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Planning, Execution, and Control of Operations in SC Activities—Baja California Manufacturing Case Study

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Abstract: This paper reports a second order structural equation model (SEM) with four latent variables and six hypotheses to analyze the *Planning*, *Execution*, and *Control* of the information and communication technologies (ICT) implementation in supply chains (SC) and the operational *Benefits* obtained. The model is validated with information obtained from 80 responses to a questionnaire applied direct to manufacturing companies in Baja California state (Mexico), specifically in Ensenada, Mexicali, Tecate, and Tijuana municipalities. The variables are statistically validated using the Cronbach's alpha index for internal and R-squared for predictive validity. Partial least squares algorithms are used to validate the model's hypotheses in software WarpPLS version7.0 ScripWarp Systems, Laredo, TX, US. Findings indicate that the direct impact of *Execution* and *Control* is positive and therefore are the basis for successful integration of ICT and obtaining agility and flexibility benefits in the SC.

Keywords: information and communication technology (ICT); supply chains (SC); ICT integration; structural equation modeling (SEM); operational benefits

MSC: 62J05; 62H25; 93E24

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1. Introduction

Companies try to improve the efficiency of their processes by integrating the information and communication technologies (ICT) to compete in the global market, specifically in Supply Chain (SC). ICT integration in SC is the main research topic of several scientific reports in a competitive and complex market since it has allowed them to obtain a higher level of coordination and collaboration among SC partners, and this process is considered an indispensable factor in achieving high performance among SC actors.

Stoldt et al. [1] indicated that the importance of ICTs in SC is that they allow digitizing, acquiring, preparing, converting data, and making decisions in managing operations and information flow in SC. This issue appears because companies have diverse strategies for improving logistical activities and operations, since real-time delivery tracking and partner communications are undertaken [1–3]. In conclusion, ICTs provide operational advantages into SC; for example, cycle time reduction, inventory reduction, and minimization of the whiplash effect allowing collaboration between SC actors [4,5].

Currently, some studies report the ICT integration in SC in many industrial sectors; for example, Hvolby and Trienekens [6] mentioned two decades ago that the ICT integration in

SC was an area of opportunity for companies, while Volpato and Stocchetti [7] goes further by indicating that they should be part of the growth strategy.

ICT application in SC has recently been studied in supermarkets to understand the impact on the agility and speed of inventory management and to identify the impact on the ease of handling and SC management [8,9]. Even nowadays, given that ICT and SC are inseparable, there are literature reviews on these topics, such as the one by Wijewickrama et al. [10].

However, implementing ICT in SC is costly and must be done gradually, as there are currently multiple options, and companies can lose money by making this type of investment [9]. For this reason, this process must be gradual and supported by previous studies, in which the needs of the companies are planned, alternatives are identified, and investments are made [11].

The different stages in implementing ICT in the SC comprise several activities. For example, Pérez-López et al. [12] analyzed the *Planning* stage and indicated all the factors that affect it and how it guarantees operational benefits. However, this *Planning* is not enough; it is necessary to carry out the integration process and to have *Control* over the acquired ICT, provide them with maintenance care for their optimal operation and guarantee the flow of information to facilitate decision-making [13].

Previous studies have analyzed the ICT integration process into SC in its different stages and isolation so that the complete process is not analyzed, even though the stages are sequential and dependent; in other words, the ICT implementation process must involve planning, execution, and control. Although the above studies are a good start to the analysis of the whole process of ICT implementation, the omission of any of the stages would lead to a limited view of the phenomenon.

Given this limitation, the following question applies: does the *Planning*, *Execution*, and *Control* activities in ICT integration into SC facilitate the benefits achievement? This article seeks to answer that question by presenting a second-order structural equation model (SEM) in which the stages associated with ICT implementation into SC are established as independent variables and the *Benefits* they generate as the dependent variable. However, the interdependence between the implementation stages involved is also quantified, analyzed, and reported.

There are three main scientific contributions of this work compared to previous studies. First, it integrates and quantifies the relationships of all the stages involved in the ICT implementation process; second, with our findings the ICT managers and investment managers will be able to identify the most important activities in each stage, and it will allow them to focus on their few resources. Third, a sensitivity analysis is reported, in which they can identify the risks incurred if there are low implementation levels in *Planning*, *Execution*, and *Control* to obtain the *Benefits* offered by ICT, or how high levels favor the ICT benefits.

This paper is organized as follows. In Section 1, we present the background regarding different research on SC and ICT to in order to introduce the problem and research objective. Section 2 presents the literature review to justify the hypotheses in this research. Section 3 presents the methodology used to analyze the information, while Section 4 describes the data analysis and sensitivity. Section 5 presents the results discussion, Section 6 reports the conclusions and industrial implications and, finally, Section 7 proposes future research.

2. Research Context and Hypothesis

Companies give importance to the main functions of production processes, such as decision-making in inventory processes, production scheduling, distribution, and information management [2,14] and ICT is supporting those tasks in SC. Achieving goals and objectives in SC consists of *Planning*, *Execution*, and *Control* during ICT implementation [15].

These ICTs have supported companies to move from simple environmentally responsible manufacturing, in which life cycle analyses and the environmental impact of production processes are developed [16], to evolve towards a circular economy and Industry 4.0 [17], and CS has not been the exception, as it must also have a circular approach [18].

That is why ICT integration should be analyzed in all its stages and not only in one. This research considers three stages: planning, execution, and control, which are analyzed below.

2.1. ICT in Planning

In SC *Planning*, decisions are made from the strategic opening of a collaborative network between partners to the operational scheduling of a truck allocation [19,20]. For example, we mention the importance of *Planning* in logistics activities, especially in the digital aspect and states that companies have planned as a function and indicate that the *Planning* stage helps to prepare and coordinate the SC activities, decreasing the investment uncertainty, and the alternatives associated with equipment and software investment are better identified. In this stage, users of alternative ICTs are identified, feedback is received, and the needs of all partners in the SC and the type of data they exchange are identified, which facilitates logistical activities, greater integration of the companies, and increases robustness and resilience [1,19,21].

2.2. ICT in Execution

As ICTs are applied in SC, they enable organizations to gather, store, access, exchange, analyze, and *Control* information, hence enhancing performance; therefore, this capability must be closely monitored [22,23]. The information obtained or analyzed through ICT should be focused on maximizing SC profitability [22].

Therefore, since the *Planning* system stage consists of developing directions to achieve goals and objectives, it must be synchronized with the *Execution* system, managing and adjusting task plans quickly and efficiently [1,19,23]. In conclusion, ICT integration *Planning* is a fundamental precursor when operating in the SC since changes in plans can be faced more quickly and in consensus with the other partners [24]. According to previous research, the following hypothesis is proposed:

Hypothesis H1. *The activities in the Planning stage of ICT integration into SC have a direct and positive effect on the activities in the Execution stage.*

2.3. Control

Chiavenato [25] stated that the administrative *Control* function consists of order picking and replenishment, on-time deliveries, and inventory supply; that is, it combines internal and external logistics activities. Therefore, a proper ICT system implemented in the company's SC helps to understand the market behavior and achieve long-term success [26,27].

Scheller et al. [28] mentioned the different ways to plan and *Control* SC activities, such as production capacity, inventory, a supply network, and resource scheduling, which require accurate and real-time information via ICT. Dutta et al. [29] and Hallikas, Korpela, Vilko, and Multaharju [5] indicated that companies have integrated ICT devices to *Control*, coordinate, and manage their operational operations by controlling an information channel and migration of forwarding compatibility across devices for stakeholder decision making in real time [30]. Therefore, the capabilities, flexibility, and agility must be monitored to validate the investment. Finally, Scheller, Blömeke, Nippraschk, Schmidt, Mennenga, Spengler, Herrmann, and Goldmann [28] indicated that *Planning* is responsible for *Control*, providing the basis for decision making in the SC, which allows for the following hypothesis:

Hypothesis H2. *The activities in the Planning stage of ICT integration into SC have a direct and positive effect on the activities in the Control stage.*

With the globalized market, we stipulate that ICT increases efficiency and effectiveness in executing logistics operations within a company. Frazelle [24] pointed out that the *Execution* stage serves as a platform for inventory stock control in the warehouse because there is information exchange on logistics data, linking it with distribution control through learning and analysis.

Most organizations and software vendors focus ICT on the *Execution* systems, leading to better decision making and, based on it, point out that by adopting ICT allow to *Control* the SC activities concerning transportation, reducing delays and errors. Therefore, the ICT implementation in plans has a positive influence on the *Control* of logistics operations and provides speed, safety, traceability, and productivity, so the following hypothesis is proposed:

Hypothesis H3. *The activities in the Execution stage in ICT integration into SC have a direct and positive effect on the activities in the Control stage.*

2.4. Benefits

ICT is recognized as an important tool in the different activities of SC [31], mainly in logistic processes, where they generate *Benefits* to the companies, including the analysis and delivery of complete information, achieving integration and collaboration between departments [32]. Among these *Benefits* are the analysis and delivery of complete information, integration, and collaboration between departments, customer loyalty, entry into new markets, new business opportunities [33], market leadership, and new commercial and competitive relationships [34]. It allows the top management to design and program SC activities, reducing uncertainty [28], and then the following hypothesis is proposed:

Hypothesis H4. *The activities in the Planning stage in the ICT integration into SC have a direct and positive effect on the Benefits obtained.*

To increase *Benefits* from ICT, the SC performance in all operations where they are integrated must be analyzed [28,32,35], i.e., it should be monitored whether decision making is adequate, fast and consensual, with lower administration and production costs, or whether the flow and availability of information are increased [24,36,37], and then the following hypothesis is proposed:

Hypothesis H5. *The activities in the Execution stage in ICT integration into SC have a direct and positive effect on the Benefits obtained.*

Integrating ICT into business process control indicates that one of the *Benefits* gained is the available information, allowing SC actors to share and coordinate operational, tactical, and strategic information of the distribution network. These *Benefits* allow the exchange, availability, and quality of information, as well as the capture of data, and then the following hypothesis is proposed:

Hypothesis H6. *The activities in the Control stage in ICT integration into SC have a direct and positive effect on the Benefits obtained.*

Figure 1 presents the hypotheses presented graphically.

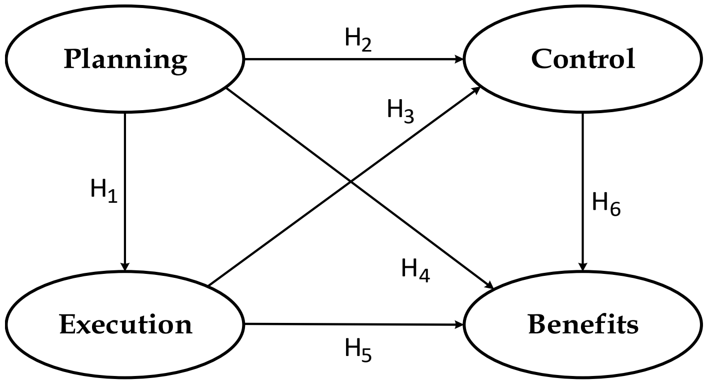

Figure 1. Hypotheses for ICT implementation in SC.

3. Methodology

3.1. Questionnaire Construction

To validate the hypotheses, industrial sector information is required. A questionnaire is utilized to obtain data on the perception of the usage of ICT in SC operations from companies established in Baja California, Mexico. Elsevier, SpringerLink Emerald, EBSCO, and Google Scholar databases were consulted to build the first draft. Small and medium-sized businesses (SMEs), information technology (IT), integration (I), information and communication technology (ICT), and SCs were the keywords (SC) for search in databases. This phase aimed to identify the main task and advantages related with the ICT integration into SC.

The final questionnaire has six sections. In the first section, demographic information about the respondent is collected, while the second to the fourth sections collect information regarding *Planning*, *Execution*, and *Control*, respectively. The fifth and sixth parts concern the *Benefits* gained, with a total of 91 items. In this study, the total items are given as an integrative model with four latent variables: *Planning*, *Execution*, *Control*, and *Benefits*. All 91 articles were organized into the latent variables shown below.

1. *Planning* [36,38–44]
   a. ICT integration
   b. Investment in ICT
   c. Training in ICT
2. *Execution* [35,37,38,40,41,45–48]
   a. Exchange of information
   b. Operations management
   c. Production Control
   d. Distribution Activities
3. *Control* [5,11,37,40,41,47,49–54]
   a. Technological innovation
   b. Availability of information
   c. Information management
4. Operating benefits [35–37,43,44,49,50,55]
   a. Customer benefits
   b. Company benefits

Please see the final survey provided in the Supplementary Material.

3.2. Survey Application for Obtain Data

The survey is uploaded to Google Forms platform and an email is sent to potential respondents, who are identified from a database provided by the state chamber of commerce. The survey was open for responses from 15 January to 15 March 2018. The National

Statistical Directory of Economic Units (DENUE) supported us with information regarding companies in Baja California state and an email of the possible responders. The survey was aimed at managers, engineers, and supervisors working in SC departments, given that they know the ICT integration process and the benefits gained after implementation. Please see the survey provided in the Supplementary Material.

Responses to the survey were based on a five-point Likert scale [56], where one indicates that the activity is not performed or no benefit is obtained, whereas five indicates that the activity is performed or the benefit is obtained [57]. The Likert scale was chosen due to its recent application in productivity and manufacturing studies [2,46,58–60].

3.3. Information Debugging

An Excel file was downloaded from the Google Forms platform on 16 March 2018. The information was debugged according to following activities: identify possible duplicate responses, replaces missing values with the median for every parameter, and eliminates extreme values or outliers that are replaced by the mean [61]. In addition, the standard deviation per item was estimated to remove non-committed responders [62].

3.4. Validation of Variables

The following indices are used for information validation for every latent variable in the model that appears in Figure 1 [63]:

- For predictive validity, R-squared and adjusted R-squared are used and values greater than 0.2 are accepted;
- For non-parametric predictive validity, Q-squared is used and positive values and similar to R-squared are accepted;
- For internal validity, Cronbach's alpha and composite reliability are used, looking values greater than 0.7;
- For convergent validity, average variance extracted is used, looking for values greater than 0.5;
- For collinearity, the variance inflation index is used and values lower than 5 are acceptable.

3.5. Descriptive Analysis of the Sample

Using the SPSS v.23® software created by Norman H. Nie et. al. (1968), Chicago IL, US., the information is aggregated and organized in crosstabulations for a descriptive analysis [64]. This analysis is conducted using the collected demographic data, which enables the identification of sample trends.

3.6. Descriptive Item Analysis

Each item's central tendency and dispersion are obtained. The median is determined as a measure of central tendency, given that these data are on an ordinal scale with values ranging from one to five and reflect only the Likert scale assessments [65]. The interquartile range of each item, the arithmetic difference between the third and first quartile, is computed as a measure of dispersion.

3.7. Structural Equation Modeling (SEM)

To test the hypotheses that appear in Figure 1, the Structural Equation Modeling (SEM) methodology based on Partial Least Squares (PLS) integrated into the software Warp-PLS version 7.0 ScriptWarp Systems: Laredo, TX, US. SEM is a multivariate statistical technique for testing and estimating causal relationships and qualitative assumptions about causality from statistical data. SEM seeks to estimate a regression parameter in which two latent variables are related, which in turn are composed of several items, so it is considered a third-order technique, where several items in an independent variable explain several items in a dependent variable, integrating factor analysis and linear regression concepts.

Some advantages of SEM are that it allows latent variables to occupy different roles as dependent and independent variables simultaneously, which allows to build a network of dependencies among them. In addition, PLS-SEM is recommended when there are small samples, data do not have a normal distribution, or come from Likert scale assessments.

In this case, a second-order SEM is reported since, within each of the stages of ICT implementation in CS, which are indicated as latent variables in the model in Figure 1, these are explained by several latent variables integrated by several items. This second-order model provides insight into the importance of each of the stages and their interactions.

3.7.1. Model Efficiency Indices

The following indices are evaluated to evaluate the SEM and determine if its interpretation is feasible [59,63]:

1. The Average Path Coefficient (APC) is used to measure the model efficient and predictive validity, looking to obtain a p-value lower than 0.05;
2. Average R-squared (ARS) and average adjusted R-squared (AARS) measure how well a model explains things, and a p-value less than 0.05 is used to test it;
3. The block average variance inflation factor (AVIF) and full collinearity index VIF (AFVIF) measures how similar the underlying variables are to each other, and the best value should be less than 5 [66];
4. The Tenenhaus Index (GoF) is a way to measure how well the model fits the data, and the right value should be higher than 0.36.

3.7.2. Model Effects

To quantify the links between latent variables by integrating the model in Figure 1, a standardized parameter is created, where the null hypothesis H0: $\beta = 0$ is compared to the alternative Hypothesis H1: $\beta \neq 0$ to quantify the relationships between latent variables. If $\beta = 0$, it is determined that there is no link between variables; if $\beta \neq 0$, it is inferred that there is either a positive or negative association between the variables. The p-value associated with the calculated parameters must be less than 0.05 for all statistical tests conducted with a confidence level of 95%.

Three types of effects between variables are calculated, which are [59,67]:

- Direct effects to test the hypotheses stated in the model in Figure 1, and there are no mediating variables [61,64];
- Indirect effects that occur through mediating variables and require two or more segments [65]. Since there may be more than one indirect effect, only the sums of these are reported in this paper;
- The total effects are the arithmetical sum of the direct effects and the sum of the indirect effects of each of the relationships that exist between the variables [68].

3.7.3. Sensibility Analysis

The sensitivity analysis is performed by identifying the occurrence probabilities of the variables at high (+) and low (−) level scenarios, given that the used software WarpPLS performs the calculations using standardized variables. In this case, it is assumed that a variable occurs in a high scenario when $P(Zi) > 1$, and it is low when $P(Zi) < -1$. Specifically, the following probabilities are calculated:

1. That the variables occur independently at their high and low levels;
2. The independent and dependent variables occur simultaneously in any combination of its scenarios, such as $P(Zi) > 1 \cap P(Zd) > 1$, $P(Zi) > 1 \cap P(Zd) < -1$, $P(Zi) < -1 \cap P(Zd) > 1$, $P(Zi) < -1 \cap P(Zd) < -1$, where Zd represents a standardized dependent variable and Zi represents a standardized independent variable;
3. The conditional probability of the dependent variable occurring given that the independent variable has occurred in any combination of scenarios; that is, the following probabilities: $P(Zd) > 1/P(Zi) > 1$, $P(Zd) > 1/P(Zi) < -1$, $P(Zd) < -1/P(Zi) > 1$, $P(Zd) < -1/P(Zi) < -1$.

4. Results

4.1. Descriptive Analysis of the Sample

Following the completion of the data cleaning procedure, a total of 80 valid surveys were collected from various manufacturing enterprises located in Baja California, Mexico. Table 1 provides a descriptive analysis of the sample, in which the industrial sector of the enterprises is indicated; according to this analysis, the manufacturing industry is the most representative of the sample, with a participation rate of 45%. The involvement of the food industry, the apparel manufacturing industry, and the computer equipment and electronic accessories industrial sector is equal to 35%, while the participation of the other industries is equal to 20%. In terms of the work position, supervisors make up 44% of the participants, followed by managers with 30%, and then department heads with 26%.

Table 1. Sector and job.

Industrial Sector	Manager/Assistant Manager	Department Head	Supervisor	Total
Manufacturing industries	8	11	17	36
Food industry	4	1	2	7
Garment manufacturing	2	5	0	7
Manufacture of computer equipment	1	1	5	7
Manufacture of electronic accessories	2	1	4	7
Plastics industry	1	2	3	6
Manufacture of metal products	2	0	3	5
Printing and related industries	2	0	1	3
Manufacture of non-metallic mineral products	1	0	0	1
Manufacture of furniture, mattresses, and blinds	1	0	0	1
Total	24	21	35	80

Table 2 presents the respondents' years of work experience, with the group of 1–2 years having the most participation (37%), followed by 2–5 years (33%), and more than 5 years (24%). In terms of gender, women constituted 32% of the total number of participants, which means that there is a lot of participation, and that it is a high percentage, since the national average is 39% performing a professional job, while males made up 68% of the total participants. The fact that all the respondents are employed in the field of logistics needs to be emphasized.

Table 2. Years on the job.

Gender	Years in Position				
	1–2	**2–5**	**5–10**	**>10**	**Total**
Male	18	21	7	8	54
Female	12	6	3	5	26
Total	30	27	10	13	80

4.2. Validation of Variables

The values for the indices that are shown in Table 3 indicate that R-squared and adjusted R-squared are both greater than or equal to 0.2, which leads one to the conclusion that each variable possesses parametric predictive validity. When the reliability index and Cronbach's alpha are analyzed, it is discovered that all the variables have values that are more than 0.7; hence, there is internal validity in the research. In addition, the extracted average variance across all the variables is larger than 0.5, which leads one to the conclusion that there is sufficient convergent validity.

In the same way, the variance inflation index shows that there are no collinearity issues within the latent variables because all values are lower than ten, and finally, the Q-squared index in all variables is greater than zero, indicating that it possesses non-parametric predictive validity. It is essential to point out that throughout this process of validation, one instance has been removed since the variance of the values that were provided was zero. This is the case that was deleted.

Table 3. Validation of latent variables.

Indices	Latent Variables			
	Planning	*Execution*	*Control*	*Benefits*
R-squared		0.580	0.817	0.821
Adjusted R-squared		0.575	0.812	0.814
Reliability index	0.914	0.906	0.921	0.956
Cronbach's alpha	0.859	0.861	0.872	0.908
Average variance extracted	0.781	0.707	0.796	0.915
Variance inflation index	2.922	5.847	5.924	5.236
Q-squared		0.582	0.816	0.820

4.3. Descriptive Item Analysis

Table 4 displays the descriptive analysis of the items, including the median and interquartile range. There are 34 items with values bigger than 4 in the column corresponding to the median, indicating that, according to the perceptions of the respondents, these activities are significant and regularly undertaken in the firm. In the column corresponding to the interquartile range, there is a characteristic with the highest value of 2.252, indicating that most likely there were questions when interpreting the question regarding the trends in the electronic industry, which explains why it is very variable. In the same column, there is an item with the lowest value of 1.397, which corresponds to the customer order follow-up; this indicates that there was substantial agreement and unanimity among respondents.

Table 4. Descriptive analysis of the data.

	Items *Planning*	**Median**	**Interquartile Range**
	ICT integration		
1	Utilizing ICT in routine meetings.	3.51	1.836
2	Utilization of ICT in the company's operations.	4.088	1.5
3	Utilization of ICT in the essential adjustments to the company's internal collaboration.	3.788	1.565
4	Utilization of ICT in company operations.	4.036	1.539
5	Utilization of ICT in decision-making.	4.182	1.656
6	Utilization of ICT while investing in new goods.	4.107	1.65
	ICT investment		
1	Your organization's computer equipment is adequate.	4.035	1.509
2	Sufficient number of ICT experts within your firm.	3.2	1.631
3	Knowledge required for the utilization of ICT.	3.462	1.707
4	Software assistance is available from the developer.	3.316	2.252
5	Retrieve details regarding suppliers, customers, and rivals.	3.56	1.765
6	Gather and analyze data to understand consumer requirements.	3.778	1.769
	ICT training		
1	Training users of information technology on changes, skills, the significance of data accuracy, and their respective duties.	3.5	1.834
2	Training users of the information system by periodic attendance at a structured training session that satisfies the necessary criteria.	3.318	1.953
3	Training the users of the information system using job-specific training teams.	3.468	1.878
4	Operational Advantages		
5	The adaptability of systems to satisfy client requirements.	4.091	1.63
6	Enhance your customer relationships.	4	1.629
7	Cost-effectiveness.	4.038	1.745
8	Reduced order cycle times.	3.878	1.82
9	Increased delivery capacity to customers.	4.123	1.609

Table 4. *Cont.*

	Items *Planning*	**Median**	**Interquartile Range**
Items *Execution*			
	Technological innovation		
1	Find and update the most advanced information technologies.	3.533	1.921
2	Effective data interchange use.	3.714	1.695
3	Maintain the system of information.	3.558	1.705
4	Maintain a robust data network with suppliers and clients to monitor and assess the information exchange.	3.745	1.748
	Availability of information		
1	Suppliers.	3.694	1.71
2	Commercial clients.	3.904	1.507
3	Customers and suppliers are involved in the product development process.	3.745	1.621
4	Supplier activity and relationship management.	3.569	1.526
5	Customer demand management.	3.887	1.502
6	Inventory control supplies.	3.83	1.49
7	Fulfillment and delivery order management.	4.018	1.478
8	Order follow-up for the customer.	4.164	1.413
	Information management		
1	Multiple internal information systems	3.745	1.483
2	The capacity of the organization's Internet connection.	3.977	1.62
3	To deliver superior services.	3.92	1.553
4	The internal computer network system.	3.83	1.637
5	Trends in electronic markets.	3.634	1.967
6	Systems for sales and purchasing.	3.863	1.575
7	The planning and programming of the activities of the organization.	3.808	1.567
8	The application utilized by the information system.	3.725	1.635
9	Warehouse management systems.	3.609	1.85
	Cost and flexibility		
1	The adaptability of systems to satisfy client requirements.	4.091	1.63
2	Enhance your customer relationships.	4	1.629
3	Cost-effectiveness.	4.038	1.745
4	Reduced order cycle times.	3.878	1.82
5	Adaptability in reaction to consumer needs.	4.123	1.609
Items *Control*			
	Exchange of information		
1	Relationship with vendors.	3.792	1.501
2	The logistical operation.	3.873	1.447
3	Meet the client's need and enhance customer service.	4.213	1.492
4	Management of inventory with suppliers and customers.	4.143	1.616
5	Relationship with vendors.	4.07	1.518
	Operations management		
1	Production processes.	3.769	1.54
2	Maintenance management.	3.407	1.652
3	Strategic manufacturing process management.	3.755	1.511
4	Production preparation.	4.05	1.397
5	Enhance the manufacturing decision-making process.	3.957	1.565
	Production		
1	Maintenance planning	3.455	1.67
2	The *Execution* of duties in the work environment.	3.7	1.68
3	Delays in the method.	3.679	1.514
4	Introduce innovative goods and services.	3.824	1.561
5	Respond to changes in the market	3.936	1.58
	Distribution		
1	Production control management.	3.98	1.51
2	Material requirements planning management.	3.83	1.649
3	Coordination of suppliers with production lines.	3.681	1.786

Table 4. *Cont.*

	Items *Planning*	**Median**	**Interquartile Range**
Items *Benefits*			
Customer benefit			
1	System adaptability to fulfill the demands of customers.	4.091	1.63
2	Improve customer connections.	4	1.629
3	Cost effectiveness.	4.038	1.745
4	Order cycles are shorter.	3.878	1.82
5	Customer reaction flexibility.	4.123	1.609
6	From vendors.	3.633	1.74
7	From opponents.	3.581	1.927
8	To offer high-quality services.	3.955	1.651
9	To meet the demands of customers.	4.2	1.545
10	The customer's information is correct.	4.153	1.531
11	In terms of information security.	4.105	1.542
12	Based on credible data (depending on capacity, trustworthiness, solvency).	4.036	1.57
13	Information that is current (relevance, recession).	4.018	1.611
Company profit			
1	On-time.	4.233	1.514
2	In terms of quality.	4.089	1.597
3	In the right quantity.	4.193	1.617
4	In the appropriate product.	4.237	1.544
5	Stock replacement.	3.787	1.686
6	Time spent cycling (from raw material to delivery).	3.773	1.819
7	Inventory control strategy.	3.97	2.086
8	The acquisition of materials is being planned.	3.857	1.838
9	Periodic inventory review.	3.902	1.796
10	Improve customer delivery time.	4.073	1.598
11	Increase the online availability of raw resources.	3.692	2.098
12	Productivity has increased.	3.76	1.617
13	Cut inventory expenses.	3.848	1.659
14	Our final items' performance.	3.782	1.497
15	The rate of delivery.	4.018	1.592
16	Volume or adaptable capacity.	3.714	1.698
17	The extent to which products differ.	3.8	1.58
18	Reduced production costs.	3.667	1.951
19	Planning efficiency is increased.	4.019	1.674

4.4. Model Efficiency Index

Table 5 displays the model's efficiency indices, where the APC index has a p-value less than 0.001, indicating that the model is efficient and has predictive validity. Similarly, the p-values for the ARS and AARSS are less than 0.001, indicating that the model has adequate predictive validity.

Table 5. Model efficiency indices.

Indices	**Value**
Average Path Coefficient (APC)	0.443, $p < 0.001$
Average R-squared (ARS)	0.739, $p < 0.001$
Average adjusted R-squared (AARS)	0.733, $p < 0.001$
Average block VIF (AVIF)	3.552
Average full collinearity VIF (AFVIF)	4.982
Tenenhaus GoF	0.769

Similarly, the AVIF and AFVIF indices indicate that there are no collinearity issues between the studied variables, as their values are less than 5. As its value is greater than 0.36, the GoF index indicates a strong match between the model data and the actual data. Given that the model efficiency indices are appropriate, we move to the model's interpretation, which is depicted in Figure 2, where a β value, a *p*-value, and an R^2 value for the dependent variables as a measure of the variance explained are shown for each association between variables.

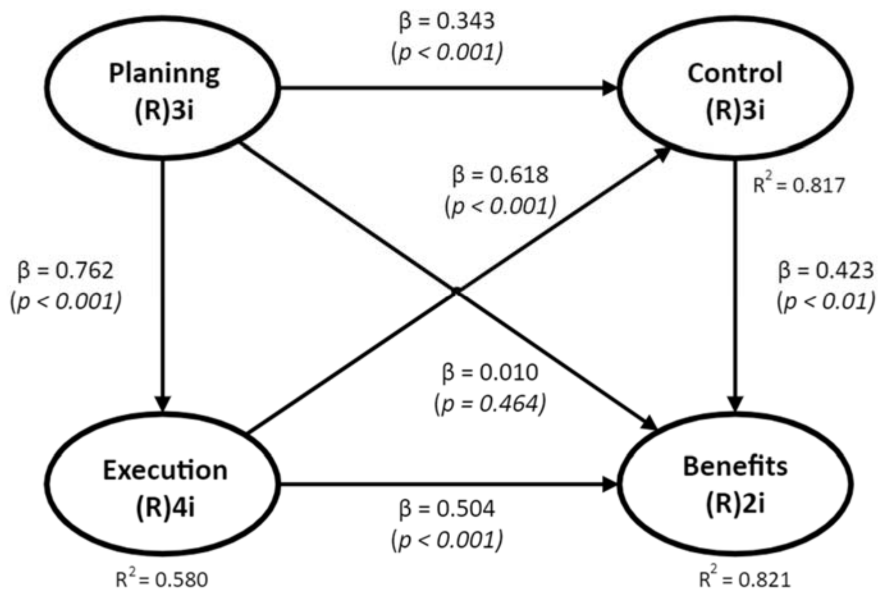

Figure 2. Structural equation model.

4.5. Model Effects

4.5.1. Direct Effects

Concerning the hypotheses presented in Figure 1 and based on the results shown in Table 6 of the direct effects, H1 shows that there is a direct relationship between *Planning* and *Execution*; that is, the *p*-value is less than 0.05, and therefore the SC activities are planned to be carried out correctly and to obtain optimal performance. The opposite case occurs in H4, where the *p*-value is above 0.05, which means that *Planning* alone does not provide *Benefits*; therefore, *Execution* and *Control* are needed in an integral way to achieve the expected *Benefits*, as shown in hypotheses H5 and H6.

Table 6. Direct effects.

Hypothesis	Relationship	β Value	*p*-Value	Conclusion
H1	*Planning* → *Execution*	0.762	<0.001	Accept
H2	*Planning* → *Control*	0.343	<0.001	Accept
H3	*Execution* → *Control*	0.618	<0.001	Accept
H4	*Planning* → *Benefits*	0.010	=0.464	Reject
H5	*Execution* → *Benefits*	0.504	<0.001	Accept
H6	*Control* → *Benefits*	0.423	<0.001	Accept

4.5.2. Sum of Indirect Effects

Table 7 depicts the sum of indirect effects among variables, and it is observed that all of them are statistically significant. The analysis of indirect effects is intriguing since, as stated previously, the direct connection between *Planning* and *Benefits* is not statistically significant, but the aggregate of all effects is, suggesting that plans do not result in *Benefits* if they are not followed.

Table 7. Sum of indirect effects (two segments).

To	From	
	Planning	*Execution*
Control	0.471 ($p < 0.001$) ES = 0.379	
Benefits	0.529 ($p < 0.001$) ES = 0.395	0.262 ($p < 0.001$) ES = 0.231

4.5.3. Total Effects

The total effects are provided in Table 8, where it is revealed that the association between *Planning* and *Control* has a total effect of 0.814 (derived by adding 0.343 and 0.471), and with a *p*-value associated lower than 0.001, showing a statistically significant effect. The remaining total effects are estimated in the same way, and it is interesting that the *p*-value for the other component associations is less than 0.05.

Table 8. Total effects.

To	From		
	Planning	*Execution*	*Control*
Execution	0.762 ($p < 0.001$) ES = 0.580		
Control	0.814 ($p < 0.001$) ES = 0.655	0.618 ($p < 0.001$) ES = 0.541	
Benefits	0.739 ($p < 0.001$) ES = 0.551	0.766 ($p < 0.001$) ES = 0.675	0.423 ($p < 0.001$) ES = 0.369

4.5.4. Sensitivity Analysis

Table 9 provides an overview of the model's sensitivity analysis results. In this case, the independent variables are arranged in columns and the dependent variables in rows. The conditional probability is denoted by "if," but the joint or simultaneous probability is denoted by "&." Thus, the probability of concurrently viewing *Execution*+ and *Planning*+ is only 0.089, while the probability of observing *Planning*+ if *Execution*+ has occurred is 0.583. However, if *Planning*+ has occurred, the likelihood of achieving *Execution*− is 0.000, which is recommended to managers in instances where sound *Planning* is required and without which there can be no *Execution*. Similarly, the remaining relationships between the variables are also comprehended.

Table 9. Sensitivity analysis.

MODEL		From	*Planning*				*Execution*				*Control*			
		Level	+		−		+		−		+		−	
To	Level		0.152		0.165		0.177		0.19		0.203		0.177	
Execution	+	0.177	&	0.089	&	0.000								
			If	0.583	If	0.000								
	−	0.190	&	0.000	&	0.127								
			If	0.000	If	0.769								
Control	+	0.203	&	0.063	&	0.203	&	0.127	&	0.000				
			If	0.417	If	0.242	If	0.714	If	0.000				
	−	0.177	&	0.000	&	0.127	&	0.000	&	0.127				
			If	0.000	If	0.769	If	0.000	If	0.667				
Benefits	+	0.177	&	0.076	&	0.000	&	0.114	&	0.000	&	0.114	&	0.000
			If	0.500	If	0.000	If	0.643	If	0.000	If	0.563	If	0.000
	−	0.177	&	0.000	&	0.101	&	0.000	&	0.152	&	0.000	&	0.114
			If	0.000	If	0.615	If	0.000	If	0.800	If	0.000	If	0.643

5. Discussion of Results

Regarding the structural equation model and hypotheses proposed in Figure 1 and values obtained in Figure 2, the following conclusions can be stated.

5.1. From the SEM

1. For the *Planning* → *Execution* relationship in H1, it is concluded that there is sufficient evidence to state that the *Planning* stage has a direct and positive effect on the *Execution* stage since when the first variable increases its standard deviation by one unit, the second increases it by 0.76 units and can explain 58% of its variability. The above indicates that the investment and training in ICT in the SC favors the operations management, information exchange, production control, and activities associated with product distribution, which agrees with Dallasega et al. [67]. That finding indicates that managers should plan the ICT implementation processes in the SC, in order to understand the activities to be carried out, the dates, and who is responsible for the execution;
2. In the *Planning*→*Control* relationship in H2, it is concluded that there is sufficient statistical evidence to state that the *Planning* stage has a direct and positive effect on the *Control* stage of the SC since when the first variable increases its standard deviation by one unit, the second increases it by 0.34 units and can explain 27.6% of its variability. This finding indicates that the investment and training in ICT for SC facilitates technological innovation, availability and information management, giving flexibility and agility to managers. These results agree with those reported by Zhou et al. [68], who state that in a contemporary smart manufacturing environment, production and operations control is almost impossible without the implementation of ICT;
3. For the *Execution*→*Control* relationship in H3, there is enough statistical evidence to state that the *Execution* stage has a direct and positive effect on the *Control* stage, since when the former variable increases its standard deviation by one unit, the latter increases it by 0.62 units and can explain 61.8% of its variability. This indicates that the exchange of information, operations management, production control, and distribution activities in which ICTs are used facilitate technological innovation and the availability and information management generated in these processes. These results coincide with Böes, J. S. and J. O. Patzlaff [69] and Nair, P. R. and S. P. Anbuudayasankar [70] and, who state that using ICT in the SC facilitates communications, decision-making among members, and allow to control every relevant task;
4. In the *Planning*→*Benefits* relationship in H4, there is sufficient statistical evidence to state that the *Planning* stage in a SC does not have a direct and positive effect on the *Benefits* obtained since the associated *p*-value is greater than 0.05. However, it can be concluded that the effect between these variables is indirect since it is given using *Control* and *Execution* as mediating variables, which has a value of 0.529 and is statistically positive, explaining 39.5% of its variability;
5. That finding indicates that ICT investment plans and programs in the SC do not directly benefit the company but that this benefit appears when ICTs are used in the *Execution* and *Control* stages; in other word, plans must be executed and controlled first. That is, a plan is useless if it is not properly executed, and these results differ from the report of Nair, P. R. and S. P. Anbuudayasankar [70], who directly related these two variables in companies established in India, so it is possible that these differences are due to cultural aspects and to the nature of the maquiladora industry analyzed in our study, which are foreign investments;
6. For the relationship between *Execution*→*Benefits* in H5, it is concluded that there is sufficient statistical evidence to state that the use of ICT in the *Execution* stage of SC operations has a direct and positive effect on the *Benefits* obtained, since when the first variable increases its standard deviation by one unit, the second increases it by 0.504 units and can explain up to 44.4 of its variability. This finding indicates that

technological innovation, availability, and information management make it possible to obtain *Benefits* for the company and the client, with greater flexibility, agility, and lower cost for the managers;

7. Finally, for the relationship between *Control*→*Benefits*, it is concluded that there is sufficient statistical evidence to state that the use of ICT controlling SC operations has a direct and positive effect on the *Benefits* obtained since when the first variable increases its standard deviation by one unit, the second increases it by 0.423 units and explains 36.9% of its variability. Managers can be sure that information exchange and operations management in the production and distribution process allows *Benefits* for the company and the customer. These results coincide with Mihardjo, L. W. W., Sasmoko, F. Alamsjah and Elidjen [71], who indicate that ICTs provide greater agility to the SC and facilitate inventory management and *Control*, as well as with Mihardjo et al. [71], who indicate that ICTs allow a quick response to customers and expedite decision making.

5.2. From the Sensitivity Analysis

In addition, from the sensitivity analysis in which scenarios are analyzed for the latent variables and their relationships, represented by "+" the high levels and "−" the low levels, the following can be observed.

1. Managers should strive for *Planning*+, as this favors the attainment of *Execution*+ in H1, Control+ in H2, and *Benefits*+ in H4 with a conditional probability of 0.583, 0.417, and 0.500, respectively. Moreover, *Planning*+ is never associated with *Execution*−, *Control*−, and *Benefits*− since the conditional probabilities are zero. However, *Planning*− is a risk since it favors *Execution*−, *Control*−, and *Benefits*− with a probability of 0.769, 0.769, and 0.615, respectively. Furthermore, *Planning*+ is not associated with *Execution*+, *Control*+, and *Benefits*+;
2. It is also observed that these plans must be properly executed to ensure better *Control* of SC operations and to obtain the *Benefits* since *Execution*+ favors *Control*+ in H3 and *Benefits*+ in H5 with a conditional probability of 0.714 and 0.643, respectively. Furthermore, *Execution*+ is not associated with *Control*− and *Benefits*−, as the probabilities are zero, justifying the investments and training in ICT. Similarly, *Execution*− is a risk, as it favors *Control*− and *Benefits*− with conditional probabilities of 0.667 and 0.800, respectively, and *Execution*− never favors *Control*+ and *Benefits*+, as the probabilities are zero;
3. Finally, it is important to note that *Control*+ favors the occurrence of *Benefits*+ in H6 with a probability of 0.563 and does not favor *Benefits*−; however, *Control*− is a risk for *Benefits*− since it favors it by 0.643, but does not favor *Benefits*+, since the probability is zero.

6. Conclusions and Industrial Implications

Businesses in Baja California, Mexico, have begun improving their SC through ICT implementation, enabling communication between manufacturers, distributors, and consumers [15]. Despite the digital gap in Mexico, companies in Baja California state show interest regarding technological innovation, which is undoubtedly reflected in digital communication, considering the information availability in several departments in the company [72].

Table 6 indicates that the *Execution* and *Control* variables individually and positively impact the *Benefits* gained. The opposite case is shown with the *Planning* variable, which clearly shows that it does not impact the *Benefits* alone or in a direct effect. To expect tangible *Benefits*, the *Planning* stage must be complemented with *Execution* and *Control*. This result coincides with Mabrouk, N., et. al. [15], who mention that *Planning* tools are a critical factor seeking to be executed in an organized and consensual manner with ICT support, optimizing SS operations.

Therefore, efforts are focused on integrating ICT into SC activities, i.e., *Control* should be manifested electronically. In this sense, Caro Soto [73] highlighted that Mexican companies are currently developing a digital environment incorporating ICT in SC operations, managing information to generate competitiveness and productivity within the organization. With this, SC partners are motivated and confident since the information is reliable and timely to implement the *Planning* activities and the *Execution* and *Control* of operations, thereby reducing uncertainty, as indicated by García-Alcaraz et al. [74]. With all of this, procurement, production, distribution, and demand can be coordinated by *Planning* requirements and capacities simultaneously with ICT implementation [68].

The findings allow us to conclude that ICT integration is crucial in the company's activities, as indicated by the company's CEOs, who mention that, especially in the SS, technologies help to *Control* through the wireless information transfer to track goods in real-time. García-Alcaraz et al [74] also indicates that, by accelerating the transfer of information by integrating ICTs in the operations of the different stages of *Planning*, *Execution*, and *Control* applied within the SC processes, the *Benefits* associated with increased efficiency, quality, and accuracy of information are expected, where better decision-making is finally expected.

7. Limitations and Future Research

This research reports a second order SEM, where the *Control* of *Planning*, *Execution*, and *Control* processes using ICT in manufacturing companies in Mexico showed the awaited *Benefits*. However, recent changes in the markets during 2019, such as the slow growth in demand and, in 2020, presenting the global recession caused by the COVID-19 pandemic with a leveraged financial system, present new challenges for companies. Therefore, it is recommended to consider a longitudinal investigation in the future to explore how ICT impacts companies of different regions of Mexico and apply the same survey. Additionally, the authors are hoping to increase the sample size for report comparative analysis to find differences among gender, job position, industrial sector classifications, among others.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/math10193468/s1, The following material is available online: https://bit.ly/3NbpDJP for the model outputs and https://bit.ly/3y7jfPj for the structural equation model that need to be open with WarpPLS v.7 software.

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