to those customers who request orders of few units.

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It also manufactures products under design, which are products with specific characteristics such as sports uniforms, school uniforms and typical costumes for cultural events. It has clients in states such as Puebla, Mexico, Guerrero and Veracruz; it makes use of delivery parcels when they are outside its boundaries. The acquisition of materials is done one day a week, as well as the delivery of the product to customers, for both cases the company makes use of its transport resources for procurement as well as for delivery.

The SME has been operating for 10 years, was created empirically by the owners, has no applied management system, methodology or tool to manage the processes; it operates immediately upon receipt of an order and does not forecast demand with proper methods but with its own experience which is highly inaccurate. Furthermore, orders are not tracked in the internal production process, the stages are not clearly identified, which makes it difficult to detect critical points.

Methodology

A two-stage methodology is presented: 1) representation of the supply chain and 2) application of the SCOR model.

For the representation of the supply chain, the flow of materials was analyzed through on-site observations and interviews with the organization's managers and employees to understand the production process. The flow of materials was tracked from arrival to final state conversion, the stages of the flow were distinguished, the existing areas were identified and the operators in each area were counted. With the participation of the workers, the activities carried out in each area were recorded; the use, quantity and mode of use of the materials were observed. During the application of the SCOR model, the operations were documented as described in the model, and the level three processes of the model were executed to identify problems in efficiency.

Results

The supply chain shown in figure 1 represents the activity of a production system of an SME in the textile sector, starting with the customer order, from which information for order fulfilment emerges.

This information is received by the administration, which registers it and makes the corresponding quotation, and then verifies the availability of the materials in the warehouse. When the list of materials for the production of the requested products is ready, the information is sent to the suppliers for the supply and that they have the materials ready; then, the movement of products begins, the company sends the transport with each supplier so that they can load the supplies and then move them. Once the products arrive, they are moved to the Raw Material Warehouse, there the Production area takes what is required and executes the processes for the manufacture, when it finishes, it sends the articles to the Finished Product Warehouse where it packs the blouses and seals them. When the packages are sealed, they are loaded to the transport, then the process of delivery to the clients begins, when they are far away from the delivery area, the product is taken to the parcels. In the case of retail customers, they are expected to purchase the product at the retail outlet; likewise, customers with orders under design are notified to pick up their product at the retail outlet.

Application of the SCOR model

The SCOR model establishes standardized processes that encompass activities generally performed in most organizations, so, using the tools it provides, the processes executed by the case study company were identified. This facilitated the location and classification of each operation, which, although they have always been executed, were not visualized as the model describes them, in an organized and systemic way.

Strategic plans were established for the efficient function of the supply chain, the model defines this category as "Plan"; likewise, procurement, where supply activities identified as source are executed; manufacturing operations were classified according to the type of order, i.e. whether it is an order under order or under design (Make); it was also the case of distribution (Deliver) and returns (Return) that depending on where they are made, if they are from customers to the company as (DR) and if it is from the company to suppliers (SR). The processes of the SCOR model are detailed in figure 2.

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Box 1

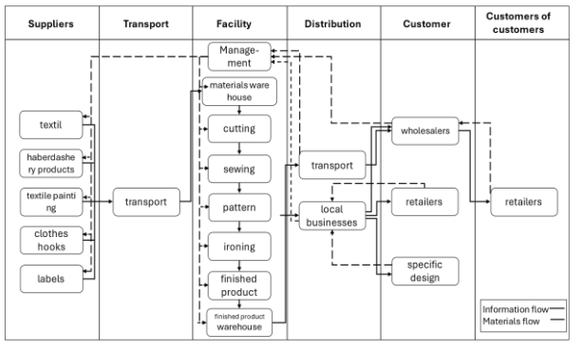

Figure 1

Supply chain of a production system of an SME in the textile industry

Source: Own elaboration based on on-site observation techniques and interviews with business owners

Box 2

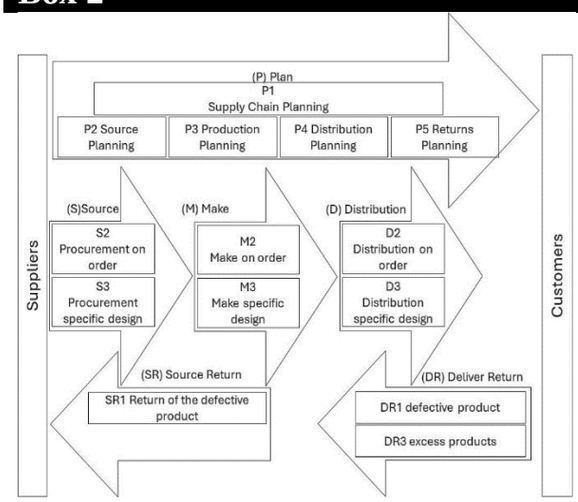

Figure 2

SCOR model for an SME supply chain in the textile industry

Source: own elaboration based on on-site observation techniques and interviews with business owners

Level one processes (plan, source, source, production, distribution and return) are considered as macro-processes covering multiple operations. Level 2 describes the capabilities of the main processes according to the situation of the organization, these are more specific; in the case of Plan, 5 categories emerge for the strategic planning of each macro-process; in the Source (S) process, operations are separated for orders to order (S2) and design (S3) as the materials differ.

The same happens with the manufacturing process, for the first case the activities are carried out for the elaboration of the orders, however, for the second case the activities vary due to the unique characteristics requested by the customer even in the order. For distribution, the products are delivered to the customers if they are in range, otherwise, other means such as parcels are used and the cost is covered by the customer; for orders under design, the products are delivered to the commercial premises since the customers are usually located in nearby areas and the quantity of these is not regularly high enough to cover the cost of transport. Retail sales are not of great importance in this case, in the normal production of orders there may be surplus products and these are sold in the shop. Returns are made in case the product has defects or excess, the customer returns the product, corrections are made and it is delivered again in the next purchase or the monetary refund is made; the same happens with the products received from the supplier, but on the other hand there is never a surplus due to the supplier's error because the company goes to the supply.

Process flow

For a better visualization of the processes, Figure 3 shows the flow of materials from the supplier to the customer, which is another way of representing the supply chain with the implementation of the SCOR model. It illustrates the movement of materials and information from one process to another, which allows to analyze problems in the structure.

Box 3

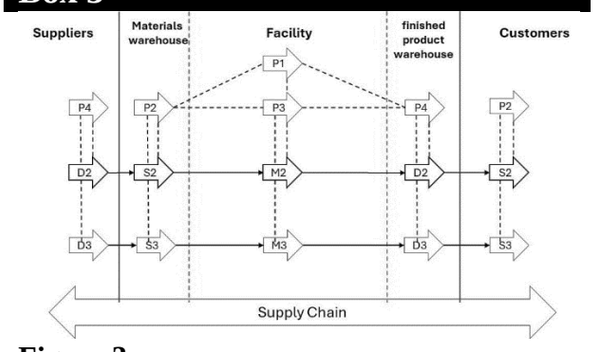

Figure 3

Material process flow of a textile SME defined with the SCOR model structure

Source: own elaboration based on on-site observation techniques and interviews with business owners

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Planning, identification of supply chain needs, scheduling and prioritization is done in P1 and covers the whole company. It is assumed that all suppliers plan the distribution P4, the delivery of material for MTO is D2 and for orders under design D3. In P2 the planning of the suppliers is done and even if there is only information flow it is classified as part of procurement, the company stores the materials in the raw material warehouse, S2 for materials under order and S3 for under design. P3 plans the production process, facilities and resources needed to proceed to M2 for make-to-order production and M3 for make-to-design production. The products arrive at the Finished Goods warehouse, P4 plans the delivery, transport and quality standards, D2 delivers the order on demand and D3 the order by design. Finally, the customers also plan their procurement P2, and each receives the product that D2 and D3 have ordered.

Level 3 processes

Level 3 analysis of the processes is performed to have more precise details in order to visualize and detect problems following the standard of the model. The level 3 manufacturing processes of the orders to order (M2) are shown in figure 4.

Box 4

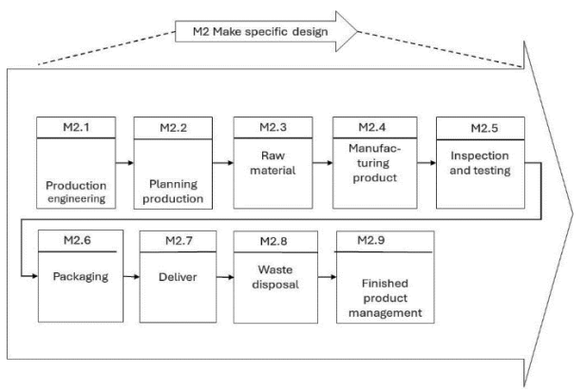

Figure 4

Level 3 process breakdown of the Make-to-Order (M2) process of an SME in the textile sector

Source: own elaboration based on on-site observation techniques and interviews with business owners

The processes shown in figure 4 are executed in the SME without any control, determination or standardization, which is one of the problems encountered.

In the M2.2 process, information is not disseminated for the efficient scheduling of activities; the parts that make up the production are notified of the order at the moment without prior notice. In M2.4 of product transformation, it was determined that the standardization of operations is necessary to control production time, as well as to determine production capacity and to be able to set performance metrics, without which high production times and delays in delivery result in high production costs.

In M2.5 inspections are not regulated, sometimes they are not carried out and therefore defective products are detected in the batches, which causes customer dissatisfaction. M2.9 the company does not carry out preventive maintenance, only when irregularities occur or when they stop working they are subjected to maintenance.

With the implementation of the model, the processes were managed to detect performance gaps which highlighted the following: poor communication between external and especially internal customers (M2.2), lack of standardization of the production process (M2.4), lack of inspection of finished products (M2.5), no preventive maintenance of equipment for the manufacture of products (M2.9); which are considered of greater impact because they cause delays in production and consequently late delivery and high production costs.

Conclusions

The SCOR model is flexible and adaptable to any type of organization to manage, measure and increase productivity. It is used to improve supply chain strategies and communication between participants from suppliers to customers. The model shows the status of processes through their levels of implementation and allows to visualize areas of improvement to develop an optimal future.

The implementation of SCOR facilitated the location of supply chain procedures and actors that served to visualize these efficiency gaps, once presented, can be followed up in future research to measure performance and present improvements to increase performance.

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Declarations

Conflict of interest

The authors declare no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

López-Lucas, Ricardo: Contributed to the project idea and research method.

Sánchez-Galván, Fabiola: Contributed to the conceptualization, technique, writing - review and editing, supervision.

Bautista-Santos, Horacio: Contributed to the conceptualization, writing - original draft preparation, project administration.

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Abbreviations

MTO	Make to Order
PyME	Pequeña y Mediana Empresa
SCOR	Supply Chain Operations Reference

References

Background

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Article

Implementation of the ILUO training system in the San Francisco de los Romo industrial park

Implementación del sistema de capacitación ILUO en el parque industrial de San Francisco de los Romo

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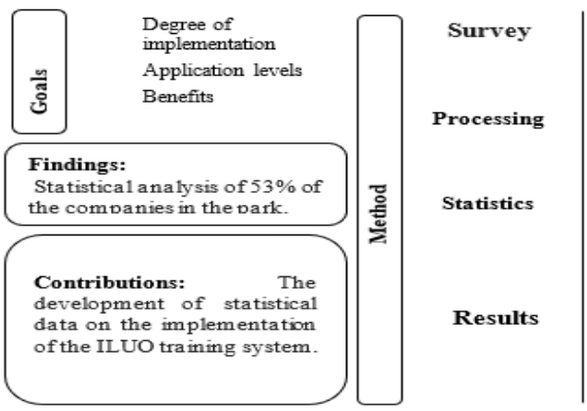
Abstract

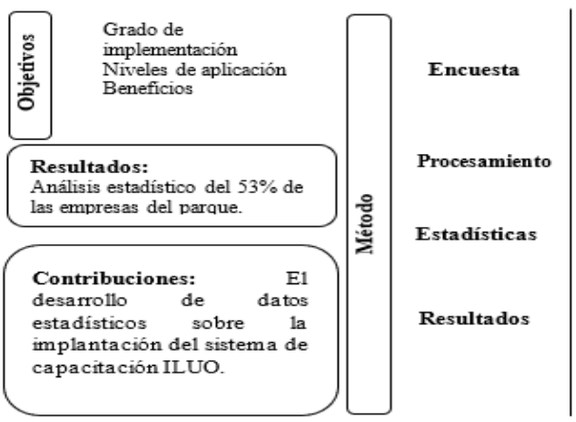
This research was carried out through an opinion survey about the ILUO matrix in the San Francisco de los Romo Industrial Park in the state of Aguascalientes, Mexico. The ILUO matrix is a tool that is used to evaluate the skill level of the operators who work in a company. The acronym ILUO represents the 4 skill levels to be measured. The objective of this work is to determine the percentages of companies that implement and do not implement this training system. At the same time, you will also be able to learn about the benefits that the ILUO matrix provides to companies that apply it in their facilities. All this in the San Francisco de los Romo Industrial Park. Some benefits that the ILUO matrix provides to companies are: Flexibility, Track progress, Continuous update and Efficiency



Training, ILUO matrix, Automotive Industry operator, Aguascalientes

Resumen

Esta investigación se realizó mediante una encuesta de opinión sobre el sistema de capacitación ILUO en el Parque Industrial San Francisco de los Romo en el estado de Aguascalientes, México. El sistema de capacitación ILUO es una herramienta que sirve para evaluar el nivel de habilidad de los operarios que trabajan en una empresa. Las siglas de ILUO representan los 4 niveles de habilidad a medir. El presente trabajo tiene como objetivo determinar cuáles son los porcentajes de empresas que implementan y que no implementan este sistema de capacitación. A su vez también se podrán conocer los beneficios que les proporciona el sistema de capacitación ILUO a las empresas que si lo aplican en sus instalaciones. Todo esto en el Parque Industrial San Francisco de los Romo. Algunos beneficios que proporciona a las empresas el sistema de capacitación ILUO son: Flexibilidad, Seguimiento del progreso, Actualización continúa y Eficiencia



Capacitación, Sistema ILUO, Operador Industria Automotriz, Aguascalientes

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Introduction

This research shows an analysis of the companies that apply the ILUO training system in their facilities and the benefits they obtain by implementing this system, as well as those companies that do not apply it. All this in the industrial park of San Francisco de los Romo.

A survey was carried out to analyse the implementation of the ILUO training system, here the necessary questions were formulated to contemplate the percentages of each question.

The companies where the use of the ILUO training system was contemplated show a series of benefits such as flexibility, progress monitoring, continuous updating and efficiency.

The results of the survey applied to a sample of 9 companies are shown below.

This project benefits the companies that do not apply this training system as they are made aware of the benefits that this system provides them and the possible improvements that ILUO would provide.

Methodology

According to Hernández Sampieri (2010) the study applied was a "Quantitative Exploratory" study using a survey type data recovery tool.

Sampling

The type of sampling was stratified.

The advantage of this type of sampling is that it tends to ensure that the sample adequately represents the population according to selected variables. It also makes it possible to obtain more precise estimates and its objective is to obtain a sample as similar as possible to the population as far as the stratified variable(s) are concerned.

The result was a sample of 9 companies out of 17 registered as automotive companies. This represents 53% of the companies that could be explored.

Box 1

Table 1

Automotive companies

Automotive companies in the San Francisco de los Romo Aguascalientes industrial park
• Advanced Composites
• Gestamp México SA de CV
• Resortes Monticello
• San-s Mexicana
• Beyonz Mexicana
• KTMex
• UNIPRESS
• Metalistik
• Sistemas de Arneses K&S Mexicana
• Sumimoto Electric Sintered Components
• Marelli
• Teklas Automotive
• SIMEPA
• SACRED Mexicana SA de CV
• Diagraph Itw
• Worldwide Design Alliance
• Manufacturas Plásticas y Metálicas Volvo

Background

The ILUO tool derived from the Lean Manufacturing Methodology that was implemented by TOYOTA in the middle of the 20th century is useful for industrial companies where production processes are carried out.

Companies in the automotive, aeronautical or metallurgical sector make use of this system because it helps them to manage the skill levels or professionalism of their workers.

The ILUO training system comes from the words: Innovation, Leadership, Union and Opportunities. It is an approach that was developed to provide training and development for workers and production teams that are focused on improving skills and techniques. ILUO therefore aims to maximise and achieve operational excellence. The history of ILUO is a clear example of continuous improvement because it is linked to the need to adapt to a constantly changing world of work, for this reason the skills that are practiced daily are no longer sufficient, so new competencies are required to succeed. The origin of ILUO can be traced back to the need for organizations to prepare their staff to face the challenges of the future. Thus, continuous learning is extremely important and essential in the competitive and constantly evolving business environment. The ILUO system has several key aspects, which are:

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Innovation: Focused on the adoption of new ideas, technologies and approaches to problem solving and performance improvement. It also involves encouraging creativity and experimentation to drive progress.

Leadership: Recognizes the importance of developing leadership skills at all levels of an organization. It therefore includes skills in communication, decision making, change management and teamwork.

Partnership: Promotes collaboration and teamwork as fundamental elements for success.

Opportunities: It is based on seeking to provide development opportunities in order to adapt them to the needs of each individual. It therefore includes training in specific skills.

When implementing the ILUO system it can vary according to the organization and its needs. It therefore adapts to the circumstances of each company and also focuses on each of its acronyms (Innovation, Leadership, Union and Opportunity).

Over the years, ILUO has been in constant research and development to improve its effectiveness and applicability in different educational and informational contexts.

With regard to the application of the ILUO training system in the industrial park of San Francisco de los Romo, it is necessary to carry out a questionnaire in the area of human resources.

The area to be analysed is shown below:

Human Resources

The work of this area consists of the people in charge of training, when recruiting new personnel and even evaluating the aptitude of the workers who are already working in the facilities according to the position, they carry out certain activities to see the level of skill that each worker has and so they can determine the job position and even see if there can be personnel rotation. One of the tools used by some companies to evaluate the skills of the staff is the ILUO training system.

Results

The survey consists of 51 questions divided into 7 sections. From each area a number of questions were selected.

Section 1 General
Section 2 Levels
Section 3 Level I (General Assistant)
Section 4 Level L (Assistant Lubricator)
Section 5 U Level (Operator)
Section 6 O Level (Universal Operator)
Section 7 Benefits of the ILUO System

SECTION 1: General

67.7% of the companies surveyed in the San Francisco de los Romo Industrial Park use **the ILUO training system** in their facilities, while 33.3% of the companies surveyed do not implement this system.

Box 2

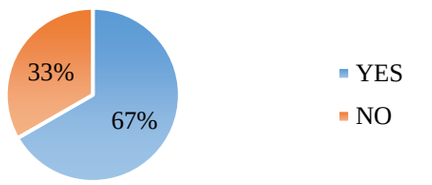

Figure 1
Implementation of ILUO training system

With regard to the surveyed companies in the automotive sector 55%.6% said that their company is large (with more than 250 people). While the other 44.4% said that their company is medium-sized (50-249 people).

Box 3

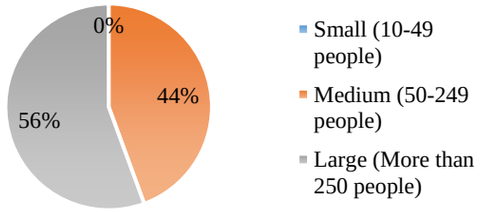

Figure 2
Magnitude of the companies

100% of the surveyed companies in the Industrial Park fully agree that all companies can use it.

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Box 4

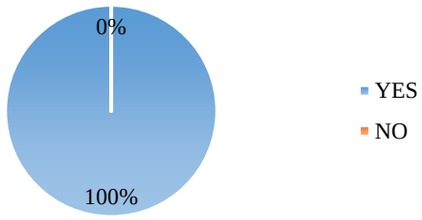

Figure 3
Companies that can use the ILUO training system

22.2% of the companies have been implementing this system for 5 to 9 years, while 33.3% have been implementing it for 10 or more years. The last 33.3% have never implemented it, while 11.1% have been implementing it for 1 to 5 years.

Box 5

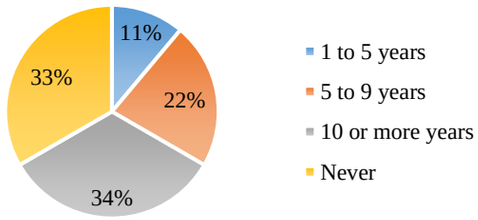

Figure 4
How long they have been implementing the ILUO system

With 100% full agreement, companies said that it is possible to measure skills with this tool.

Box 6

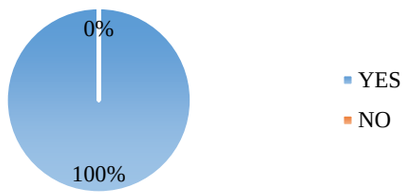

Figure 5
Ability to measure ability

Section 2: Levels

Only 77.8% of companies agree that the 4 levels are sufficient to measure the skill, however 22.2% disagree.

Box 7

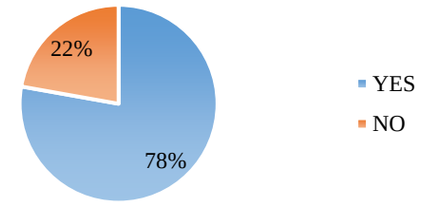

Figure 6
Sufficiency of the 4 levels of ILUO

Based on their respective facilities, 11.1% of the companies mention that the level with the highest ILUO skill level is level 1, 11.1% of the companies mention level 2. On the other hand, 44.4% mention level 3 and 33.3% say level 4.

Box 8

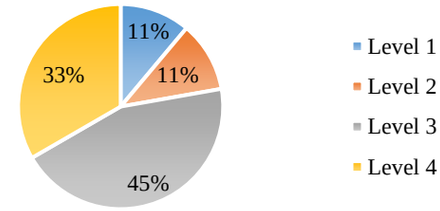

Figure 7
Level with greater capacity of the ILUO acronym corresponding to each company

77.8% of the enterprises have staff at level 1 (General Assistants). While 22.2% have no staff at this level.

Box 9

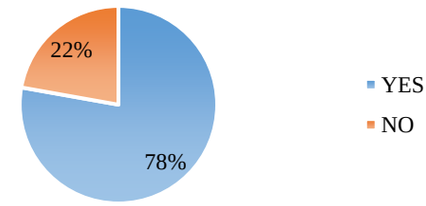

Figure 8
Level 1 staff

Of the companies surveyed, 55.6% mentioned that the percentage of level 1 staff in their facilities is 25%, while 44.4% mentioned that the percentage of level 1 staff is less than 25%.

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Box 10

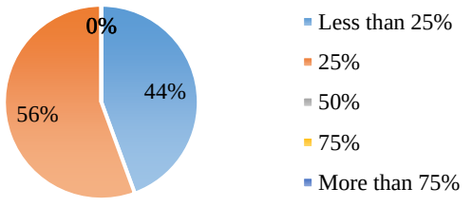

Figure 9
Personnel from companies with level 1

Of the companies that responded to the survey, 25% mentioned that the percentage of Level 2 staff on their premises is less than 25%. Another 25% of the companies mentioned that they have 25% of their staff with level 2. A further 37.5% say they have 50% and lastly 12.5% of the companies say they have 75%.

Box 11

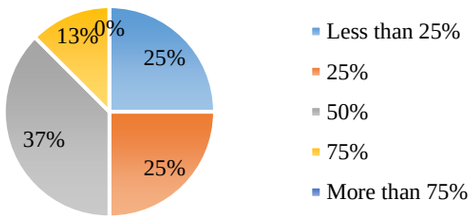

Figure 10
Personnel from companies with level 2

33.3% of the companies mentioned that they have less than 25% of staff with level 4, 11.1% of the companies have 25% of staff with level 4, another 22.2% have 50% of staff with level 4 and finally the other 33.3% of the companies have more than 75% of staff with this level.

Box 12

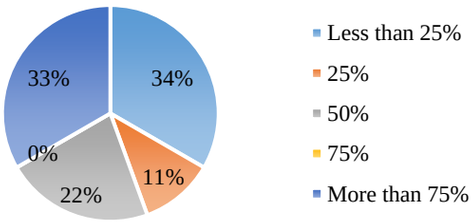

Figure 11
Personnel from companies with level 4

A worker fit to be a universal worker must have level 3 according to 55.6% of the companies, while 33.3% say they must have level 4 and 11.1% say they must have level 2 to be fit.

Box 13

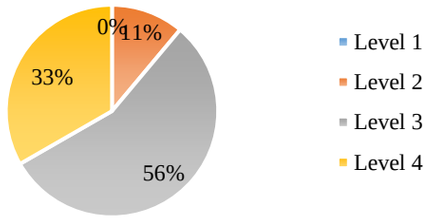

Figure 12
Level that an operator must have in order to be considered as a universal operator

Section 3: Level I (General Assistant)

100% of the companies state that the employee must attend the training programme for operational staff at the first level.

Box 14

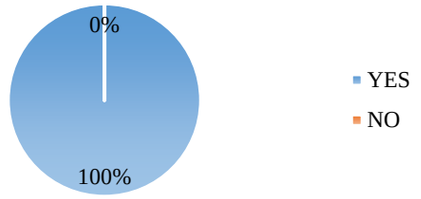

Figure 13
Attendance at the training programme for level 1

According to 77.8% of the companies, the time that the worker must have been in the company to be considered suitable for Level I is 3 months, although on the other hand, according to 22.2% of the companies, the operator must have been in the company for 1 month.

Box 15

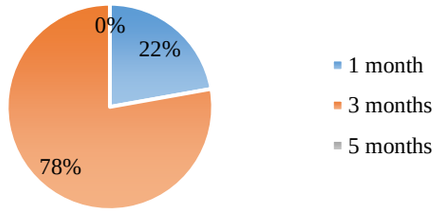

Figure 14
Time worked that a level 1 operator must have

According to the number of months that the operator has been working in the company at the time of the theoretical evaluation, the minimum average that the operator must obtain is 80 according to 55.6% of the companies, another average that the operator must obtain according to 22.2% of the companies is 90 and finally the other 22.2% of the companies say that the average must be 60.

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Box 16

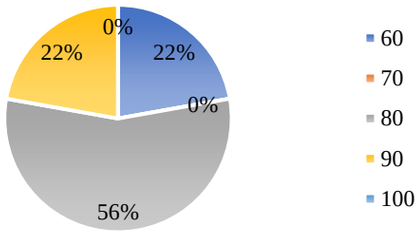

Figure 15
Minimum average that a level 1 operator must have

It takes the company 3 months to train staff to level 1 as 77.8% of the companies surveyed stated. The other 22.2% stated that it takes 6 months.

Box 17

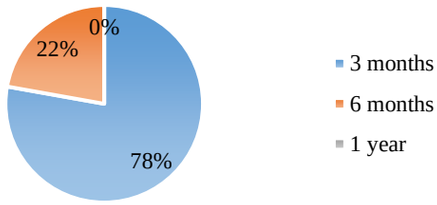

Figure 16
Training time for level 1

Section 4: Level L (Assistant Lubricator)

Of the companies surveyed 88.9% say it is absolutely true that level 2 operators should intervene in production processes, however 11.1% say it is false.

Box 18

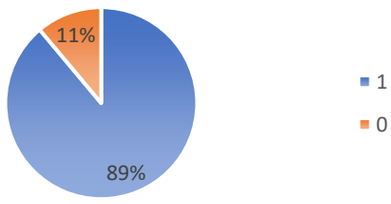

Figure 17
Operators intervening in the production process

In terms of the minimum percentage of machine knowledge that an operator should have, 11.1% of the companies said 100%. 33.3% of the companies said that the knowledge should be 90%, 33.3% of the companies said that the knowledge should be 80% and 22.2% said that the knowledge should be 70%.

Box 19

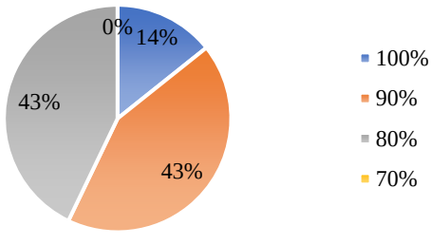

Figure 18
Minimum percentage of knowledge in handling machinery

In terms of the 5'S, 100% of the companies fully agree that operational staff should keep in their work area what they need to work.

Box 20

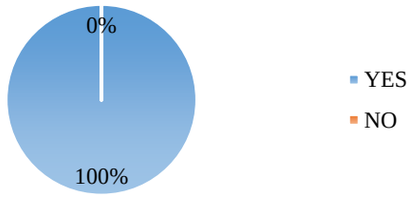

Figure 19
Application of the 5'S

The time it takes for companies to train operational staff at level 2 is 3 months according to 22.2% of the companies, 6 months according to 66.7% and more than 1 year according to 11.1% of the companies.

Box 21

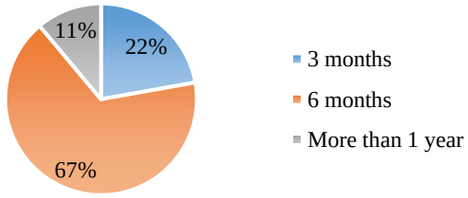

Figure 20
Training time for level 2

Section 5: Level U (Operator)

The percentage of companies that say it is true that operational personnel with level 3 can technically train level I and L operators is 77.8%, while 22.2% say it is false.

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Box 22

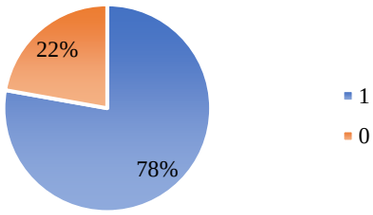

Figure 21
Level 2 personnel train level 1 and level 2

With a percentage of 100% of the companies, the companies mentioned that the operational staff should not have to pass any defect in the following process.

Box 23

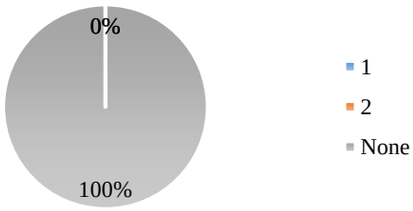

Figure 22
Level 2 zero-defect staff

At level 3 operators are trained to take initiative for continuous improvement with a percentage of 11.1%, for safety another percentage of 11.1% and 77.8% mention that it is for all of the above where continuous improvement, safety, quality and line compliance are included.

Box 24

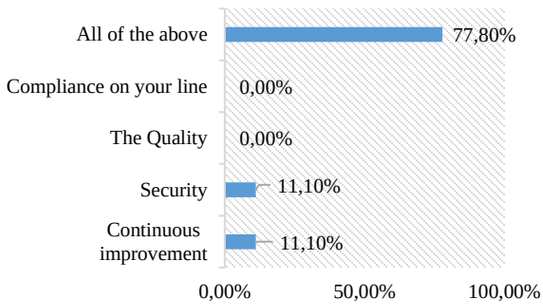

Figure 23
Reason for training for level 3

According to 66.7% of the companies do allow operators to contribute ideas to improve the standard and update their operation sheets, but 33.3% allow it on some occasions.

Box 25

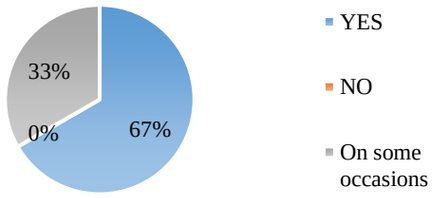

Figure 24
Permissions that level 3 personnel have

66.7% of companies take more than 1 year to train operational staff to level 3, 22.2% of companies take 6 months and 11.1% of companies take 3 months.

Box 26

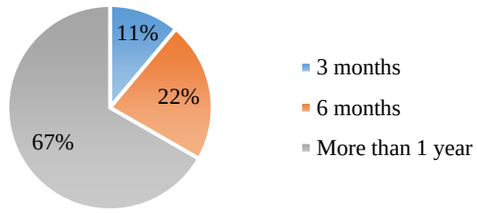

Figure 25
Training time for level 3

Section 6: Level O (Universal Operator)

Of the companies surveyed, 66.7% mentioned that it takes more than 1.5 years to train staff to level 4, 22.2% took 1 year and 11.1% took 1.5 years.

Box 27

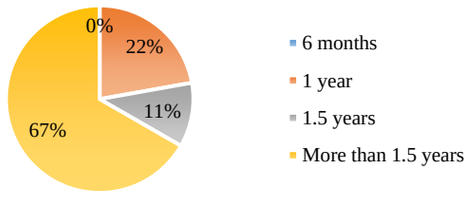

Figure 26
Training time for level 4

Section 7: Benefits

With regard to the benefits that the ILUO training system brings to the companies, 11.1% of the companies mentioned that it brings flexibility to their company, only 22.2% have had follow-up of the process, another 22.2% of the companies have had continuous updating, 11.1% have had efficiency, 66.7% have had all the benefits mentioned above, and finally 22.2% have had no benefits at all.

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Box 28

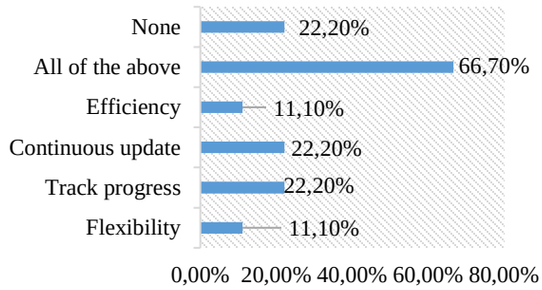

Figure 27
Benefits provided by ILUO

88.9% of the companies find it an easy tool to qualify the workers in their company, but 11.1% of the companies do not find it easy.

Box 29

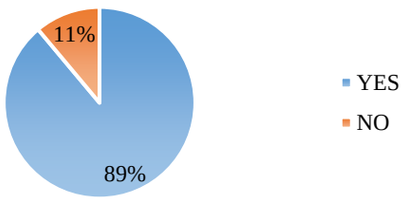

Figure 28
Ease of tools

Companies that use the ILUO format to easily see the skills of their staff are 55.6%. 44.4% do not use it.

Box 30

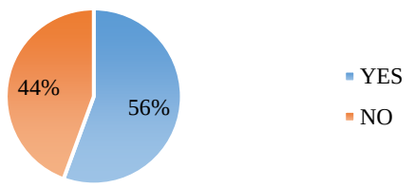

Figure 29
Companies applying ILUO

The percentage of accuracy that the ILUO training system allows them to track staff progress is 100% according to 33.3% of the companies that could be surveyed, while the other 33.3% of the companies say that the percentage of accuracy is 75%. Finally, the remaining 33.3% of the companies say that the accuracy rate is 50%.

Box 31

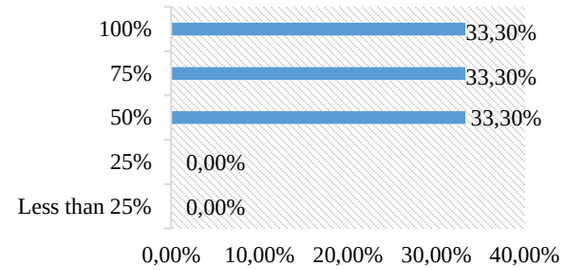

Figure 30
Track progres

66.7% of the companies mentioned that the implementation of the ILUO training system in their company does provide them with immediate feedback on the performance of their staff. 22.2% said that sometimes and 11.1% said that it does not.

Box 32

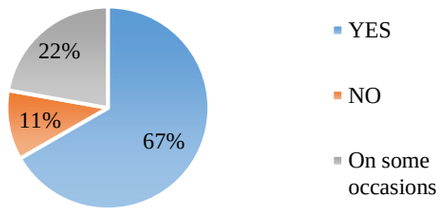

Figure 31
Immediate feedback

On the basis of whether the ILUO training system adapts to the individual needs and learning styles of workers 77.8% of the companies said yes, while 22.2% said no.

Box 33

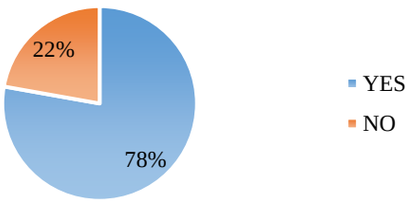

Figure 32
Individual adaptation of each operator

88.9% of the companies mentioned that the ILUO training system does allow them to rotate staff in their company, but 11.1% of the companies said that it does not allow them to rotate staff.

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Box 34

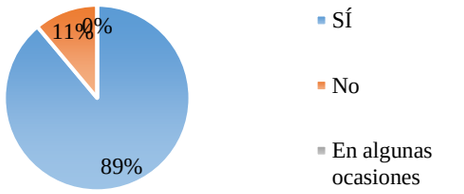

Figure 33

Staff turnover

44.4% of the companies say that the percentage that the ILUO training system has allowed them to optimize time and resources for workers and trainers is 75%. Another 44.4% of the companies say 50%, while 11.1% of the companies say a percentage of less than 25%.

Box 35

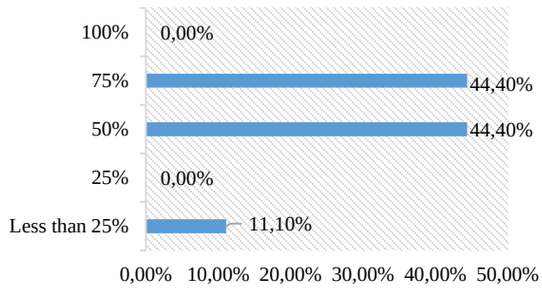

Figure 34

Optimizing staff time and resources

With 55.6% of the companies saying that the way in which the ILUO training system has enabled them to update and adapt easily to changes in the labour market is 75%, on the other hand 33.3% of the companies say 50%, while the remaining 11.1% of the companies say less than 25%.

Box 36

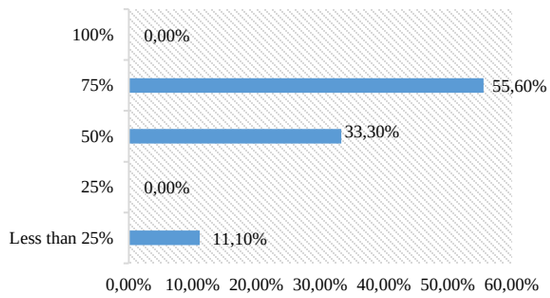

Figure 35

Updating and adapting to changes

Based on the companies that do not implement the ILUO system. The percentage of 33.3% of the companies believe that they can improve production by 50% if they implement it. 22.2% of the surveyed companies believe that they can improve with 100%. Another 22.2% of the companies think that they can improve with a percentage of less than 25%. 11.1% of the companies think they can improve with 75% and the remaining 11.1% say they can improve with a percentage of 25%.

Box 37

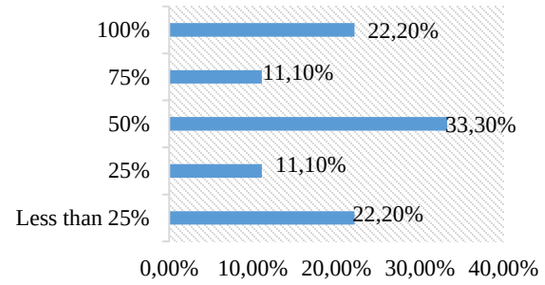

Figure 36

Possible improvements

22.2% of the companies surveyed mentioned that the competitiveness provided by the ILUO training system can be 100%. On the other hand, 11.1% of the companies mentioned that the competitiveness could be less than 25%. 33.3% mentioned that it could be 50%. The remaining 33.3% mentioned that if they implemented this system in their facilities, the competitiveness they could obtain could be 75%.

Box 38

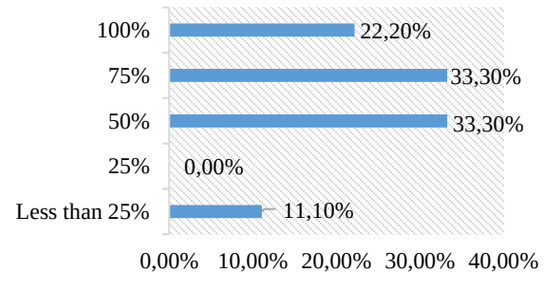

Figure 37

Competitiveness enabled by ILUO

The percentage of companies agreeing that the ILUO training system can achieve operational excellence is 88.9%. 11.1% do not agree.

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Box 39

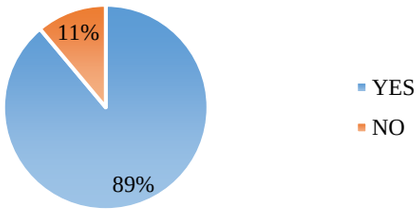

Figure 38

Operational excellence provided by ILUO

Conclusions

The ILUO training system is known by most of the companies in the automotive sector to which the survey was applied, with a percentage of 88.9%. Most of the companies are large, with more than 250 people working in their facilities. However, it should be taken into account that this system is only implemented in 66.7% of the companies in the San Francisco de los Romo Industrial Park, although all the companies are capable of using it. However, 64% of the companies have been implementing this system for 10 years or even more. With this, all companies assured that the ILUO training system can really measure the skills of the staff, as well as it can be applied frequently in the company premises.

Based on the 4 levels corresponding to the ILUO acronym, 77.8% of the companies agree that these 4 levels are sufficient to measure the ability of the staff. Each company has a completely different level of maximum ability, but the majority of companies (44.4%) have assigned level 3 (letter U) as the highest of all levels. The majority of the companies claim to have level 1 staff in their facilities with approximately 25% of the operators being at this level. A level 3 operator is worthy of being a Universal Operator, as mentioned by 55.6% of the companies. Finally, more than 75% of the staff in most companies are at level 4.

Operational staff with level 1 must compulsorily attend the training programme. Thus, in order for a worker to be considered level 1, he/she must have been working in the company for 3 months, as mentioned by 77.8% of the automotive companies. During that time they have been working, they must obtain a minimum of 80% of correct answers in the theoretical assessment. It takes 77.8% of the companies approximately 3 months to train staff at this level.

Operational personnel at level 2 are involved in production processes, or at least this is what 88.9% of the companies mentioned, and they must also have a capacity of 80% to 90% of knowledge in the handling of machinery. Similarly, at the time of work, they must maintain in their work area what is necessary to be able to work applying the 5'S methodology and at the same time they must not make mistakes in their work, and they must also comply with zero defects to the client. It takes 66.7% of the companies 6 months to train level 2 operational staff.

Personnel with level 3 are able to train operators with level 1 and 2, 77.8% of the companies said so. Operators with this level have a very big responsibility because they cannot pass any defect to the next process and this leads them to know the critical points of their operation. Most of the companies that responded to the survey mentioned that level 3 operators are trained to take initiative in various aspects such as continuous improvement, safety, quality and line compliance. Companies allow workers at this level to contribute ideas to improve the standard and update their operation's sheets. Training for level 3 takes more than 1 year according to 66.7% of companies.

Operators with level 4 can train levels 1, 2 and 3. Training for this level takes more than 1.5 years according to 66.7% of the companies.

By implementing the ILUO training system in the industry, it provides certain benefits such as flexibility, progress monitoring, continuous updating and efficiency in the company. As a result, this tool allows for easy qualification of personnel. Therefore, 55.6% of the companies use the format to visualize the skills of their workers. ILUO allows to track the progress of the personnel with a percentage of 50% to 100% and also provides immediate feedback of the worker's performance. This system allows the company to choose the area in which the worker will perform best and at the same time adapts to the individual needs and styles of the workers, as 77.8% of the companies ensure this. The majority of the companies mentioned that the ILUO training system allows staff rotation, optimizes time and resources for workers and company instructors from 50% to 75%, as 44.4% of the automotive companies stated.

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55.6% of the companies agree that this system allows updating and adapting to changes in the labour field with an ease of 75%. Thus, ILUO allows to eliminate 50% of downtime and also allows to have a competitiveness of 50% to 75% as mentioned by the majority of the companies. Furthermore 88.9% of the companies agree that ILUO can achieve excellence and can also improve production with a percentage of 50% effectiveness.

Recommendations

There could be a reduction in the time it takes for operators to move up a level. Normally the time they give operators to train them is time they are not spending on productive tasks. This makes companies see this as a loss of productivity. Most companies are under pressure to meet targets, which can put training on the back burner. By devoting more time to staff training, operators would become multi-skilled which would allow for staff turnover, thus increasing the company's production.

When implementing the ILUO training system, it is recommended that constant follow-up is given, so that immediate feedback can be given and accurate data on the operational staff can be obtained. This will make it easier for the company to choose the right area for each operator according to his or her skills in relation to the position.

Continue with the training activities according to the company so that the personnel in charge of the training can apply them to the operative personnel, regardless of the level of each worker, so that when interacting with the activities, tools and machines, the same operative personnel with a higher level can give feedback to operators with a lower level. Similarly, the company can encourage its workers to continue with their studies, give them scholarships to obtain a university degree or TSU, with this they would have more knowledge that would benefit the company and even the workers themselves, as they could obtain a better position in the company. With the survey that was carried out, it is clear that some companies do not know the ILUO training system, which means that the companies do not have adequate training and cannot apply continuous improvement in their facilities. Courses could be held in the companies, especially in the area of training.

Declarations

Conflict of interest

The authors declare that they have no conflicts of interest. They have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this article.

Authors' contribution

Rivas-Castorena, Britney Daniela: Contact of personnel of the companies selected to answer the survey. Editing the document.

Vázquez-Gutiérrez, Rosa Inés: I contributed in the selection of the topic, supervision and support in contacting personnel of the companies selected to answer the survey. Supervision and explanation of how to edit the document.

Núñez-Montalvo, Juan Manuel: Support in the revision of the document

Availability of data and materials

The availability of the data obtained in this research was obtained through surveys.

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Thanks to their kindness in lending some of their valuable time to answer the survey that was conducted, they made it possible for this project to conclude successfully. Their data was a key part of this research.

It was also a pleasure to be assigned the research topic by Rosa Inés Vázquez Gutierrez, who gave me the confidence to carry out this article and who guided me at all times during the completion of this project.

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I would also like to thank the UTNA authorities who supported us in carrying out this research.

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Article

Individual public passenger transportation service for continuous improvement

Servicio de transporte público individual de pasajeros para una mejora continua

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Abstract

The world is changing rapidly due to factors such as globalization, the pandemic and high inflation, which affects both large companies and microentrepreneurs. In Tabasco, the taxi sector faces low productivity and greater demands due to the new mobility law and unfair competition. The objective of this research is to improve productivity in this sector. According to V.E.G.A. (2017), transportation is crucial for economic development, generating jobs and improving quality of life. The transportation union in Tabasco has 8 decades of experience and has competent human talent. Even so, it is necessary to measure and improve strategic management. Productivity is defined as the sum of efficiency (optimization of resources) and effectiveness (achievement of objectives and adaptation to the environment). The aim is to promote good labor practices and develop proposals that maximize economic benefits and improve the reputation of the sector.

Productivity, Mobility, Taxis

Resumen

El mundo está cambiando rápidamente debido a factores como la globalización, la pandemia y la alta inflación, lo que afecta tanto a grandes empresas como a microempresarios. En Tabasco, el sector de taxis enfrenta baja productividad y mayores exigencias debido a la nueva ley de movilidad y la competencia desleal. El objetivo de esta investigación es mejorar la productividad en este sector. Según V.E.G.A. (2017), el transporte es crucial para el desarrollo económico, generando empleos y mejorando la calidad de vida. El gremio del transporte en Tabasco, cuenta con 8 décadas de experiencia y dispone de talento humano competente. Aun así es necesario medir y mejorar la gestión estratégica. La productividad se define como la suma de eficiencia (optimización de recursos) y eficacia (logro de objetivos y adaptación al entorno). Se busca fomentar buenas prácticas laborales y desarrollar propuestas que maximicen beneficios económicos y mejoren la reputación del sector.

Productividad, Movilidad, Taxis

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Article

Introduction

The world is changing at a rapid pace, affecting both large companies and micro-entrepreneurs. Factors such as globalization, pandemics and high global economic inflation have had a significant impact on various sectors, including public transport in the form of taxis. In Tabasco, this sector faces new demands due to the implementation of the new Mobility Law, which is framed by the right to mobility and the United Nations 2030 Agenda for Sustainable Development. In addition, unfair competition and constant changes in the environment have affected their productivity.

The objective of this research is to determine to what extent productivity can be improved in this sector. According to V.E.G.A. (2017), "Transport is fundamental to the economic development of cities. It creates employment opportunities, enables social interaction, lowers costs, raises productivity and increases people's quality of life. It contributes to an efficient and competitive transport system". Currently, public transport generates both direct and indirect employment, which contributes significantly to the development of the state of Tabasco.

The aim is to measure performance in the management of strategies and improve the productivity of public transport in the taxi mode, as well as to propose a comprehensive model for measuring productivity. According to Dr. Hortensia Eliseo Dantes (2023), productivity is the sum of efficiency plus effectiveness. Efficiency implies optimizing available resources, while effectiveness refers to the achievement of objectives and adaptation to changes in the environment. Encouraging good working practices fosters an integral corporate culture and develops proposals for improvement through a model that integrates social, environmental and cultural responsibility to maximise economic benefits and achieve a competitive reputation that is well perceived by users.

For this purpose, the structure of an individual public passenger transport cooperative will be analyzed. Based on the organization's own needs, a comprehensive productivity evaluation tool will be defined and a comprehensive measurement model will be proposed.

The results of the proposed model will be analyzed and the necessary measures to improve the cooperative's productivity and efficiency will be proposed.

Box 1

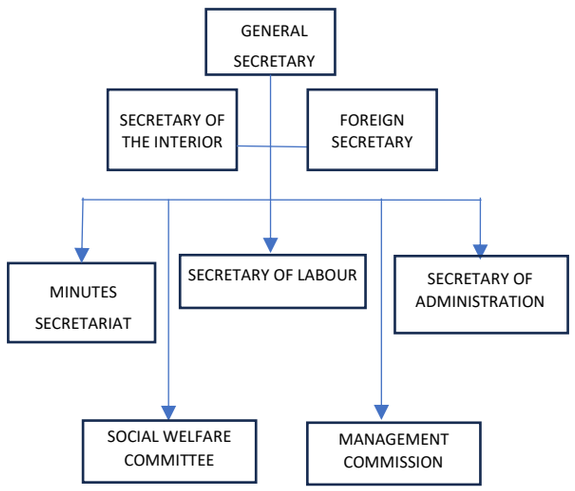

Figure 1
Functional organization chart of an individual public passenger transport cooperative
Source: Own elaboration

Mission: To provide an individual public transport service of quality and excellence, by drivers trained according to the needs of users and with social responsibility.

Vision: To be the leading cooperative of individual public passenger transport, contributing to the socio-economic development of Tabasco and the country.

Objective of the cooperative: To watch over and always procure the unity, democracy, dignity, welfare, social justice and progress of the authentic worker of the steering wheel and their families, without distinction of race, religious creed, political doctrines or social condition.

Values: Responsibility, Democracy, Equality, Equity and Solidarity.

Methodology

Currently, the groups dedicated to providing public transport services in taxi mode have low productivity. According to Islas Rivera et al. (2000), "the productivity of public transport service must be adapted to the reality of each city".

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Rodríguez-Valencia, Blanca Susana, Castro-De La Cruz, Jucelly, López-Valdiviezo, Leticia and Meneses-Hernández, José Luis. Individual public passenger transportation service for continuous improvement. Journal- Industrial Organization. 2024. 8-15: 20-26.
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Performance productivity should be measured by identifying the economic, political, social, cultural, technological and environmental variables that influence the productivity of individual public passenger transport services.

The definition of a taxi-type transport system according to Betanzo-Quezada et al. (2015) is based on the interaction of a set of complementary actors, such as public transport, road infrastructure capacity, quality of service provision and user-provider interaction.

Public transport must provide safety and comfort, requirements that also apply to taxi services, where driver friendliness, responsiveness, safety, credibility and technology are required.

Instrumentation

To obtain information on the productivity of this sector, the "Integrated Productivity Measurement Technique" (TIEP) of Dr. Hortensia Eliseo Dantés (2023), based on 10 priority elements in any organization, will be used.

This tool is structured to relate these elements directly to the variables of the social, cultural, technological, environmental, economic and political context. This avoids biases in the collection of information, ensuring that every piece of data collected is relevant to the study.

Comprehensive Productivity Assessment Instrument: The objective of this instrument is to measure the knowledge that the leaders of each department have regarding each of the 10 elements, placing a weighting on each of the relationships to determine their relevance within the organization.

The sum of these weightings must always add up to unity.

Box 2

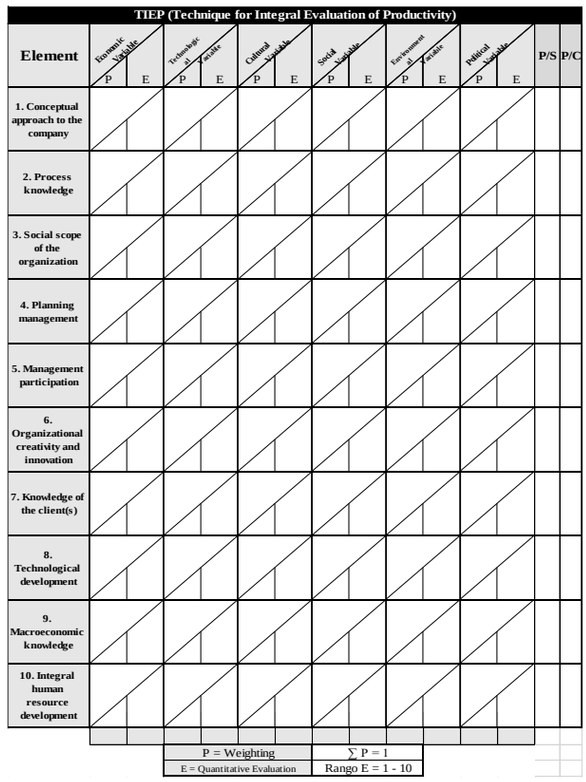

Table 1

Format of the Comprehensive Productivity Assessment Tool

Source: TIEP. Dr. Hortensia Eliseo Dantés (2023)

Procedure

In order to apply the measurement instruments, it is important to know the different areas into which the activities managed by the management are divided. This will make it possible to comprehensively study the variables that affect productivity in this sector. The integrated productivity measurement tool will be applied to obtain complete information on the management in each of these areas:

1. General Secretary
2. Secretary of Labour, Conciliation and Surveillance
3. Steering Committee
4. Home Secretary

Results

The graphs show the results of both the simple averages of each of the elements and the composite average of the elements.

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Box 3

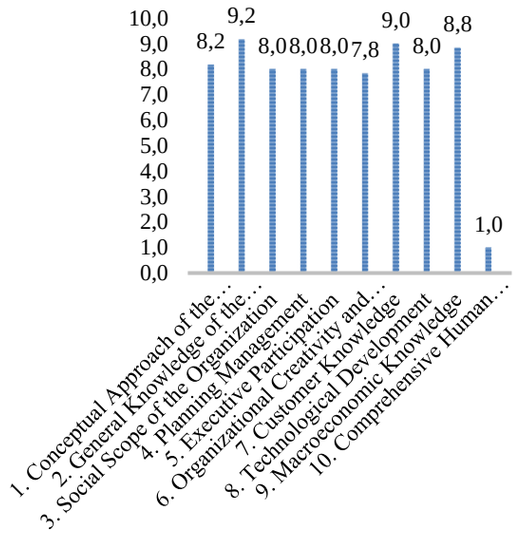

Figure 2

Simple Average: Management Commission Department

Source: Own elaboration

The simple average is the data obtained by calculating the quantitative evaluation of each of the elements of the tool with respect to the employee's knowledge of each element. In this case, the scores for process knowledge and macroeconomic knowledge are equal, with close scores for the other elements. However, element 6 (creativity and innovation) and element 10 (integrated resource development) have the lowest scores, representing an area of opportunity for continuous improvement.

Box 4

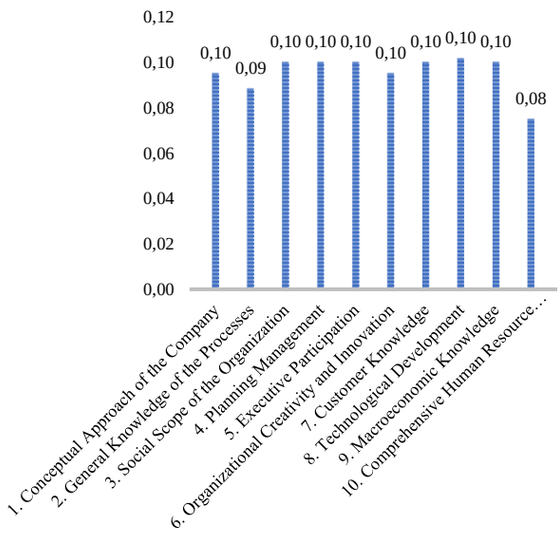

Figure 3

Composite Average. Management Commission Department

In this graph, the quantitative assessments are averaged together with the weights of each of the elements in relation to the context variables. Elements 1 (conceptual approach), 3 (social domain) and 9 (client knowledge) score well, but the integral human resource development (element 10) and the cultural and social variables need attention.

Box 5

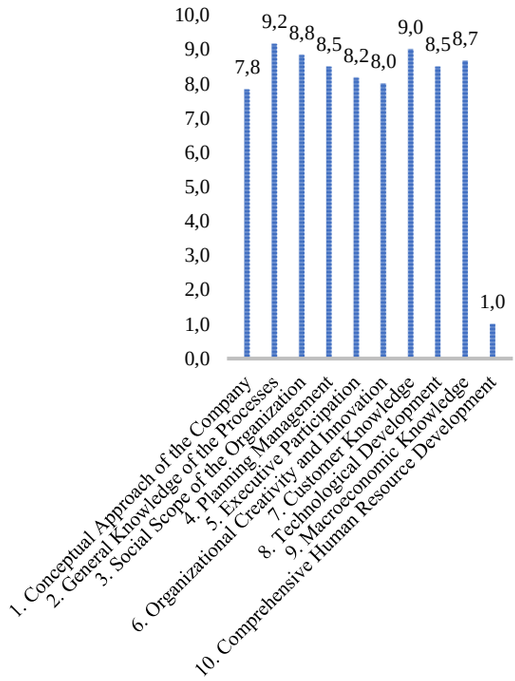

Figure 4

Simple averages: Department of Labour Secretariat

Regarding the knowledge of each element, favourable results are shown for variables 2 (process knowledge), 3 (social domain) and 7 (customer knowledge). However, the conceptual approach (element 1) and the integral development of human resources (element 10) have the lowest scores, representing areas of opportunity for continuous improvement.

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Box 6

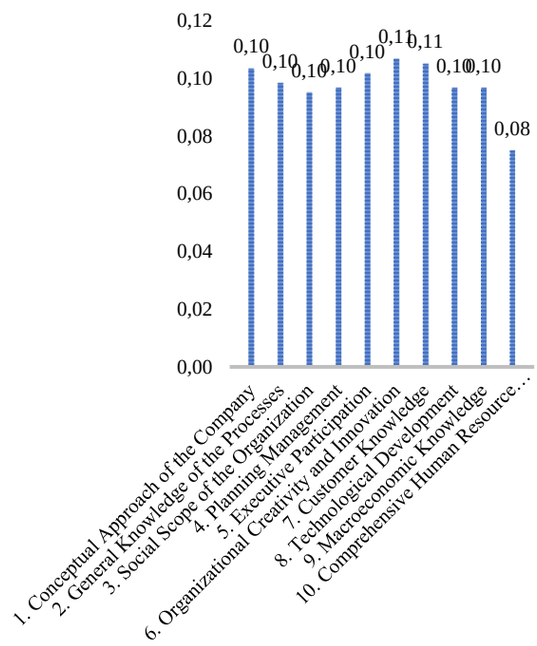

Figure 5
Composite averages: Ministry of Labour

Attention needs to be paid to the integral development of human resources without neglecting the other elements, trying to achieve a comprehensive analysis in order to identify areas for improvement.

Box 7

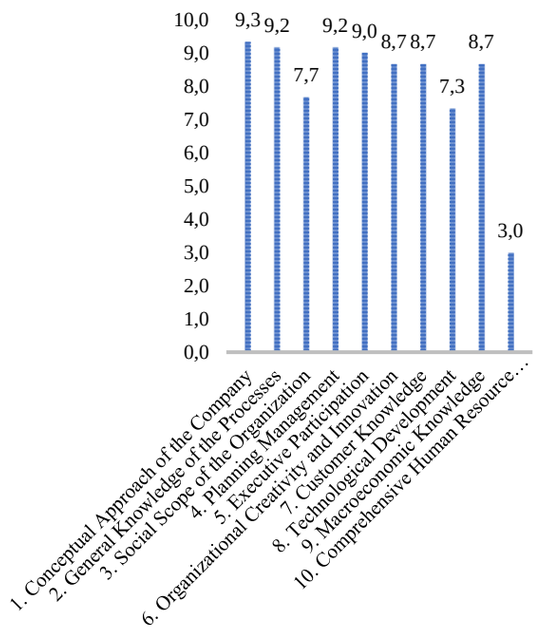

Figure 6
Simple Average: Transport service cooperative leader

The result in this department shows little variability in the ratings, with conceptual approach to business and macroeconomic knowledge standing out above the others. However, the social domain of the organization (element 3) and integral human resource development (element 10) have the lowest scores.

Box 8

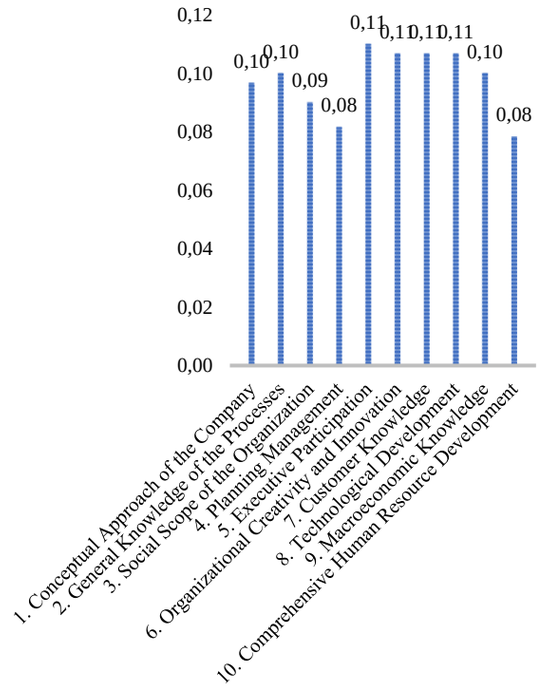

Figure 7
Composite Average: Transport service cooperative leader

This department requires attention to the integral development of human resources and the social sphere without neglecting the other elements. A comprehensive analysis should be carried out to identify areas for improvement. The results obtained from the comprehensive productivity assessment matrix show that the company has an average level of performance, with strengths in some elements, such as the conceptual approach to the company and macroeconomic knowledge. However, there are areas for improvement in the integral development of human resources and the social environment of the organization. In order to generate strategies for the implementation of continuous improvement, a model to follow is proposed. According to the author (Daza-Rodriguez, 2017, p. 24.) it emphasises differentiation, which will mark the path to success of the public transport union.

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In order to establish a follow-up of a productivity improvement model, it should not be a specific job, but an integral one, giving follow-up and being committed in a general way in each of the steps of this model that is presented, contributing in the possible way the part of the work that each member of the work team corresponds to him/her. The results of the follow-up of a continuous improvement model are not always immediate, these can be given gradually while the adequate feedback is made, it is required to cover in a general and integral way the intangible areas that have this sector, therefore, the measurement tool must be structured in such a way that these elements can be directly related to each one of the variables of the context that are going to be analysed in this research study, in such a way that bias is avoided in the compilation of the information and of each collected data is of importance for this analysis

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Box 10

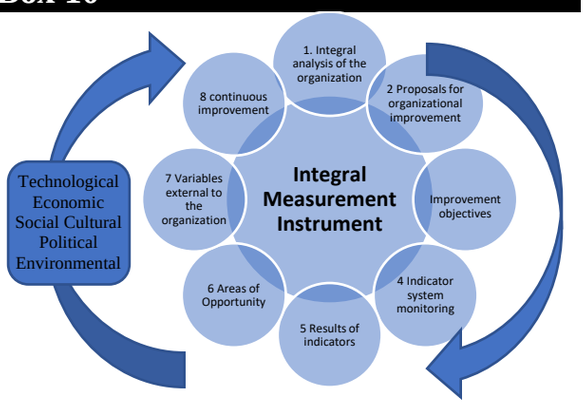

Figure 9

Proposal for a Comprehensive Productivity Measurement Model

This model covers the following aspects:

1. Sensitization of top management
2. Identification of a corporate culture
3. Organizational and customer moment of truth
4. Customer satisfaction assessment
5. Strategy definition
6. Planned training
7. Continuous improvement training
8. Monitoring of changes requested by customers
9. Productivity-focused leadership
10. Involvement and Motivation
11. Competence development of human talent
12. Communication and Engagement
13. Support in service transformation processes
14. Training of human talent.

Recommendations

1. Continuous Training: Implement training and refresher programmes for drivers, focused on improving customer service, technical knowledge and personal development.
2. Innovation and Technology: Incorporate emerging technologies to optimize routes, improve safety and efficiency in service delivery.
3. Work Environment Improvement: Foster a positive and collaborative work environment, promoting employee motivation and engagement.
4. Social and Environmental Responsibility: Adopting sustainable and responsible practices, aligned with sustainable development objectives.
5. Continuous Evaluation: Implement a system of continuous performance and productivity evaluation, using comprehensive tools such as the TIEP to identify areas for improvement and establish action plans.

Conclusions

Productivity in the public transport taxi sector in Tabasco can be improved through a comprehensive approach that considers training, technological innovation, integrated human resource development, and social and environmental responsibility.

The application of evaluation tools such as the TIEP provides a clear vision of the areas of opportunity and strengths, allowing the implementation of effective strategies to improve the performance and competitiveness of the sector. This document has been structured to provide a comprehensive overview of the current situation of the public transport taxi sector in Tabasco, and to propose concrete actions to improve its productivity, in line with the current demands and requirements of the environment.

Abbreviations

TIEP Integrated Productivity Evaluation Technique

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Viability of the open-pit cultivation of bell peppers in Meoqui, Chihuahua

Viabilidad del cultivo de chile morrón (*Capsicum annuum L*) a campo abierto en Meoqui, Chihuahua

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CONAHCYT classification:

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Campo: Agricultural Sciences
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Subdisciplina: Crop production

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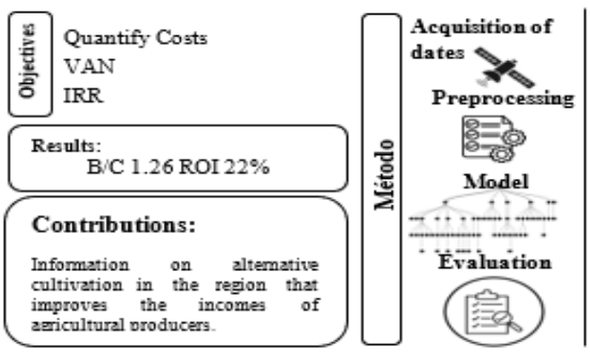
Abstract

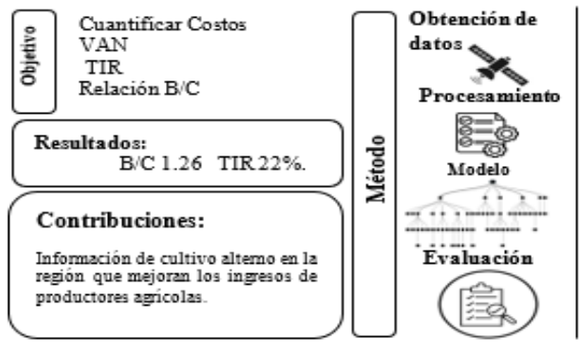
Chili bell pepper (Capsicum annuum L.) has its origin in South and Central America, domesticated in Mexico (Mendoza, 2010), and is part of the small genus of tropical herbs. In Mexico, there is a lack of sufficient economic information about the production costs of the chile bell pepper crop; however, it is considered an economic alternative due to the low input costs it requires. The objective of this study was to determine the economic viability of this crop in a plot established in the municipality of Meoqui Chihuahua, Mexico, where the costs of cultural activities and necessary inputs were collected from land preparation, establishment of the plantation until harvest, and the financial indicators net present value (NPV), internal rate of return (IRR) and the benefit-cost ratio (B/C) were considered. A B/C ratio of 1.26 was obtained, an IRR of 22%, higher than the discount rate (12%), which indicates viability.



Costs, Economic indicators, Harvest

Resumen

El chile morrón (*Capsicum annuum L.*) tiene su origen en América del sur y América central, domesticado en México (Mendoza, 2010), forma parte del reducido género de hierbas tropicales. En México se carece de suficiente información económica acerca de los costos de producción del cultivo chile morrón, sin embargo, se considera una alternativa económica debido a los bajos costos de insumos que este requiere. El objetivo de este estudio fue determinar la viabilidad económica de este cultivo en una parcela establecida en el municipio de Meoqui Chihuahua México, en donde se recabaron costos de las actividades culturales e insumos necesarios desde la preparación del terreno, establecimiento de la plantación hasta la cosecha y se consideraron los indicadores financieros valor actual neto (VAN), tasa interna de retorno (TIR) y la relación beneficio costo (B/C). Se obtuvo una relación de B/C 1.26, una TIR del 22%, mayor que la tasa de actualización (12%), lo que indica viabilidad.



Costos, Indicadores económicos, Cosecha

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Introduction

The chilli pepper (Capsicum annuum L.), also known as pepper, has its origin in South America. Researchers Walsh and Hoot (2001) after a study of molecular analysis of both wild and domesticated species concluded that the genus capsicum originated in the arid regions of the Andean mountains; in particular, what is now Peru and Bolivia.

The genus Capsicum has been part of the human diet and Native Americans used various chilli species as early as 5,200 BC (Nadeem et al., 2011). Prior to the arrival of the Spanish in the Americas, the pepper was not known in Europe, Asia and Africa. However, there is evidence that Christopher Columbus, on his return from his second voyage to the New World, brought some samples of bell peppers as a gift to the King and Queen of Spain, which led to its distribution and knowledge of it to the rest of the world (Bosland and Votava, 2012). In fact, Christopher Columbus is also credited with having christened this chilli pepper, although an inappropriate term, as it is as hot as black pepper. In Mexico, chilli production in 2020 was 2,818,443 tonnes, which were harvested on 157,911 ha, giving a national average yield of 17.8 tonnes ha-1 (Bastida Cañada, 2023).

Regarding bell peppers, Mexico is considered the world's main fresh pepper exporter, with a world share of 29%. In the period January-November 2021, the value of fresh pepper exports totalled 1,366 million dollars (SADER, 2022).

According to the same source, this amount represents an increase of 5.4% compared to the same time in the previous year. Around 50% of the production of bell peppers is carried out under protected agriculture, i.e. under greenhouses, shade netting or macro tunnel, which makes it available on the market all year round.

In the open-air production modality, the state of Sinaloa is the main producer. It is important to mention that, apart from the names of chili pepper or pepper, in some regions it is identified as sweet pepper, brown pepper, sweet pepper or paprika.

The state of Chihuahua, located in northern Mexico, has traditionally been the main producer of the various types of chilli; for example, in 2020, 675,131 tonnes were produced, representing 24% of national production (Bastida Cañada, 2023). In particular, bell peppers are grown in three production systems: open field, shade house and greenhouse. Higher yields are obtained with the shade net system; however, the construction of a greenhouse means a significant investment and this must be carefully analysed (Huerta et al., 2009).

In this State, there are few producers dedicated to the production of bell peppers, hence the need to investigate the economic impact that would be generated, as well as to investigate the technical management, in order to analyse how to achieve greater profitability. Therefore, the objective was to analyse the economic profitability of pepper cultivation under an open field system. It is hoped that this information will be useful for agricultural producers in the south-central region of the state of Chihuahua, who are interested in the production of this crop.

Materials and methods

The study was carried out in a farm located in the town of Las Puentes, in the municipality of Meoqui, Chihuahua State, Mexico (Figure 1).

Box 1

Figure 1
Location of the agricultural property under study
Source: Own elaboration

The project was supported by a cooperating producer who has been involved in the production of bell peppers in the region. It started with the transplanting of the plants to the field, which was in April 2023, and then a flow chart was used to describe the technical and financial management of the whole production process.

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The termination of the study was with the harvesting actions and the study was completed until June 2023.

Economic and financial analysis

For the calculation of the total cost of cultivation (TCC), the fixed costs (FC) and variable costs (VC) that were incurred in the entire crop production process were taken into account. Figure 2 shows this relationship. That is, the costs incurred for land preparation, seedling production and transplanting to the field, number of irrigations, fertilization, weed control, pest and disease control, harvesting and, finally, packing were computed.

Box 2

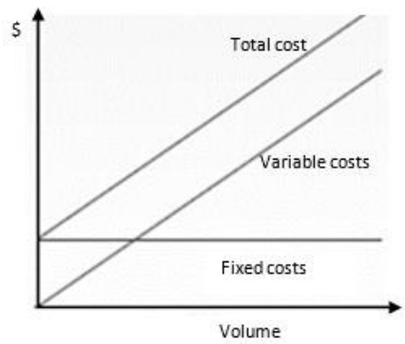

Figure 2
Graph showing the total cost concept
Source: Ramírez, 2008

In the particular case of land preparation, the necessary expenses were considered, such as soil preparation, subsoiling, harrowing, fallowing, levelling, furrowing and bed formation. The purpose of all these activities was to provide the plant with a suitable environment for root development, improving aeration and soil structure. It is important to mention that the mulch was installed in the field and the expenses incurred for the establishment of the tape were noted, as the irrigation was done using the technique known as drip irrigation. In the particular case of harvesting and packing activities, cardboard boxes were purchased, and to complement these expenses, transport and freight costs were also taken into account.

With the information provided, a profitability analysis was weighted, for which the financial variables of Net Present Value (NPV), the Internal Rate of Return (IRR) and the Benefit-Cost Ratio (B/C) were considered.

The NPV calculation analyses the investment of a project based on the future income and expenditure to be made (Montes, 2023). Consequently, it is possible to know how much would be gained or lost by making a given investment, in this particular case, with the planting of bell peppers (Le, 2021). The IRR is an indicator of the profitability of projects or investments; therefore, the higher the IRR, the higher the profitability (Magni, 2011), thus helping to make a good decision on the investment to be made. With regard to the B/C ratio, this parameter represents the relationship between costs and benefits over a given period, and is calculated using the simplest formula (Ortega et al., 2023).

$$\text{Cost Benefit} = \left(\frac{\text{Benefit neto}}{\text{Neto cost}}\right) \times 100 \qquad (1)$$

Results and discussion

Table 1 shows the main variable costs, which were: seedling production and labour for transplanting $65,535.00, fertilizer $14,789.00, and trampling and boxes $100,000.00. As recommended by BTC Bank (2023), variable costs are considered to be those that increase or decrease according to production. In terms of fixed costs, administrative payments of $89,992.80 and water usage of $121,086.00 can be observed for this activity; fixed costs are those that do not change with the level of production.

It can be seen that seedling production and labour are the largest proportion of expenses in this activity. Accordingly, BTC Bank mentions that some elements of the cost of agricultural production, such as soil, sunlight, heat and rainfall are natural inputs, therefore, they do not require financial management.

With a cost in the first year of $414,858.56, the amount of 20 tons of product was obtained. To determine the selling price per ton, the price of the competition was analyzed to enter the market with a selling price of $30,000.00 per ton, obtaining an income in the first year of $600,000.00. According to Martínez S. (2022) the formula to determine the selling price of a product is: Selling price = Cost price + (cost price + margin), in the simplest form.

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Box 3

Table 1

Five-year projected variable and fixed costs

Concept/month	Year 1	Year 2	Year 3	Year 4	Year 5
Variable costs					
Land preparation	4,000.00	4,480.00	5,017.60	5,619.71	6,294.08
Labour, webbing and padding	2,400.00	2,688.00	3,010.56	3,371.83	3,776.45
Prod.plant and labour transplant	65,985.00	73,903.20	82,771.58	92,704.17	103,828.67
Manpower irrigation	13,625.00	15,260.00	17,091.20	19,142.14	21,439.20
Fertiliser	14,789.00	16,563.68	18,551.32	20,777.48	23,270.78
Agrochemicals	2,389.00	2,675.68	2,996.76	3,356.37	3,759.14
Pizca	60,000.00	67,200.00	75,264.00	84,295.68	94,411.16
Boxes	40,000.00	44,800.00	50,176.00	56,197.12	62,940.77
Transport	7,000.00	7,840.00	8,780.80	9,834.50	11,014.64
Fuel	20,591.76	23,062.77	25,830.30	28,929.94	32,401.53
Subtotal	**230,779.76**	**258,473.33**	**289,490.13**	**324,228.95**	**363,136.42**
Fixed costs					
Administrator	53,992.80	60,471.94	67,728.57	75,856.00	84,958.72
Water	121,086.00	135,616.32	151,890.28	170,117.11	190,531.17
Capataz	36,000.00	40,320.00	45,158.40	50,577.41	56,646.70
Subtotal	**184,078.80**	**206,168.26**	**230,908.45**	**258,617.46**	**289,651.56**
Total cost	**414,858.56**	**464,641.59**	**520,398.58**	**582,846.41**	**652,787.98**

Source: Own elaboration

For the profitability analysis, the initial investment, income, costs and the discount rate were used to determine the 5-year projection (*Montes, et al. 2023*). A NPV greater than 1, IRR greater than the evaluation rate, and a benefit-cost ratio greater than 1 were obtained, which means that each invested peso recovers a surplus of 0.26 pesos.

Box 4

Table 2

Cash flow

YEAR	REVENUE	COSTS	CASH FLOW	TASA 1/(1+t)^N	REVENUE ACTUALIZ	C EGRESS ACTUALIZ
0		$275,792.00	$275,792.00	1	$ -	
1	$600,000.00	$414,858.56	-$90,650.56	0.893	$535,714.29	$370,409.43
2	$600,000.00	$464,641.59	$44,707.85	0.797	$1,014,030.61	$740,818.86
3	$600,000.00	$520,398.58	$1,165,106.43	0.712	$1,441,098.76	$1,111,228.29
4	$600,000.00	$582,846.41	$2,347,952.84	0.636	$1,822,409.61	$1,481,637.71
5	$600,000.00	$652,787.98	$3,600,740.81	0.567	$2,162,865.72	$1,852,047.14
TOTAL	$3,000,000.00	$2,911,325.11	$7,343,649.37		$6,976,118.99	$5,556,141.43

Source: Own elaboration

Box 5

Table 3

Total

VAN	$1,419,977.56
TIR	22%
B/C	$1.26

Source: Own elaboration

Conclusions and recommendations

From the present study it is concluded that investing in the cultivation of bell peppers in the region is feasible according to the costs and the results of the financial indicators, and it has the opportunity to be easily commercialized in a developing market.

This crop has low water requirements and does not require profound and structural changes to the production system. However, it is recommended that under the conditions of the region, a pruning system and the use of shade netting should be used to obtain higher production and better product quality, as well as to increase the number of harvests with higher production and profitability.

Declarations

Conflict of interest

The authors declare that they have no conflicts of interest. They have no known competing financial interests or personal relationships that might have appeared to influence the article reported in this paper.

Authors' contribution

Pacheco-Meléndez, Brenda Marina: I contributed the project idea and research development.

Macías-López, María Guadalupe: I contributed with the research method.

Ortega-Montes, Fabiola Iveth: I contribute with data analysis and editing.

Pérez, Jerónima Antonieta: I am contributing with data analysis and revision.

Availability of data and materials

Data sets used or analysed during the current study are available from the corresponding author upon reasonable request.

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Abbreviations

B/C	Benefit-Cost Ratio
CF	Fixed Costs
CTC	Total Cost of Cultivation
CV	Variable Costs
TIR	Internal Rate of Return
VAN	Net Present Value

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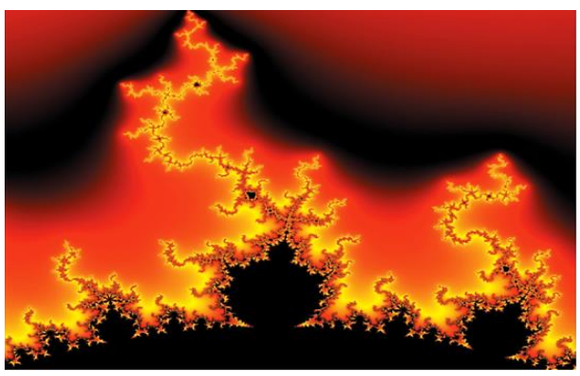

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