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RINOE Journal-Economic Systems

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Support the international scientific community in its written production Science, Technology and Innovation in the Field of Social Sciences, in Subdisciplines of Capitalist systems; Socialist systems and transitional economies; Socialist institutions and their transitions, Other economic systems; Comparative economic systems, Comparative analysis of Economic Systems, Comparative studies of particular economies.

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Presentation of the content

In the first article we present *Formalism of E-Commerce for SME of Pottery* by GONZÁLEZ-CASTOLO, Juan Carlos, RAMOS-CABRAL, Silvia and ZATARAIN-DURÁN, Omar Alí with adscription in the Universidad de Guadalajara, in the next article *The impact that has had the quality management, on the competitiveness of organizations* by QUIROZ-VELÁZQUEZ, Manuela Elvia & RAMIREZ-HERNÁNDEZ, Marivel with adscription in the Instituto Tecnológico de Toluca, in the next article *Modification to a process of making skewers in a company that produces meat products* by CANO-CARRASCO, Adolfo, FORNÉS-RIVERA, René Daniel, CONANT-PABLOS, Marco Antonio and RODRÍGUEZ-MUÑIZ, Miroslava Teresa with adscription in the Instituto Tecnológico de Sonora, in the next article *Logistics distribution network of tomato in Mexico* by QUINTERO-RAMIREZ, Juan Manuel, OMAÑA-SILVESTRE, José Miguel and AYLLON-BENITEZ, Julio Cesar with adscription in the Colegio de Posgraduados.
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Formalism of E-Commerce for SME of Pottery

Formalismo de Comercio Electrónico para PyMES de Alfarería

GONZÁLEZ-CASTOLO, Juan Carlos†*, RAMOS-CABRAL, Silvia and ZATARAIN-DURÁN, Omar Alí

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DOI: 10.35429/JES.2019.5.3.1.8 Received July 11, 2019; Accepted December 03, 2019

Abstract

This work presents the essential elements that must be contained in marketing strategy oriented to virtual commerce, which is colloquially known as e-commerce. The presentation of the mentioned elements is done from a reflexing of some concepts that are formally showed. It is to say that the dissertation on the validity of the proposal is supported by mathematical approaches. Although the exhibition of this research is acceptable for all types of Small and Medium Enterprises (SME), it is focused on the characteristics and needs of the pottery industry. The elements of the proposed marketing strategy are aimed at maximizing the customers shopping experience. The essential questions addressed are 1) How to keep customers to contact with products? 2) How to make customers feel that they are served? 3) How to get buyers to remain as customers and attract more? 4) How can buyers help to improve e-commerce? 5) What is the trend of the marketing strategy for e-commerce?

Resumen

Este trabajo presenta los elementos esenciales que deben estar contenidos en la estrategia de mercadotecnia orientada al comercio virtual, que se conoce coloquialmente como comercio electrónico. La presentación de los elementos mencionados se hace a partir de una reflexión de algunos conceptos que se muestran formales. Es decir que la tesis sobre la validez de la propuesta está respaldada por enfoques matemáticos. Aunque la exposición de esta investigación es válida para todos los tipos de Pequeñas y Medianas Empresas (PyMES), se centra en las características y necesidades de la industria de la cerámica. Los elementos de la estrategia de marketing propuesta tienen como objetivo maximizar la experiencia de compra del consumidor. Las preguntas esenciales que se abordan son: 1) ¿Cómo mantener a los clientes en contacto con los productos?, 2) ¿Cómo hacer que los clientes se sientan atendidos?, 3) ¿Cómo lograr que los compradores permanezcan como clientes y atraigan a más clientes? 4) ¿Cómo pueden ayudar los compradores a mejorar el comercio electrónico? 5) ¿Cuál es la tendencia de la estrategia de marketing para el comercio electrónico?

Citation: GONZÁLEZ-CASTOLO, Juan Carlos, RAMOS-CABRAL, Silvia and ZATARAIN-DURÁN, Omar Alí. Formalism of E-Commerce for SME of Pottery. Journal-Economic Systems. 2019. 3-5: 1-8

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Introduction

A company with a small number of employees is classified as SMEs (Saavedra García & Tapia Sánchez, 2013), (INEGI, 2009). The pottery industries of Jalisco state are SMEs. It is known that the basic aspiration of all SMEs is to expand their market area. To achieve this, the marketing strategy needs to consider the use of information and communication technologies (ICT). Currently, the use ICT is massive (Calvo Marín & Ospina Ospina, 2014). With the use of ICT there are vertiginous changes in the way of doing business (Barrientos Felipa, 2017) that it is known as e-bussines, and changes in social networks (González Castolo, Ramos Cabral, & Hernández Gallardo, 2018) that introduce the social-commerce, (Lia & Kub, 2018). The e-commerce and social-commerce are application areas of e-bussines (Grándon, Ramírez-Correa, & Luna Orrego, 2019). The discussion of social-commerce is not included here.

There are studies that try to enhance e-commerce with various strategies such as to give compensation in automated models, (Shojaiemehr & Rafsanjani, 2018). In the same context, there are studies such as transaction security verification (Yu, Ding, Liu, Wang, & Crossley, 2018); logistics analysis and supply chain management (Yu, Wang, Zhong, & Huang, 2017), (Pei & Yan, 2019); study of activities to balance supply and demand (Gólgecia, Karakasb, & Tatoglu, 2018); price prediction (Tseng, Lin, Zhou, Kurniajaya, & Li, 2018); sales prediction (Yuan, Xu, Li, & Lau, 2018); purchasing prediction (Dong & Jiang, 2019); analysis of purchase intention (Dachyar & Banjarnahor, 2017), (Ramírez-Correa, Grándon, & Arenas-Gaitán, 2019), (Li, Feng, & Zhai, 2019); customer loss prediction (Berger & Kompan, 2019); analysis of elements to attract and retain customers (Choshin & Ghaffari, 2017), (Deng & Gao, 2018), (Jannach, Ludewig, & Lercbe, 2017), (Wu, Zhang, Tian, & Wu, 2019), (Chen, 2019); trust analysis (Kim & Peterson, 2017), (Sánchez-Alzate & Montoya Restrepo, 2017), (Masseya, Wanga, & Kyngdon, 2019); etc. This work takes the e-commerce strategy as a marketing strategy because the arguments showed are more general

This paper is organized as follow: In the next section, fundamental consideration theoretical is presented about satisfaction grade and some related concepts are also included.

Then, characteristics that the marketing strategy required is shown. Next, discussions that have implicit answers to research questions are presented. Finally, the conclusions are given.

Satisfaction Grade

The satisfaction grade (SG) of the customer (Cmer) is directly related to the grade to which the expectation (E) is met regarding an object and/or service. Hereafter, the object and/or service will be called product (P). The P has characteristics (Ch) to attend E that are referred to as product benefit (Pb). The SG is a function of E and Pb, (1)

\[
SG = f(E, Pb)
\]

(1)

The E is a variable that is a function of marketing (Mk), utilitarian constant (K) and the valuation of who sells and/or where it is sold (Kp), (2). Then Mk is the variable that modifies E. The utilitarian constant is inherently associated with the solution of a task and/or service attention. For example, the tool is useful for doing things and pottery is useful for decorating a place.

\[
E(t) = f(Mk(t), K, Kp)
\]

(2)

The SG is variant in time with greater importance from the acquisition of P to the event of first use. The present work presents arguments from this point.

The Mk encourages the desire of P through its Pb promotion. The P has physical Pb (PPb) and/or ethereal Pb (EPb). For example, PPb refers to material type, design, texture, etc. The EPb refers to comfort, status, investment, etc. Each Ch could be has PPb or EPb or both, (3).

\[
PPb \cup EPb \cup PPb \cap EPb \in Pb \ni \{Pb\} \in P \ni \{\{PPb \cup EPb \cup PPb \cap EPb\}\} \in P
\]

(3)

The Mk always has a presence in the market, although in some cases it is not obvious. For example, people must expose P to the view of Cmer and even approach to make the offers in case of they sell pots on the public road. This practice has an implicit Mk.
Balance of $E$ and $Pb$ is the main propose of $Mk$ in order to maximize the number of greed state ($Gs$) and therefore maximize the accumulated gain ($TP$) in a given time. The $Gs$ is denoted when the excitement of desire causes that the $Cmer$ acquires $P$. The $TP$ is the sum of simple profit ($SP$), (4). The $SP$ is the difference between the sale price ($Sp$) and the production cost ($PC$) where $SP$ can be positive, negative or zero. (5). The variable $n_s(t)$ represents sold units. It should be noted that $Sp$ is part of $PPb$ ($Sp \in PPb$).

$$TP(t) = \sum SP(t)$$  \hspace{1cm} (4)

$$SP(t) = n_s(t)Sp(t) - PC(t)$$  \hspace{1cm} (5)

The $PC$ is integrated by manufacturing cost ($MC$), marketing cost ($MkC$) and research cost ($RC$). The above concepts are represented as variables in function of time, (6).

$$SP(t) = n_s(t)Sp(t) - p(t)MC(t) - MkC(t) - RC(t)$$  \hspace{1cm} (6)

The variable $n_s(t)$ represents made units such that $\sum t n_s(t) \leq \sum t n_p(t)$. The sum of sold products tends to be equal to sum of produced products when the company has production on demand policy.

Let it assumes that all variables of equation 6 in $t$ are zero. After of $t_0$, $RC(t)$ value starts increment because $P$ project requires the research of the market, $P$ characteristic, material supplies, $P$ design, etc. The $RC(t)$ tends to zero after an increase, according to solve advance of $P$ proposal.

The $Mk$ campaign begins shortly before this proposal is resolved. The $MkC(t)$ overlaps in time with the $MC(t)$. At first, $MC(t)$ has a higher value attributable to inexperience in $P$ elaboration, but this will tend to decrease and stabilize. The $t_0$ is the moment in which the $TP(t)$ has maximum negative, where receipts due to the number of sold products is equal to the $PC(t)$, Fig. 1(a). The $SP(0, ta)$, $SP(ta, tc)$, $SP(tc, td)$ as well as $SP(td, t)$ curves are not necessarily monotonic because variables are susceptible to the market, (6). The return of investment is at $t_0$ instant.

The maximum gain in the shortest time is in $t_0$ that it can be given by a high volume of purchase-sale transactions ($n_s(t)Sp(t) \gg PC(t)$).

Due to market saturation or past the $P$ novelty period, $SP$ has a drop that it will tend to stabilize after $t_0$. The curve of $TP(t)$ is described in Fig. 1(b). If $TP(t)$ is negative after $t_0$ it means that $Cmer$ loses interest in $P$.

![Illustrative curve of SP and TP](Image)

Let’s define, sales success as the fact of obtaining a profit of twice the investment in half of the time that product takes to appear on the market from $P$ project start.

Valuation and Opinion

The $SG$ is displayed internally as valuation ($Val$) and externally through opinion ($Op$). The $Op$ is the $Val$ manifestation, and they are directly proportional with variations over time. The $Val$ can be seen as a variable that is due to $Cmer$ interaction with $P$ (continuous qualitative variable) and $Op$ as the manifestation of said $Val$ at a given moment (discrete qualitative variable). After $P$ introduction in the market, $Op$ in the short-term pushes operations purchase-sale due $Cmer$ focused attention over this $P$. The $Op$ on the medium and long term is more related to stability and/or $P$ life in the market. The $Val$ can be seen as the difference between $Pb$ and $E$, (7).

If $Pb$ is greater than $E$ then it has a supra $Val$ ($V^+$) and otherwise, it has an infra $Val$ ($V^-$). With $V^+$ a positive opinion ($Op^+$) is expressed and with $V^-$ a negative opinion ($Op^-$) is said, (7). An atypical case occurs when $Pb$ is equal to $E$ because $Cmer$ always take a position with his $Op$ in a positive or negative way, (8).

$$Val = (Pb - E)^{V^-} \Rightarrow Op^-$$  \hspace{1cm} (7)

$$V^+ \Rightarrow Op^+$$  \hspace{1cm} (8)

The unbalance between $Pb$ and $E$ is revealed through $Op$. The $Op$ is positive ($Op^+$) when $Pb$ satisfy $E$ otherwise it is negative ($Op^-$). For all practical purposes it has that $Op^+ = 1$ and $Op^- = -1$. The $Op^-$ has more influence in the market than $Op^+$ then weight of $Op^-$ ($w_{Op^-}$) is greater than weight of $Op^+$ ($w_{Op^+}$), (9). The $K_u$ is an adjustment constant. The product qualification ($PQ$) is defined as the difference of $w_{Op^+}$ sum and $w_{Op^-}$ sum, (10).
The product qualification perception (PQP) is obtained with PQ that results as positive (pos) or negative (neg), (11). If P is associated with a brand and/or commercial space then PQ contributes to the company perception and/or place. This will be referred as company qualification perception (CQP), (12).

\[ w_{Op}^+ \equiv O_p^+ \text{ and } w_{Op}^- = K_u w_{Op}^+ \text{ where } K_u \in \mathbb{N} \]

\[ PQ = \sum w_{Op}^+ - \sum w_{Op}^- \text{ where } PQ \in \mathbb{Z} \]

If PQ is negative then it is illogical that Cmer buy P and a reflection is not considered in this case, Table 1.

<table>
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<th>Val before</th>
<th>Val during</th>
<th>Val after</th>
<th>Effect</th>
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<tr>
<td>Pos</td>
<td>Neg</td>
<td>Pos</td>
<td>New P in the market with a high initial sales push due to Mk where Val during and Val after does not influence Val before, Val before = f(Mk). The P does not penetrate the market.</td>
</tr>
<tr>
<td>Pos</td>
<td>Neg</td>
<td>Pos</td>
<td>The Mk causes that E &gt; Pb and it gets Gs. Although Val during is a factor that influences Val after the condition gets Pb ≥ E after some time This is interpreted as an erroneous strategy of Mk.</td>
</tr>
<tr>
<td>Pos</td>
<td>Pos</td>
<td>Neg</td>
<td>The P will sell well at the beginning but after it will sales decrease because the competition is better.</td>
</tr>
<tr>
<td>Pos</td>
<td>Pos</td>
<td>Pos</td>
<td>The P that penetrates the market with a stable presence.</td>
</tr>
</tbody>
</table>

| Table 1 Effect of Val of the P in marked |

The Sp is part of PPb in any strategy of Mk approach, and they are inversely proportional. This is the strategy of Mk approach and vice-versa. A nice feeling can be an evocation of affection, pleasure, adventure, etc. The service promise can be the type of material, ergonomics, etc. The social status promise tries to put Cmer within a privileged group. The P elaboration must be careful to justify a high Sp in this case. A high Sp of the P guarantees that only a select group of people has it. Moreover, the slope of Pb is small because Sp ≪ PbE|Sp ∈ PbP and therefore Val is affected little. Only in the service promise, Sp is adjusted carefully because Pb is reduced with any change to rise of Sp.

Purchase-sale Transactions Valuation

The Val can be seen in three moments associated with the purchase-sale transactions, 1) Val before, 2) Val during and 3) Val after.

The Val before is motivated with PQP and/or Mk. The PQP is due to Op of Cmer that acquired P previously. The Mk affects Val because it promotes desire until Gs is obtained. The Val during is present at first approach of Cmer with P and it is related to Pb and E, (7). The Val after is due to P integration into Cmer environment that is denoted as product use (Puse). The Val during and Val after constitute Op. The Op and Mk affect PQP and therefore Val before of new Cmer, (14).

\[ Val\_before = f(PQP,Mk) \]
\[ Val\_during = f(Pb,E) \]
\[ Val\_after = f(P,Val\_during,Puse) \]

Val before \(\Rightarrow\) PQP, Val during \(\Rightarrow\) PQP

This means that Mk must be corrected because the consumer is not properly informed and this has felt as cheating. Correct Mk does not mean increase MkC. Finally, if Mc moves away from 1 in a positive direction (Mc > 1) then Pb is higher than E. The above reveals that there is a potential market to offer P. The strategy of Mk can be extended to publicize P and promote Gs in order to increase SP through increasing ns. As in the previous case, extend the strategy of Mk it does not mean increase MkC.

Strategy of Mk approach

The strategy of Mk must ensure that Pb satisfies E and achieve Gs at the same time. The introduction of P in the market can be from the next strategies of Mk approach and/or a combination of them.

- Nice feeling.
- Service promise and/or
- Social status promise.
According to (10), $O{P}^{-}$ number must be lower than $O{P}^{+}$ number or zero. The $w_{O{P}^{+}} < w_{O{P}^{-}}$ because $O{P}^{-}$ is out of normality.

As has been argued before, the $Mk$ has two clear objectives, 1) to look the balance between $E$ and $Pb$, and 2) to induce $Cmer$ to buy $P$. The first objective is obtained by an adequate $P$ description. The second objective is procured by stimulating $Cmer$ senses. This last objective tries to find a pleasant and/or satisfactory image that is empathetic with $Cmer$.

Discussion of Strategy of Mk

The question of interest is, how to stimulate the desire of the $Cmer$? People have needs and their desire is stimulated by $P$ promoting. Then, $P$ tries to satisfy a group of specific needs with high percent. The first contact of $Cmer$ with $P$ is fundamental because, from that, $Cmer$ will try to recreate his positive experience or avoid his negative experience.

The strategy of Mk must guide $Cmer$ also about the environment of $P$ and/or use of $P$. The environment of $P$ corresponds to the place where $Ch$ of $P$ are relevant such as workshop, office, house, etc. The use of $P$ has to do with $P$ handling as ignition, maintenance, storage, etc. The strategy of Mk must also attend the $P$ support and $P$ life can be seen as part of $EPb$. The $P$ support has to do with the attention that company is offered post-sale. The $P$ life refers to time sure that $P$ will be in the market. The $P$ must $Cmer$ attention attract as an element that wants to integrate into his environment and/or experience. The senses are the channel through the desire of $Cmer$ is stimulated. Currently, the desire in e-commerce is stimulated through sense of sight and exceptionally sense of ear.

The number of senses to stimulate is reduced in e-commerce, so more attention must be paid to the strategy of Mk. In successive will be discussed points that are within e-commerce context.

a) Consumption is the scheme of interpersonal relationships. The $Cmer$ satisfies accompaniment wish, mitigates loneliness, and/or reduce fears through purchase-sale transactions. According to this, the communication and propagation of $P$ experience and/or $Ch$ of $P$ must be facilitated.

b) Since consumption is usually emotional and not rational, then $Cmer$ must perceive in a sideboard an empathy with his desired world. The $P$ must help to recreate and/or to modify a space where $Cmer$ moves away from mundane everyday life.

An images catalog must try to identify a pleasant scenario where $P$ is used and/or places where it is.

c) The contribution of $Cmer$ to images catalog helps to indicate $Pb$. In addition, it exhibits the message that good choice of $P$ is distinguished.

The $Cmer$ must have the facility to public $P$ images. The publication of images where $Cmer$ use $P$ helps to meet $Cmer$ recognition. The validation of material before its publication attend image catalog.

d) The idiomatic messages associated with $P$ contribute to $Mk$ purpose because they accentuate the good $Cmer$ decision with an acquisition. The paragraphs project knowledge and authority on $P$.

e) It is important to give a personalized shopping experience. The effort to attend $Cmer$ needs should be shown.

The strategy of Mk must be assisted by algorithms that according to the $Cmer$ search history and/or purchases make suggestions of new $P$. The artificial intelligence could assist here.

f) The innovation of strategy of Mk must be constant to find $Cmer$ satisfaction in purchase immersion. It is desirable to stay in the mind of $Cmer$.

The analysis of the strategy of Mk is necessary to appreciate the market trend and anticipate changes.
g) The shopping experience should try to recreate the feeling of the ride that the Cmer would do in a physical process.

The strategy of Mk can be included the virtual reality of displacement through shop windows where P image is amplified when the mouse cursor passes over it. With clicking on virtual P is shown a box with specific information about P and opinions and/or photographs. Recommendation and opinion are very important to stimulate desire.

h) The strategy of Mk proposition must be the idea of easy to buy, fast delivery, availability, and assistance after sales.

The strategy of Mk must avoid physical move inconveniences of Cmer. Also guarantee existence, diversity of payment forms, search tools, serious transaction (Sánchez-Alzate & Montoya Restrepo, 2017), and assistance.

i) In order to have differentiators from the competition, strategies must be devised that make it difficult for competitors to enter the market.

The strategy of Mk should be based on the offer of some exclusive P.

j) Even if the strategy of Mk has a specific marketing portal, it should not underestimate the use social networks portals.

The P offer should be made in different digital showcases such as YouTube, Reddit, Instagram, Pinterest, Facebook, Twitter, etc.

Conclusions

In synthesis, the proposed is give the Cmer what it is looking for and offer proposals that meet their needs. Pleasure to buy, feel loved, feel appreciated, feel part of an exclusive world. It convenient gives the promise to transform her environment through P.

The e-commerce must get the trust of Cmer. This could be obtained with clear rules, something contributed to the community, tips given without expecting something in return, authority demonstrated, business transparency show, questions attention, and commitments fulfill.

This paper presented a formal description elementary aspect of e-commerce. The reflection shows that SG is a function of E and PB; that Mk modulates E; that P has Pb; that Sp is a Pb; that Val and Op are effects of SG; that stimulating desire gets Gs. The implicit questions had been answered in the discussion of the strategy of Mk section.

E-Commerce must evolve with TIC advance with the aim of offering the best shopping experience. The evolution trend of e-commerce is with the use of virtual reality, artificial intelligence, and it needs to get involved in the dynamics of virtual social networks. The future work is the strategy of Mk atomization in order to develop the WEB portal for SME pottery.

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The impact that has had the quality management, on the competitiveness of organizations

El impacto que ha tenido la gestión de la calidad, en la competitividad de las organizaciones

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Abstract

Overview of quality management systems are essential for the competitiveness of the organizations, since they allow to promote a culture of continuous improvement in the same, higher education institutions are not exempt and is for this reason that they have implemented these systems as in the Nacional Tecnológico de Mexico, which currently has a comprehensive system (System of management of quality (ISO 9001:2015), environmental management (ISO 14001:2015) system, equity of gender (MEG), system model Energy management, health and safety at work management system, recognition of Social responsibility and in some cases the institutional environmental programme (PAI), for it is important to know how they have impacted the community. Some findings about the management system in the Instituto Tecnológico de Toluca, is that, if there is knowledge of the processes, care of environment due to institutional environmental program

Organizations, Quality, Competitiveness

Resumen

Los sistemas de gestión de calidad son imprescindibles para la competitividad de las organizaciones, ya que permiten fomentar la cultura de mejora continua en las mismas, las Instituciones de Educación Superior no están exentas y es por ello que se han implementado estos sistemas como en el Tecnológico Nacional de México. Institución que actualmente cuenta con un sistema integral Sistema de Gestión de Calidad (ISO 9001:2015), Sistema de Gestión Ambiental (ISO 14001:2015), Modelo de equidad de Género (MEG), Sistema de Gestión de Energía, Sistema de Gestión de Salud y Seguridad en el Trabajo, Reconocimiento a la Responsabilidad Social y en algunos casos el Programa Ambiental Institucional (PAI), para ello es importante conocer como han impactado en la comunidad tecnológica. Algunos hallazgos sobre el sistema de gestión en el Instituto Tecnológico de Toluca, es que, si existe conocimiento de los procesos, cuidado de medio ambiente debido al Programa Ambiental Institucional y al sistema de gestión ambiental ISO 14001:2015 sin embargo, aún existen oportunidades de mejora en las actividades que se realizan en la organización, como la participación y concientización de la comunidad tecnológica constituida por docentes, estudiantes y personal de apoyo a la educación.

Organizaciones, Calidad, Competitividad

Citation: QUIROZ-VELÁZQUEZ, Manuela Elvia & RAMIREZ-HERNÁNDEZ, Marivel. The impact that has had the quality management, on the competitiveness of organizations. Journal-Economic Systems. 2019. 3-5: 9-17

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Introduction

This article presents a different way of evaluating quality management systems since within the best known models are audits, the use of indicators and SERVQUAL as the most used. In this sense, the evaluation is done to diagnose the impact of Quality Management Systems (QMS) in a Higher Education Institution represented by the National Technological Institute of Mexico, made up of 260 decentralized and centralized Technological Institutes.

To carry out this study, the case study of the Technological Institute of Toluca was used, which has implemented an integral system in addition to the Integral Environmental Program (PAI), and the questionnaire for the application of semi-structured interviews to those responsible for the systems was also designed of management, teachers, students and alumni.

With the objective of identifying the opinion regarding the aforementioned management systems. The qualitative method for the realization of this research project has been used in some cases, since quantitative methods are used more frequently, here the importance of using the method and its wealth, with the support of ATLAS IT software (software used to analyze documentary information and interviews).

The results allowed us to know the situation of the management systems, from the point of view of the actors, mainly those responsible for the management systems of the Technological Institute of Toluca, the teachers who teach some of the learning units related in a way Indirect with any of the management systems, as well as the students currently studying some of the careers in this Institution, graduates of this Institution allowed us to know their opinions about the operationalization of the management systems.

The conclusions according to the results that in the Institutions of Higher Education as an example the Technological Institute of Toluca, management systems such as quality (ISO 9001: 2015, ISO 1400: 2015), as well as the Gender equity model and the Institutional Environmental Program are in a dynamic process that allows them to continuously improve.

As well as the Technological Institute has managed to establish the importance of management systems in the heads of each program, teachers of different careers, students and graduates.

The main recommendations mean that there is little dissemination and communication within, so that greater actions related to the dissemination and communication of management systems must be implemented, as well as encouraging the participation of the technological community, to generate awareness and awareness. Therefore, the planning, organization and implementation of different strategies for the improvement of quality management systems is necessary.

Theoretical framework

Quality is to translate the future needs of users into measurable characteristics, only then can a product be designed and manufactured to satisfy a price that the customer will pay; Quality can be defined only in terms of the agent. The word quality has multiple meanings. Two of them are the most representative: Quality consists of those product characteristics that are based on customer needs and therefore provide product satisfaction; Quality consists of freedom after deficiencies (Juran, 1990)

In a brief way, quality means product quality. More specific, quality is work quality, service quality, information quality, process quality, people quality, system quality, company quality, quality of objectives. “Quality is compliance with the requirements. The requirements must be clearly established so that there are no misunderstandings; the measurements must be taken continuously to determine compliance with those requirements; the nonconformity detected is an absence of quality” (Alexander, 2002)

The factors proposed by Ishikawa are the following:

- The customer is the most important.
- We must prevent, not correct.
- Reduce costs and waste in general.
- Long term results. No short paths to achieve quality.
- Participation and involvement of all members.
You have to work in a team.
- Measure results.
- Give recognition.
- The commitment and support of senior management is required.
- Institute effective and intense training and development programs.
- Create awareness of the need.

Have a process and tool for permanent improvement. From this last point, Ishikawa managed to define a technical philosophy that is part of the quality, he called it the seven statistical tools of the administration for the analysis of problems such as:

1. Pareto chart.
2. Cause and effect diagram.
3. Stratification.
4. Verification sheet.
5. Histograms.

Quality, strategic matter

Total quality management (GCT) is not a current fad that will disappear tomorrow. The GCT is a strategic business issue that affects customer satisfaction, market share and business profit. The GCT implies ensuring that the company does the right thing at the first and at all times. It goes beyond ensuring the suitability of a service or product, since it makes possible a comprehensive management of added value by meeting and exceeding customer expectations.

Therefore, the GCT requires the personal attention of the first executive and his leadership; This is an issue that is too important to be left to functional experts.

The GCT is a strategic issue, because:

- World market competition has never been so tough.
- Companies that increase their market shares are those that offer the best relationship between customer value and price.
- The best value for money comes from a competitive quality at a competitive price (Duque Olivas, 2005)

One of the best known quality management systems worldwide is the ISO (International Standards Organization) which since 1947 is an independent, non-governmental organization with a membership of 162 national standards bodies, through its members brings together Experts to share knowledge and develop voluntary international standards based on consensus and relevant to the market, that support innovation and provide solutions to global challenges, the Central Secretariat is in Geneva, Switzerland (ISO, 2017)

ISO management systems allow a systems approach, however one of the criticisms is that these systems have a high cost in their planning, organization, management and control, as well as their competitive vision rather than sustainable except ISO 14001; Another aspect is that these systems are implemented in large transnational companies and these production patterns have influenced so that the countries of the region integrated to globalization, adopt environmental incorporations to their productive processes in accordance with the guidelines originated in the countries from North.

Similar to what is happening in developed countries, certification policies have spread throughout the region, mainly through ISO 14000 standards.

This certification is carried out through environmental companies that prepare industries and others that carry them out.

There have been no real evaluations of the efficiency of the processes, but there are already serious questions about the real impact of them, many certification companies act through subsidiaries, the control of the efficiency and the seriousness of these is very variable, which puts a mantle of doubt about the quality and veracity of any of the certifications.

On the other hand, there are many national certifications made based on environmental regulations and some based on the principle of gradualness to incorporate environmental standards, they have very lax and distant standards of international standards (Giglio, 2006)
Quality management systems in the educational system: National technology of mexico

One of the relevant aspects in studies that relate to Higher Education Institutions in Mexico (HEI) is that many of them work under a systems approach, since their administration seen under this systemic school, considers HEI as a set of parts, so associated, that forms a coherent whole or unity according to Münch (2014); One of the Higher Education Institutions (IES) is the Tecnológico Nacional de México (TecNM); It is constituted by 260 Technological Institutes with a centralized and decentralized character, both of which depend on the Ministry of Public Education, of which 126 are federal Technological Institutes and 134 are Decentralized Technological Institutes, 4 Team Optimization and Development Centers (CRODES), a Center Interdisciplinary Research and Teaching in Technical Education (CHIDET) and a National Center for Research and Technological Development (CENIDET). The TecNM is a Higher Education system that serves 521,105 among the students of the 41 undergraduate and Postgraduate degrees (TECNM, 2013-2018)

The System of Technological Institutes in a national network of HEI and the objectives are aligned to the National Development Plan 2013-2018 where the objectives and strategies are established to be carried out at all educational levels. In the current Development plan, it is considered that education must be of quality and specifically in Strategy 3.5.3, it refers to promoting the development of local scientific, technological and innovation vocations and capacities, to strengthen sustainable regional development and inclusive, so they were integrated into different lines of action such as:

a) The design of differentiated public policies that allow the promotion of scientific and technological progress in regions and federal entities, based on their economic vocations and local capacities.

b) Promotion of the formation of high-level human resources, associated with the development needs of the federative entities according to their vocations.

c) Support for the establishment of scientific-technological ecosystems that favor regional development.

d) Increase investment in Total Intellectual Capital (CTI) at state and regional level with the concurrence of the different areas of government and sectors of society. (; PND, 2013-2018)

It should be noted that within points a) and b) mentioned above and according to what was stated in the PND there should be differentiated educational policies regarding academic levels, regions and / or territories; However, in reality only an educational policy was established as a guideline for all academic levels without differentiating regions and territories either. The system analyzed is the Tecnológico Nacional de México (TecNM), within the vision of TecNM there is a focus on sustainability since it considers the following: To be one of the pillars of the nation's sustainable, sustainable and equitable development. Likewise, in the mission: Offer quality technological higher education services, with relevant and equitable national coverage, which contributes to the formation of a just and humane society, with a sustainability perspective.

In addition, the TecNM has different management processes that allow it to address academic, linkage and financial aspects to achieve the objectives, strategies, lines of action and indicators with which they were defined in the National Development Plan (2013-2018) and in the Education Sector Program 2013-2018 (SEP, 2013). Which were based on six strategic objectives aimed at achieving goals within the program; The objectives are:

1. Strengthen the quality of educational services
2. Increase coverage, promote inclusion and educational equity
3. Promote the integral formation of students
4. Boost science, technology and innovation
5. Strengthen the link with the public, social and private sectors; as well as
6. Modernize institutional management with transparency and accountability. In this last strategic objective, it is committed to increasing certified units and centers, as well as modernizing institutional management, strengthening transparency and accountability.
The TecNM has several ISO 9001: 2015 Quality Management systems: The ISO 1400: 2015 Environmental Care Management System and some technology companies also have the Institutional Environmental Program (MYP), the Gender Equality Model or Gender Equality and Non-Discrimination System (SGIG) better known as MEG. The TecNM has established its commitment to mainstreaming the gender perspective as a strategic element to advance the incorporation of the perspectives of labor equality and non-discrimination, as well as the eradication of gender violence from its headquarters, Institutes, units and centers. To this end, the TecNM Gender Equality and Non-Discrimination Management System manual has been established (SGEG/TECNM, 2017). In the TecNM the information of the Quality Management Systems is centralized through the corresponding Department, whose main function is to work for continuous improvement and its planning, organization, direction and control is carried out by the Quality Manager, and is in coordination with the head of each Technological; which entails having a series of human, material and financial resources. The objectives and goals must be aligned to the Interinstitutional Development Program (PIID) as well as its budget is reflected in the Annual Operational Program (POA) so it is a way to control the results.

It is also worth mentioning within the strategies of the National Development Plan in relation to the issue of sustainability, the TecNM has set some objectives that allow them to be fulfilled; That is why he has participated with the National Association of Universities and Institutions of Higher Education (ANUIES) and with the Ministry of Environment and Natural Resources (SEMARNAT) and with the National Institute of Ecology (INE) for the conformation of Institutional Environmental Plans (PAI). In the first phase an environmental training course was invited to 144 Higher Education Institutions (IES) belonging to the National Association of Universities and Institutions of Higher Education (ANUIES) of which 100 attended the call, but only 44 participated and complied with the development of the EPI; among which the following Technological Institutes participated: I.T. Tijuana, I.T. Sonora, I.T. Cd. Madero, I.T. Cd. Matamoros, I.T. Zacatecas, I.T. Colima, I.T. Aguascalientes, I.T. Puebla, I.T. Orizaba, I.T. Campeche, I.T. Minatitlán and the I.T. Toluca (Bravo, 2012).

The aforementioned plan; It was created to respond to the commitment made with the signing of the Earth Charter, consisting of carrying out actions in favor of the environment and strengthening the operations of the program for certification in ISO 14001, following the request of the SEMARNAT in the sense that the Higher Education Institutions (HEI) of the country must have an environmental program. The Institutional Environmental Program (PAI) constitutes an environmental education program that contemplates the management and use of waste generated by activities of the population within the educational institutions of the region. The objective of the EPI is to sensitize, raise awareness and educate the technology community, its content is a management plan (which contains procedures, actions, controls until reaching the results). The activities carried out are internal and external (inside and outside the facilities), donation and coordination of containers for the collection of batteries, the collection of paper, PET and solid waste, its collection is given by others organizations for the purpose of reuse, storage or final disposal. Other actions that the EPI contains, in which authorities from different institutions take part: State Commission of Natural Parks and Wildlife (CEPANAF), National Commission of Protected Natural Areas (CONANP) for the contribution to the care and restoration of the Nevado de Parque Nacional de Nevado de Toluca and the Sierra Morelos park, which together with the active participation of members of the technological community collaborate with the maintenance of green areas. There are several actions that are contemplated in the Institutional Environmental Program such as those mentioned above, where students of different engineering are integrated, for the release of their social service, as well as support in the preparation of studies and projects related to the subject of environment for the release of professional residences and Master’s thesis in Environmental Engineering Sciences and the Doctorate in Environmental Sciences such actions are examples of sustainable activities that are carried out at the Technological Institute of Toluca.

That is why, you have the following research questions: What has been the impact of management systems in the organization called Tecnológico Nacional de México? What has been the impact of the Integral management system on a Technological as a case study?
Overall Objective:
To explore the impact of quality management practices in the Technological National of Mexico through a case study: Instituto Tecnológico de Toluca

Specific Objectives:
– Determine the qualitative method to identify the perception that the technological community has regarding the integral management system
– Apply the tools and determine the results
– Make recommendations for the quality management system.

Methodology
The qualitative research method tries to know the facts, processes, structures and people as a whole and not measuring the elements; it uses procedures that make observation less comparable in time and in different cultural circumstances, getting closer to naturalness, that is, without manipulating or stimulating any element with respect to reality. (García, 2015)

Another method used is the case study, it promotes the determination and analysis of solutions to the problems that arise, not only based on the most appropriate theories and in the history of the organization, but through the collective discussion that helps to develop the strategic, analytical and synthetic mentality that organizations require, thus obtaining security in the decisions made and in the conduct of staff (López, 1995)

The case study method is a valuable research tool and its greatest strength is that through it the behavior of the people involved in the studied phenomenon is measured and recorded (Martínez C. P., 2006)

In this way, the Technological Institute of Toluca was analyzed as a case study; since it is one of the Higher Education Institutions belonging to the TECNM system that has the Quality Management Systems (QMS), as well as the Institutional Environmental Program (MYP). Considering that the system is large (260 Institutes) and complex to be able to make some recommendations that are relevant.

Regarding the research techniques that were used are the following:

Documentary research is the collection of information in documentary sources such as: National Development Plan 2013-2018 (PND), Educational Sector Program (PSE), Institutional Program of Innovation and Development 2013-2018, as well as internal programs of the Technological Institute from Toluca. The SWOT Analysis, which consists of detecting strengths, opportunities, weaknesses and threats that can affect the achievement of the plans, the purpose of the SWOT is to convert weaknesses into strengths and threats into opportunities. It is based on the analysis of the environment and is based on statistical, economic and financial projections (Münch, 2014).

Because a SWOT was carried out for the TECNM and for the Technological Institute of Toluca, considering its strengths, opportunities, weaknesses and threats, analysis of the environment and thus project the alternatives to follow, as well as the strategies (see figure 1)

Another technique used was the semi-structured interview; It allows flexibility in obtaining the information and that the interviewee has the freedom to express his opinion regarding how he sees the management systems in his Technological, and for this, the interviewees who are related to the management systems were chosen.

The informants were selected within a frame of reference based on the knowledge of the Environmental Management Systems such as: ISO 14001, ISO 9001, Institutional Environmental Program and the person in charge of the system of gender equity and equality as part of compliance with the institutional objectives, as well as the head of the Department of Technology Management and Linking

In order to carry out the qualitative analysis of the semi-structured interviews, the first part of the construction of the questionnaire is first and through the Atlas Ti program, it allows us to work the interviews and identify the citations, categories, memos and concepts; using citations and categories in the Atlas IT system, management systems, educational organization, quality, continuous improvement, sustainability were obtained.

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Results

Quality management systems, gender equity and those related to environmental aspects of the technological system known as the TecNM are considered as an integral, dynamic system with areas of opportunity for continuous improvement. The information that was collected in a documentary way, showed us how from the National Development Plan the national education policy is dictated and this is operationalized through the Educational Sector Plan and the Inter-Institutional Development Program (PIID) until the Institutional Program Annual are instruments that allow the operationalization of Management systems in the Technological Institute of Toluca.

Likewise, the information obtained with the personnel in charge of the management systems, informed us about their importance, the interrelations that exist between the systems and the areas of opportunity for their improvement and the possible participation of more teachers and students to achieve the objectives.

Teachers who participated in the interviews recognize the role that management systems currently have (from ISO 9001: 2015 to ISO 14001: 2015, which is being implemented), they believe that greater participation is required by academies and They determine that they need a greater relationship with those responsible for each system to improve communication.

In the case of students, participation in management systems; It occurs through various activities for the release of academic credits, social service and accreditation of professional residences, in relation to what they think of the systems, they consider them important for the Institute and could be an example for other educational Institutions, for this they consider that they also have areas of improvement and especially in the internal communication towards them.

The research project has been considered as a relevant aspect to continue the process of continuous improvement and especially for the generation of awareness as described by some managers of management systems, aware that they could reach excellence, not only for the achievement of objectives and goals; or compliance in audits, but to form a quality culture.

Conclusions

One of the first conclusions, related to compliance, application and operationalization of ISO standards in a Higher Educational Institution such as the Technological Institute of Toluca, allowed us to identify the impact that management systems have had on a qualitative level which represents

To know in depth the opinion that is had on these, this information was made known to us by those responsible for these systems, as well as the identification of the areas of opportunity that they currently have, on the part of the teachers determined that there are areas of interest and improve participation with those responsible for management systems, students recognize that they are part of an educational model that allows them to participate in quality management systems.

Regarding the qualitative method used, it should be noted that when conducting semi-structured interviews, more information is obtained from the interviewees, resulting in a series of comments that are often limited in the survey responses.

It can be concluded according to the results; that, in the Technological Institute of Toluca, management systems such as quality (ISO 9001: 2015, ISO 1400: 2015), as well as the Gender equity model and the Institutional Environmental Program are in a dynamic process that It allows continuous improvement in both the actions and the participation of the technological community constituted by teachers, administrators and students.

The Technological Institute has also managed to establish the commitment of senior management, those responsible for each management system, the participation of teachers from different careers, as well as students and graduates.

Recommendations

The quality management systems at the Technological Institute of Toluca have supported the main operating processes (ISO 9001: 2008 and 2015).
In addition to allowing the implementation of the other quality management systems such as ISO 14001: 2015 and those that are complementary but no less important, such as gender equity and constitute the integral system, as well as the Institutional Environmental Program (MYP) that has largely supported ISO 14001, however it is worth mentioning that when consulting In charge of these systems, they recognize that there are still many actions with the technological community due to the lack of communication, dissemination and involvement of the same, which makes them rethink the strategy to raise awareness among members of the technological community.

Likewise, when the technological community was interviewed, teachers who are immersed in these processes participate partially; that is to say in the academic process, but even with few actions, students also participate little in these processes either in academic activities and related to the MYP or indirectly to release certain academic credits, however, they recognize that they still need them more diffusion and greater participation. This constitutes a double effort for those responsible for management systems, on the one hand, what is requested in the corresponding audits and the generation of commitment and awareness by the technology community.

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Modification to a process of making skewers in a company that produces meat products

Modificación a un proceso de elaboración de brochetas en una empresa productora de derivados de la carne

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Abstract
This research analyzes a skewer production line of a meat processing company due to the fact that it presents bottlenecks and leisure time, with the objective of proposing improvements in the method through the analysis of operations. The procedure was to know the specifications of the product and the process, study the activities and determine standard times by the Maytag Company method. The results show that the critical operations are those of portioning and assembling the product for which three improvement proposals were designed whose evaluation determined that the mold method is the most suitable for the production of skewers. The chosen method is considered more efficient, since when compared to the current method, it presents a decrease in the operating time of 11.68s per product, as well as 7.88s in leisure time, resulting in an increase in production of 321.95 kg per shift, this represents an increase of 124.83% in the efficiency of the production line, making evident the relevance of these techniques for the continuous improvement of the processes.

Resumen
Esta investigación analiza una línea de producción de brochetas de una empresa procesadora de carne debido a que esta presenta cuellos de botella y tiempo de ocio, teniendo por objetivo proponer mejoras en el método mediante el análisis de las operaciones. El procedimiento fue conocer las especificaciones del producto y el proceso, estudiar las actividades y determinar tiempos estándares por el método Maytag Company. Los resultados muestran que las operaciones críticas son las de porcionar y ensamblar el producto para las cuales se diseñaron tres propuestas de mejora cuya evaluación determinó que el método con molde es el más adecuado para la producción de brochetas. El método elegido se considera más eficiente, ya que al compararlo con el método actual, presenta una disminución en el tiempo de operación de 11.68s por producto, así como 7.88s en tiempo de ocio, resultando esto en un incremento de la producción en 321.95 kg por turno, esto representa un aumento del 124.83% en la eficiencia de la línea de producción, haciendo evidente la relevancia de estas técnicas para el mejoramiento continuo de los procesos.

Actions, Improvement, Efficiency

Acciones, Mejora, Eficiencia
Introduction

The production of meat in Mexico is the result of the contribution of all its states in greater or lesser quantity, however there are States that excel in the national production of meat such as Veracruz and Jalisco in beef and chicken, as well as the case of Jalisco and Sonora who are leaders in pork (Haro, 2019).

The market in which this type of industry develops requires a high range of products, as an example there are different types of cuts and others ranging from portioned pork dishes to ready-to-eat dishes, where a wide variety of combinations is included, there are more than sixty product presentations that are made in some of the producing companies implying having an area or department (in most cases it is small) of new product development involving a high use of installed capacity (Taddei y Preciado, 2008). Nowadays companies face the need to adapt to a dynamic and unpredictable environment, product of constant local and global change, which is why their actions are aimed at achieving higher levels of quality, so they frequently work to improve products and processes to ensure customer satisfaction and thus be competitive (Yánez y Yánez, 2012).

From the point of view of the food processing industry, the link with customers is only possible through retailers that control and regulate the market. Most food and beverage manufacturers have to do business with powerful retailers, which demand a wide range of products, shorter and more frequent delivery times, and price reductions. For any sector in the food processing industry, cost is a major driving force. Low-cost leadership is the "predominant" business strategy in the food processing industry (Rakesh & Om Prakash, 2006).

The mechanism under which Mexican producers export to more than 60 countries around the world is the TIF (Federal Inspection Type) system, which ensures that the processes carried out there comply with strict health standards, resulting in products with exportation quality.

As of this year 2018, pork can be exported to the US, since the American country has determined that Mexican pork is free of traditional swine fever.

Considerations of the possible new NAFTA (North American Free Trade Agreement) agreement have caused Mexico to seek new export destinations for all types of meat it produces (Rioja-Scott, 2018). According to a market study prepared by ICEX Spain, Mexico ranks as third exporter, with a growth of 49.77% since 2014 (ICEX, 2019).

The above raises an area of opportunity for the productive sector allowing the increase in the use of the resources that constitute its installed production capacity implying the need to innovate and improve the processes of meat production and thus remain in the international market.

Problem

The company under study consists of a trace of this nature TIF. The main products of this company are destined for the Asian market, being its most important client the Japanese market and the most demanded product is pork. The swine meat market in Japan is especially relevant. According to FAO statistics, this country is the second largest importer of pork meat only behind China, and the fifth in pork sausages. In addition, pork is the second most imported agricultural and livestock product in Japan, after corn (ICEX, 2019).

Part of the operational processes of this organization are carried out in the portioning area, where the research work will be carried out, in this part value is added to the product with operations that detail the raw material consisting of parts of the pig such as the loin , ham, jowl and bacon, are processed by specific cuts to obtain products such as chop loin, belly kushi (skewers), jowl kushi, which must meet specific characteristics of size, color, shape and weight, to meet specifications of customers.

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Objective

Propose improvements in the method of making skewers by analyzing operations to make it more efficient.

Theoretical framework

A culture of continuous improvement is directly related to the typical patterns of behavior with which organizations cope with their activities. The company's values rest on a set of guidelines. A value is something in which the organization and its people believe, therefore it determines the way in which people behave. Some evidence of these values is the training provided for all, aimed at the elimination of errors and waste, the construction of continuous improvement teams, involvement from above to lower levels in decision making, preparing the worker for innovation, communicating and to try new ideas.

These values are put into practice on a day-to-day basis by sharing ideas among team members, weekly reports of developed topics, problems and successes, regular teamwork sessions, celebration of individual and team achievements. (Institute of Management Services, 2008).

An important fact published by Lucey (2008) states that the level of adoption of Lean practices in the United Kingdom varies depending on the sector, so the engineering sector shows 34%, Electronics 14%, Pharmaceutical 8%, Telecommunications 7% and the food and beverage sector with 6%. Which shows that the highest level of concentration lies in the engineering sector and the lowest in the food and beverage sector. (Bhasin, 2015).

Some authors (such as Lucey 2005; Manos 2007; Proudlove et al. 2008) cited by Machado & Crespo (2012) suggest that the medium and long term results in the implementation of Lean and Six sigma are due to a standardized training, commitment of employees with the company and the client, monitoring of results, commitment and responsibility of management to maintain and improve profits and also learn from external support on how to develop internal mechanisms for continuous improvement.

There are many resources that are invested in improving processes, among which we can mention the purchase of machinery, training, and efforts to reach quality standards, however they devote little money to the development of technology.

The main purpose of many companies is to develop new processes and products or the continuous improvement of these (Domínguez, 2006).

One of the survival strategies of companies competing in a sector is to develop innovative approaches to reduce the costs they face in their processes. One of the main approaches that production companies apply to gain competitive advantage is process innovation (Felekoglu & ÖzmehmetTasan, 2019).

Reduce the cost per transaction and production, more competitive and better quality products, advantages in the development of relations between producer and buyer as well as, an improvement in relations with customers and suppliers are examples of what process innovation can provide (Reguia 2014).

Process innovation is the implementation/adoption of new or significantly improved production or delivery methods that may involve changes in equipment, human resources, work methods or a combination of these (OECD 2005, p. 9).

Production processes consist of value-added activities, non-value-added activities and non-value-added activities necessary for the operation, in which the value is defined by the customer's requirements. (Womack & Jones, 1996).

Slender manufacturing (lean production) has in general terms the intention of making production processes efficient through cost reduction, reliable deliveries, low cycle times based on different methods and techniques such as Kaizen, 5s, Poka Yoke, Work Standardized, Teamwork, Total productive maintenance, Failure Mode Analysis, among others.

The first contributions were thanks to the work of Ohno, Womack and Jones in the 90's (Neumann, Kohlhuber & Hanusch, 2012).
Methodology

An applied research was carried out in the portioning area (added value), specifically in the operations of the belly kushi 30 gr. Processing line, in which 14 operators participate. The following resources were used to carry out this investigation: (1) Format for time study. Work analysis questionnaires. (2) Qualification table of the Westinghouse System. (3) Work sampling methodology. (4) T student table. (4) Formulas for calculating the standard operating time and line balancing. (5) Digital camera. (6) Stopwatch. (9) Tools for product development. Short knife, scale, plastic sheets, belly marking mold, protective gloves and vernier.

The methodology is an adaptation of Freivalds and Niebel (2014). The steps taken consisted of: (1) Identification of activities and relevant information of the belly kushi making process 30 gr. (2) Use of questionnaires to evaluate the operations and analyze the work. (3) Classification of the activities in elements and qualification of the operator's performance. Tolerances were established based on the table of supplements and tolerances, these tolerances were used for the determination of the standard time. (4) Analysis of operations and study of times to detect activities of No added value, unnecessary or that should be improved. (5) Preparation of proposals using flowcharts to describe operations. (6) Each proposal was executed in a pilot way identifying its advantages and disadvantages. (7) Selection of the proposal using productivity criteria. (8) Detailed documentation of the procedure according to characteristics in raw material and product. (9) Pilot test of the improvement proposal, to obtain standard time and compare the proposal with the current method. (10) Balancing the line of the new method.

Results

Three improvement proposals were designed and the mold method was found to be the most suitable for the production of skewers (see annex 2 for photos related to the new process).

To make the new method efficient, the line was balanced, the parameters considered were those shown in Table 1.

<table>
<thead>
<tr>
<th>Line Balancing Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line operations time: 19.49</td>
</tr>
<tr>
<td>Skewers to produce: 19500</td>
</tr>
<tr>
<td>Kilograms to produce: 585</td>
</tr>
<tr>
<td>Operators Required: 14</td>
</tr>
<tr>
<td>Units per hour: 2437.5</td>
</tr>
<tr>
<td>Estimated Time Allocated x Station: 1.47692308</td>
</tr>
<tr>
<td>Skewers per second: 0.6771</td>
</tr>
</tbody>
</table>

Table 1 Parameters considered for balancing operations

For the implementation of this method, the work line would be distributed in 3 stations A, B and C as shown in table 2, the number of operators required would be 14 as shown in table 2.

<table>
<thead>
<tr>
<th>Parameters considered for balancing operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomar Belly</td>
</tr>
<tr>
<td>Marcar Belly</td>
</tr>
<tr>
<td>Cuadrar Belly</td>
</tr>
<tr>
<td>Cortar Tiras de Belly</td>
</tr>
<tr>
<td>Tiempo total</td>
</tr>
<tr>
<td>A. Cortar Belly</td>
</tr>
<tr>
<td>Tiempo total</td>
</tr>
<tr>
<td>B. Ensamblar Brocheta</td>
</tr>
<tr>
<td>Colocar plástico</td>
</tr>
<tr>
<td>Tiempo total</td>
</tr>
<tr>
<td>C. Moldear y colocar en charola</td>
</tr>
</tbody>
</table>

Table 2 Balance of operations analysis

With this configuration the balancing efficiency results in 87% see equation (1).

Efficiencia = \frac{\text{Tiempo estándar}}{\text{Estándar} + \text{No. operators} \times \text{Estándar}} \times 100 \% \quad (1)

The data presented in Table 3 compare the production between the current and the proposed method.

<table>
<thead>
<tr>
<th>Método Actual</th>
<th>Tiempo Estándar</th>
<th>Método Propuesto</th>
<th>Tiempo Estándar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomar y acomodar piezas de belly</td>
<td>0.49</td>
<td>Tomar y acomodar piezas de belly</td>
<td>0.36</td>
</tr>
<tr>
<td>Corta cuadros Belly</td>
<td>0.96</td>
<td>Marcar piezas belly</td>
<td>0.46</td>
</tr>
<tr>
<td>Porcionar</td>
<td>9.87</td>
<td>Cuadrar belly</td>
<td>0.22</td>
</tr>
<tr>
<td>Ensamblar brocheta</td>
<td>13.41</td>
<td>Cortar tiras de belly</td>
<td>0.15</td>
</tr>
<tr>
<td>Verificar peso</td>
<td>1.55</td>
<td>Ensamblar brocheta</td>
<td>13.41</td>
</tr>
<tr>
<td>Moldear</td>
<td>3.27</td>
<td>Moldear</td>
<td>3.27</td>
</tr>
<tr>
<td>Colocar plástico en charola</td>
<td>0.45</td>
<td>Colocar plástico en charola</td>
<td>0.45</td>
</tr>
<tr>
<td>Colocar brocheta en charola</td>
<td>1.16</td>
<td>Colocar brocheta en charola</td>
<td>1.16</td>
</tr>
<tr>
<td>Tiempo de ocio</td>
<td>9.27</td>
<td>Tiempo de ocio</td>
<td>1.01</td>
</tr>
<tr>
<td>31.16seg</td>
<td>19.48seg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Finally, the production run complied with the specifications by 95%, as a summary see table 4 the current method allows a decrease of the operating time of 11.68 sec / u, in the same way the leisure time decreases 8.7 sec the time of leisure.

Another aspect that is considered important is that at the time the proposal is implemented an increase in production of 321.95 kilograms is expected, this represents an increase in the efficiency of the line of 124.83%.

<table>
<thead>
<tr>
<th>Method</th>
<th>Actual</th>
<th>Difference</th>
<th>Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brochets cnt.</td>
<td>8597</td>
<td>10731.85</td>
<td>19329</td>
</tr>
<tr>
<td>Kilograms</td>
<td>257.91</td>
<td>321.95</td>
<td>579.86</td>
</tr>
<tr>
<td>Time per brochetta</td>
<td>31.16</td>
<td>11.68</td>
<td>19.48</td>
</tr>
<tr>
<td>Time of leisure (sec)</td>
<td>9.27</td>
<td>8.703</td>
<td>0.5675</td>
</tr>
</tbody>
</table>

From table 4 the production deficit of (19500-19329) is 171 skewers that will require a time of 171 * 13.41sec which is equivalent to 38.2 minutes of time that can be sustained with the help of a station 3 operator. The recommendation is to use it for one hour increasing the capacity to 19600 skewers and the capacity of the station 3 drops to 22820 which does not affect the planned standard of 19500 skewers.

Even though the work template is the same as in the previous method, the new process executes the operation more efficiently and allows to reach a higher level of product quality.

Conclusions

The application of work study techniques is useful for any productive system as evidenced in the results of this project, in which the use of work study techniques contributed to the continuous improvement of the process. In this case, an increase of 321.95 kilograms is projected, which represents a 124.83 % increase in efficiency, which will make it possible to reach and even exceed current demand.

Although the improvements presented are simple, the impact they produce is significant. One factor that prevented the implementation of the proposal was the potential delay in the delivery of products to the customer, so managers said that training staff for the implementation of the new method could cause an increase in the delivery time of orders.

It is considered that the present research work can be adapted to other products such as the skewers of 50gr and 100gr and in this way increase the productivity in the production line of these products.

References


### Annexes

#### Annex 1 Product Spec Sheet

<table>
<thead>
<tr>
<th>Features</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material</td>
<td>Belly (Bacon)</td>
</tr>
<tr>
<td>Smell</td>
<td>Not acidic, not rancid.</td>
</tr>
<tr>
<td>Weight</td>
<td>29 - 32 gr. piece</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Lenght: 9 cm. skewer.</td>
</tr>
<tr>
<td></td>
<td>Width: 3.5 cm.</td>
</tr>
<tr>
<td></td>
<td>Thickness: 0.9 cm.</td>
</tr>
<tr>
<td>Amount of fat</td>
<td>Maximum 50% of the total content of the piece.</td>
</tr>
<tr>
<td>Foreign materials</td>
<td>Absent</td>
</tr>
<tr>
<td>Harmful fauna</td>
<td>Absent</td>
</tr>
<tr>
<td>Temperature</td>
<td>Frozen -15 °C.</td>
</tr>
</tbody>
</table>

#### Raw Material Presentation

60 pieces will be packed in a 38 x 18 x 8.5 cm box, inside the box a 48 x 50 cm blue plastic sheet is placed, then 6 layers with 9 pieces and a 6 pieces layer are placed. 6 boxes with these specifications are made. Subsequently the 6 boxes are placed in a box with dimensions 38 x 41 x 28.5 cm.

**Description.**

Skewer of rectangular shape of individual cuts, only 4 pieces are assembled on the wooden stick of 15 cm. long which should not exceed the top of the product at the time of assembly, nor should it be visible on the surface of the product. At the time of assembly the piece must have meat on the top and fat on the bottom.

#### Annex 2 Photos of activities in the proposed process

**Marking mold**

Marked framing of Belly with mold
Framing belly with mold.

Belly cut marked.

Measurement of dimensions

Comfort in mold for insertion. Which was discarded for producing defect in the stick. The use of a pressure change cap is recommended.

Packed in trays
Abstract

In this investigation, the shortage at national level of tomato is solved, where its logistics is scarce in its supply chain towards the demanding states that do not cultivate or harvest small quantities. The 32 states of the Mexican Republic are contemplated. The methodology is based on modelling on linear programming as an analysis tool, where tomato claiming states and supplying producer states are identified, to later identify the supply connections with the calculation including the logistics of transport costs between these states. By analysing and applying the method, results are obtained that demonstrate the optimization of the amounts to be distributed among the states (equilibrium between supply and demand), where one or more supplying states can supply the demanding state, minimizing transportation costs within its supply chain. The model determines the optimal connections between bidder-consumer, allowing the design of a Distribution Network in Mexico optimizing the supply of logistics in the supply chain.

Tomato, logistics, supply chain, linear programming

Resumen

En esta investigación se resuelve el desabasto a nivel nacional de jitomate, donde su logística es escasa en su cadena de suministro hacia los estados demandantes que no cultivan o cosechan pocas cantidades. Se contemplan los 32 estados de la República Mexicana. La metodología se basa en la modelación sobre programación lineal como herramienta de análisis, donde se identifican los estados demandantes de jitomate y los estados productores oferentes, para posteriormente identificar las conexiones de suministro con el cálculo incluyendo la logística de costos de transporte entre estos estados. Al analizar y aplicar el método, se obtienen resultados que demuestran la optimización de las cantidades a distribuir entre los estados (equilibrio entre oferta y demanda), donde uno o más estados oferentes pueden abastecer al estado demandante, minimizando los costos de transporte dentro de su cadena de suministro. El modelo determina las conexiones óptimas entre oferente-consumidor, permitiendo el diseño de una Red de Distribución en México optimizando el abasto en la logística en la cadena de suministro.

Jitomate, logística, cadena de suministro, programación lineal
Introduction

Red tomato or tomato is one of the vegetables that in Mexico is in great demand for the preparation of a great diversity of foods; either fresh or as a condiment preparation with other foods. The commercialization and diffusion achieved have made it become part of the diet of various cultures in the world over time, allowing us to occupy the second place in the world consumption of horticultural products (Olvera GJ et.al., 2010).

According to the Tomato Product System (2015), red tomato or tomato is a very important economic activity in the north of the country, becoming one of the most promising items both for its demand and for its production; On the other hand, one of the limitations in the trade of this vegetable is the poor communication with the distributors due to the lack of coordination between the production points and the possible points of sale. This causes a high impact on the operating costs of the different distributors, as well as the performance of the supply chain directly affecting the storage costs, the increase in shrinkage, generating lag in delivery times, etc.

In Mexico, one of the problems with the tomato is a poor performance in its commercial distribution, which translates into a reduction of about 40% in the post-harvest period and that its consumption is not equitable at the national level; as well as the poor planning of a supply to the different states with high transport costs. The creation of a distribution network nationwide, allows to supply in a balanced way to all consumers, with the optimization of transportation costs. In order to carry out this research, information is identified to determine its modeling and programming, such as: consumer demand, the capacity of production units and the cost of transportation from each plant to consumers.

The methodology contains the decision variables such as the objective function and the supply and demand restrictions. Statistical data were obtained from official sources of information. In the closed market model, national production and consumption is considered. To define the objective function, all transport costs from each of the origins to each of the destinations must be known. In the supply restrictions, the origins and quantities available and, in the demands, the destinations and the quantities required.

Linear Programming (PL) is a technique that is used to obtain an optimal solution of a system of equations. When there are as many linear equations as unknowns it is possible to arrive at a unique solution of the system, or in those where there are more unknowns than equations there will be an infinite number of solutions (Ronald, 1972).

The results show which bidding states, according to the optimization of transport costs, can send to the demanding states of tomato, the necessary quantities, be it to one or several states which can supply according to the correct quantities demanded. To achieve a balance in the marketing of tomatoes in Mexico, distributors are required to compete in certainty, have the technical, financial and human resources to address the aspects of productivity, logistics, promotion and performance.

Tomato consumption

In Mexico, as in other parts of the world, the preference for fresh tomato consumption is predominant; It is also used as an industrialized product, for the preparation of pasta, sauces, purées, juices, etc.; derivatives that have gained importance in recent years, thanks to the technological advances achieved for their processing, as well as the tastes and customs of the new generations. This situation leads to greater demands on quality for distribution and sale in fresh, which in turn determines renewed niches and market conditions.

At present, transporting fresh products must maintain safety until consumer purchase to meet their nutritional needs.

According to the figures of the United States Department of Agriculture (USDA, 2012), Mexico exported in 2010 approximately 934,384 tons of red tomato to the United States of America (USA), becoming the main exporter of red tomato to the union American, thereby monopolizing 50% of the imports of red tomato in the US, already in 2012 it was reported that these exports increased with what Mexico exported about 1.1 million tons of red tomato to the US, representing 44% of the US market.

Likewise, the Institutional Trust in relation to Agriculture (FIRA, 2014), mentions that Mexico is the country that has the largest area and has had the greatest growth in recent years.
The United States and Canada have slowed their growth due to the increase in labor and fuel costs. Canada is the country that produces the largest volume of greenhouse tomatoes; although Mexico is the one with the highest growth in recent years based on increasing the area. In Mexico, it is a crop with traditional roots whose consumption is daily in the Mexican diet. The harvested areas confirm the growth and consolidation that the vegetable has since the first decades of this century, which is why it was called the queen of vegetables. (Matus G., J. A., and Puente, G., A., 1993).

The global trade of fresh tomatoes is expanding, mainly, between neighboring countries, thanks to the reduction of tariffs (signing of trade agreements) and less transport costs derived from geographical proximity, as is the case of the United States of America, Canada and Mexico. Agrifood imports maintain a growing trend in the main centers of consumption in the world and represent a great opportunity for the continuity and growth of Mexican agri-food exports. It is required to have a logistic model that optimizes the operations of the tomato movement to the border and thus reduce costs, generating a proposal for the distribution of the production of the partners of the Tomato Product System based on the demand of its customers and the variables of decision involved. (SAGARPA, 2015).

For this research, fresh tomato production was estimated to be distributed by the consumer centers in the retail markets of the states of Mexico and the information was used for the year 2014, where a total sum of 2,875 thousand was reached. tons of this vegetable, according to the SIAP for that year. From this total amount, the exportable product, the quantity sent to industry and the waste (of approximately 40% in the post-harvest) was eliminated, and the scarce product that was imported from other countries was added. In that year, the average yield was 56.42 tons per hectare and had an average rural price of $5,472.91 per ton.

**Logistics and Supply Chain**

According to Ballou (2004), logistics is a set of functional activities that are repeated through the channel, in which the inputs are converted into finished products and subsequently sent to the consumer; and in each activity the product obtains an added value (cost).

In the same way, the interaction between the departments of a company must be connected under the system of working by processes, not by departments, with the perspective of internal client-supplier, improving the flow of the product or service for an effective administration of Supply Chain.

"The supply chain encompasses the business processes, people, organization, technology and physical infrastructure that allows the transformation of raw materials into intermediate and finished products and services that are offered and distributed to the consumer to meet their demand” (Pilot, 2015).

Chopra & Meindl (2008), mention that supply chain management is important today, derived from the fact that organizations are achieving a significant competitive advantage because of the way they configure and manage supply chain operations.

Transportation is an important factor for the agribusiness sector, especially in the transfer of fresh produce. Considering that many of these are perishable, it is necessary that the means of transport provide adequate temperature and storage conditions so that the products arrive in good condition to the consumer and do not lose their quality ahead of time.

It is recommended that the organization controls the cleanliness of the units and maintains the safety of its products.

It is also essential to carry out a follow-up or traceability of all the processes through which the product passes, from its origin until it reaches the final consumer. The company must not only demonstrate that it can make the traceability of the products, but also can respond to any eventuality in the shortest possible time (Peña and Dávila, 2012).

**Linear Programming (LP)**

The need to work with given levels of fixed resources means that the typical PL solution is confined to short-term problems, which shows us a static nature of the model, since it is assumed that the facilities available for production are fixed and not they take into account the possibility of making changes (Ronald, 1972).
Villalba Vilá (1990), proposes stages of the process of modeling PL problems that can be used in the case of other problems. The phases that stand out are, definition of variables, definition of restrictions, definition of the objective function, resolution and analysis of the solution.

The PL applied to the method of networks for the distribution of the tomato, allows to obtain competitive advantages in comparison with the optimization of material, financial and human resources; other secondary benefits such as lengthening production cycles, lower risk of loss of plant production with better organoleptic and plant characteristics free of toxic substances, which represent an opportunity and competitive advantage to participate in the market.

The transport problem is a special type of PL problem; It is known as transport because its applications determine the optimal way of transporting goods, although it has many other applications that have nothing to do with transport, as is the case with production scheduling. In its general form, the transport problem consists in determining the routes to be used and the quantities to be sent in a way that results in a minimum transport cost, having origin nodes with supplies and destination nodes with demands and knowing the transport costs between each of the points of origin and destination (Medina, 2007).

Methodology

In order to carry out the present investigation, the search for information was carried out in different sources, where statistics, official databases consulted and first-hand field information were obtained with transport agents in charge of distribution.

As there is only one merchandise, a destination can receive its demand from one or more sources. The basic assumption of the model is that the cost of transport on a route is directly proportional to the number of units transported (Taha, 1995).

In the execution of the model, the decision variables were integrated, such as the objective function and the supply and demand restrictions, as well as the transportation cost of the determined optimal routes.

In this closed market distribution model (national level), the following are considered variables: state production and consumption, among others. To define the objective function, all transport costs from each of the origins to each of the resulting destinations (optimal route) must be known. In the supply restrictions, the origins and quantities available and; in the demands, the destinations and the quantities required.

To carry out this analysis, information from the Agrifood and Fisheries Information Service (SAGARPA-SIAP), the National Population Council (CONAPO) and the 2010 Population and Housing Censuses of INEGI, Tariff Information System (SIAVI) of the Secretariat of Information Economy and the Ministry of Communications and Transportation (SCT), as well as direct information from land transport agents that integrated the transportation costs of the optimal routes that resulted. Once all the necessary information was collected and its processing was carried out, the nodes of the requesting and bidding states were obtained, which allowed obtaining and programming the transportation model and its distribution costs from the offering states to the complainants, calculating each of the routes to supply its distribution cost under the formula:

\[ C_{\text{Trans}} = CF + CV(D) \]  

Where:

\[ C_{\text{Trans}} = \text{Transport cost} \]
\[ CF = \text{Fixed Costs: Wages and salaries of management and management, insurance, taxes, rights, etc.} \]
\[ CV = \text{Variable Costs: Fuel, maintenance, tires, truck expenses, operator, etc.} \]
\[ D = \text{Distance between the offering node to the requesting node} \]

An important factor for this model is the distance to travel; since for this modeling it was estimated on a 20 ton cargo truck, identifying the fixed and variable costs per ton. Also, the location of the nodes was located in the capital city, central supply or central city of each state. The cost of operation varies by the type and state of the roads; The higher the road roughness index, or what is the same, that shows greater deterioration, the cost of operation of the vehicle rises considerably, accentuating if the road has steep slopes and high levels of sinuosity.
For the optimization of the fresh tomato distribution model, the objective function was elaborated considering the transport costs $C_{ij}$ of the origins (m) to each of the destinations (n), multiplied by the quantity to be distributed ($X_{nm}$) that should be sent to each of them, representing as $X_{nm}$.

What the resulting objective function to execute in this model, is as follows:

$$Min\ Z_0 = C_{11}X_{11} + C_{12}X_{12} + \ldots + C_{ij}X_{ij}$$  \hspace{1cm} (2)

Where:

$Z_0$ = Value of the objective function  
$i$ = Index of the source state (bidder), where $i=1,2,\ldots,m$  
$j$ = Destination State Index (complainant), where $j=1,2,\ldots,n$  
$X_{ij}$ = is the amount of tomato assigned from origin i to destination j.  
$C_{ij}$ = represents the cost of transportation per ton of origin and destination j.

The model has as many supply restrictions as the number of origins $i$ exist, and as many demand restrictions as the number of destinations $j$ that exist.

In an abstract way, the closed market model seeks to optimize the distribution of tomatoes from producing entities with excess to states with low or no harvests, which, by structuring the objective function to minimize transportation costs in distribution, is formulated as follows:

**Objective Function:**

$$Min\ Z = \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij}X_{ij}$$  \hspace{1cm} (3)

Subject to:

$$\sum_{i=1}^{m} X_{ij} \leq a_i \hspace{1cm} i=1, \ldots, m$$  \hspace{1cm} (4)

$$\sum_{j=1}^{n} X_{ij} = b_j \hspace{1cm} j=1, \ldots, n$$  \hspace{1cm} (5)

$$X_{ij} \geq 0 \hspace{1cm} i=1, \ldots, m \hspace{1cm} j=1, \ldots, n$$  \hspace{1cm} (6)

In formula 4, it is indicated that all the flow of the product that is offered from the origin i and that is sent to all possible m destinations, cannot exceed the offer of the origin i that is ai, where there is such a restriction by Each of the origins.

For formula 5, it indicates that all the flow of the product that is received at the consumption center $j$ of all possible origins, must meet the demand of the consumption center $b_j$, where there is such a restriction for each demanding unit. In the case of formula 6 of Non-Negativity, it indicates that the direction of product flow is from origins to destinations only (Quintero, 2014)

**Results**

With the information of all the required variables, the execution in PL projects the results with the optimization in the minimization of the transport costs of all the origins towards the centers of consumption to be able to supply all the states with this important vegetable.

When processing the information, the bidding states (origins or producing state) and demanding states (destinations or centers of consumption) are identified. Table 1 shows these statements with the supply amounts of the surplus states and demanding consumption centers (deficits). In this model, the balance between supply and demand is sought, everything that is produced, is all that is consumed.

Subsequently, a matrix of connection points of each surplus state was generated against the deficit states, calculating the minimum transport cost, having as standardized measure for the land transport of a 5-axis unit, with a 2.0 km / Lt, fuel efficiency diesel; and, for the maritime, the quotation made on the ferry for transhipment from Baja California Sur to Sinaloa (to optimize the logistics route) was taken, according to the information in the MAPPIR application Trace your route from the Ministry of Communications and Transportation.

With this information an algorithm was generated with the PL method that identified the surplus states that distribute the lowest cost of transportation to the tomato to the deficit states with the quantities requested to supply the required demand, according to equation 3.
Baja California Norte and Sur with 2% each; Durango and Jalisco with 1% each; Guanajuato 3%; Michoacán with 22%; Morelos with 11%; with 4% each are Nayarit, Coahuila and Querétaro; Oaxaca 8%; San Luis Potosí with 10%; Sinaloa and Sonora with 6% each; and Zacatecas 15%; that well, they are called the offer and in the same way they identify the states with deficit consumption, which are: Aguascalientes with 0.04%, Campeche with 1.6%, Colima with 0.4%, Chiapas with 5.9%, Chihuahua with 6.4%, Mexico City with 22.2%, Guerrero with 5.2%, Hidalgo with 1.3%, Mexico with 22.6%, Nuevo León 5%, Puebla with 0.4%, Quintana Roo 3.6%, Tabasco with 5.8%, Tamaulipas with 1.2%, Tlaxcala with 3.1%, Veracruz 10.4%, and Yucatan with 4.8%; which are called the demand; having a total net amount to distribute of: 502,386.34 tons (Table 1).

Table 2 shows the 15 surplus states where it is identified according to the optimization of the PL where its totality or fraction is distributed, the surplus production they have to those deficit states; as well as, the result of optimizing the transport costs for distribution is minimized.

The road structure that exists in Mexico, plays a very important role in mapping the logistics routes, due to the types of roads existing for the determined means of transport, integrating all the expenses that may occur in the course of the trip and that were integrated in this investigation.

<table>
<thead>
<tr>
<th>Offering State</th>
<th>Amount of tomato sent to the requesting state (Cant-edo / cant-edo /...)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCN</td>
<td>9,642.04-Chih</td>
</tr>
<tr>
<td>BCS</td>
<td>1,886.44-Col / 2,050.30-Pue / 3,706.22-Tab</td>
</tr>
<tr>
<td>Coah</td>
<td>17,834.63-N L</td>
</tr>
<tr>
<td>Dgo</td>
<td>217.03-Ags / 3,786.36-CDMX</td>
</tr>
<tr>
<td>Gto</td>
<td>16,040.38-CDMX</td>
</tr>
<tr>
<td>Jal</td>
<td>4,561.93-Ver</td>
</tr>
<tr>
<td>Mich</td>
<td>3,032.76-Camp / 15,493.93-EdoMex / 25,656.48-Tab / 38,913.42-Ver / 24,158.56-Yuc</td>
</tr>
<tr>
<td>Mor</td>
<td>31,522.52-CDMX / 25,981.66-Gro</td>
</tr>
<tr>
<td>Nay</td>
<td>22,020.02-EdoMex</td>
</tr>
<tr>
<td>Oax</td>
<td>29,725.01-Chis / 12,374.19-Q.Roo</td>
</tr>
<tr>
<td>Qro</td>
<td>21,057.97-EdoMex</td>
</tr>
<tr>
<td>S.L.P.</td>
<td>51,181.06-CDMX</td>
</tr>
<tr>
<td>Sin</td>
<td>29,111.73-Tamp</td>
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<tr>
<td>Ver</td>
<td>52,251.43-Tabsc</td>
</tr>
<tr>
<td>Yuc</td>
<td>24,158.56-CDMX</td>
</tr>
</tbody>
</table>

Table 2 Matrix of Tomato Distribution Nodes in Mexico
Source: Own Elaboration with summary of model results

<table>
<thead>
<tr>
<th>Surplus Market State</th>
<th>Quantity (Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCN</td>
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</tr>
<tr>
<td>BCS</td>
<td>7,642.97</td>
</tr>
<tr>
<td>Coah</td>
<td>17,834.64</td>
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<tr>
<td>Durg</td>
<td>4,003.39</td>
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<tr>
<td>Guaj</td>
<td>16,040.38</td>
</tr>
<tr>
<td>Jal</td>
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</tr>
<tr>
<td>Mich</td>
<td>112,255.16</td>
</tr>
<tr>
<td>Morl</td>
<td>57,504.18</td>
</tr>
<tr>
<td>Nayr</td>
<td>22,020.02</td>
</tr>
<tr>
<td>Oaxc</td>
<td>42,099.20</td>
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<td>30,066.35</td>
</tr>
<tr>
<td>Sonr</td>
<td>29,111.73</td>
</tr>
<tr>
<td>Zacs</td>
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</table>

Total= **502,386.34**

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<thead>
<tr>
<th>Deficit Market State</th>
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<tr>
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<td>217.03</td>
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<tr>
<td>Camp</td>
<td>8,032.76</td>
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<td>Colm</td>
<td>1,886.44</td>
</tr>
<tr>
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</tr>
<tr>
<td>Chih</td>
<td>32,252.59</td>
</tr>
<tr>
<td>CDMX</td>
<td>111,708.29</td>
</tr>
<tr>
<td>Guer</td>
<td>25,981.66</td>
</tr>
<tr>
<td>Hidg</td>
<td>6,525.89</td>
</tr>
<tr>
<td>Méx</td>
<td>113,273.00</td>
</tr>
<tr>
<td>NLéon</td>
<td>25,272.66</td>
</tr>
<tr>
<td>Pueb</td>
<td>2,050.30</td>
</tr>
<tr>
<td>Q Roo</td>
<td>17,867.98</td>
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<tr>
<td>Tabsc</td>
<td>29,362.71</td>
</tr>
<tr>
<td>Tamp</td>
<td>6,024.53</td>
</tr>
<tr>
<td>Tlax</td>
<td>15,795.49</td>
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<tr>
<td>Ver</td>
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<tr>
<td>Yuct</td>
<td>24,158.56</td>
</tr>
</tbody>
</table>

Total= **502,386.34**

With the programming tool to execute the PL of the mathematical model, the general objective function is integrated with the transportation costs of each route and the restrictions, both of supply and demand, which balance the quantities to be distributed according to the optimization of calculated transportation costs.

When developing the algorithm in PL focused on the objective function to minimize transportation costs, the interactions were executed to calculate each of the points of origin towards their different destinations, resulting in a matrix of 15 bidders for 17 plaintiffs, with a total amount of 255 possible combinations.

These combinations represent the optimal routes that the transport will use in the distribution of the vegetable.

From the results obtained with the PL, the states with surplus tomato production were identified, of which they have already supplied their own consumption of their population, being.

<table>
<thead>
<tr>
<th>Surplus Market</th>
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<tbody>
<tr>
<td>BCN</td>
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<tr>
<td>Mich</td>
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Total= **502,386.34**

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<tr>
<td>Yuct</td>
<td>24,158.56</td>
</tr>
</tbody>
</table>

Total= **502,386.34**
The results obtained in the model, it can be seen that the states of: Baja California distributes its 100% surplus to Chihuahua; Baja California Sur distributes its surplus 25% to Colima, 27% to Puebla and 48% to Tabasco; Coahuila distributes all its surplus to Nuevo León; Durango distributes its surplus 5% to Aguascalientes and 95% to Mexico City; Guanajuato distributes its surplus to Mexico City; Jalisco to Veracruz 100% of its surplus; Michoacán distributes 7% to Campeche, 14% to the State of Mexico, 23% to Tabasco, 35% to Veracruz and 22% to Yucatán; Morelos distributes 55% of its surplus to Mexico City, 45% to Guerrero; Nayarit delivers its 100% surplus to the State of Mexico; Oaxaca distributes from its surplus 71% to Chiapas and 29% to Quintana Roo; Querétaro gives its 100% to the State of Mexico; San Luis Potosí distributes its 100% surplus to Mexico City; Sinaloa distributes from its surplus 18% to Quintana Roo, 53% to Tlaxcala and 29% to Veracruz; Sonora distributes its surplus 76% to Chihuahua and 24% toNuevo León; Zacatecas distributes its surplus 12% to Mexico City, 9% to Hidalgo, 71% to the State of Mexico, 0.4% to Nuevo León and 8% to Tamaulipas.

With this information of knowing the supplying and demanding states, it is possible to know graphically how the distribution network is generated at national level, as well as where the production to be consumed comes from; where one or several states can send part or all of their surplus production to the consumption center that requires fresh tomato.

In the Map of the Tomato Distribution Network in Mexico (figure 1), the interaction of surplus states together with deficit states to integrate the distribution network can be observed.

It can be seen that the states of the center and most of the southern states of the country have demand available; in the same way it is appreciated that to a large extent the northern states of the country have the availability to offer and that given the distance between them, the cost of transportation can be optimized to be able to supply the vegetable.

Under the results obtained in the model, it can be seen that the supplying states self-supply their consumption and distribute part of their surplus supply to be able to share it towards another deficit state; which demonstrates that the optimization of the model balances the quantity sent to be able to be efficient the cost of transporting said merchandise.

**Conclusions**

In the analysis of this research, transportation costs are optimized for fresh tomato distribution among surplus and deficit states in Mexico; since, when processing and optimizing the model, it results in the distribution of 502,386.34 tons, calculating its logistics with a minimum total transportation cost moving through the optimal federal highway routes equivalent to: $2,956,440,000.00.

With the investigation carried out, the opportunity percentages of each deficit state are also identified in order to cover their local demand through the implementation of new production and distribution practices in their agrologistic sector.

The formulation and analysis of the PL for this type of modeling, provides relevant information to create optimal scenarios by simulating the data and also making the best decision among many alternatives; when those alternatives include satisfying several criteria at the same time and in the same way interacting with the restrictions of the process, thus allowing a good planning to be carried out before the correct consumption.
This modeling allows to optimize the distribution of the national tomato production to those states lacking the product of those surplus states, making efficient the transport costs necessary for a good logistics in the distribution chain contemplating the distance between said points; thus allowing the creation of the national fresh tomato distribution network for Mexico.

The model developed in this research examines the optimization of transport costs due to the use of some practices that are not very suitable for quoting the transfer services; Some companies in this sector calculate their costs with a percentage below the competition with the objective of winning the transfer of the merchandise, but on the other hand they do not know the effect on the maintenance of the unit, the salaries of the operators, road accidents, fuel consumption, tire consumption, tolls, service quality, etc., so it is recommended to make this contribution to transport agents so that the different factors in the price of this service are taken into account.

The implementation of the Jitomate Distribution network connection in Mexico, implies developing a partnership for the national freight administration, with the premise of coordinating the operational rules of the logistics routes.

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* Correspondence to Author (example@example.org)
† Researcher contributing as first author.

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Clearly explain the problem to be solved and the central hypothesis.

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