Efficient Selection and Evaluation of Suppliers: A Model for a Microenterprise in the Textile Sector in Lima, Peru

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Abstract—In Peru, the textile sector has experienced a decline in recent years and generates a significant number of direct and indirect jobs. One of the main causes of this is a destabilized supply chain, and supplier management is one of the main obstacles. To improve the fulfillment of the orders of the companies with their final customers, be competitive and to establish a balance and good agreements with their suppliers in a situation of uncertainty, with this study a supplier management model has been developed. It is based on Supply Chain Reference Model and Supplier Potential Matrix which give the framework to evaluate those suppliers who can help to streamline the supply chain. The success of the study is reflected on savings and time reduction for the procurement process.

Keywords—supply chain, supply chain operation reference, selection and evaluation of suppliers, management model, microenterprises

I. INTRODUCTION

Microenterprises in Peru represent the bulk of the business demographics (94.9%) [1]. However, have the shortest average life span in the market and in terms of sustainability, they are the weakest. The manufacturing sector, for example, ranks fifth in relation to the number of companies that have been terminated in Metropolitan Lima [2]. In addition, it is one of the sectors that has presented the greatest decrease with respect to gross value added, -2.3%, and the textile and leather industry specifically presented -6.7% [3]. The factors that generate this situation are diverse, among them the inadequate management of the supply chain, or the adequate monitoring of suppliers, terms that are more used in large or medium-sized companies due to the complexity of their application and the demand for knowledge. Therefore, the objective of this article is to develop a simplified model to efficiently manage suppliers in microenterprises. This will be done based on the Supply Chain Operations Reference Model (SCOR) and the Supplier Potential Matrix (SPM), supported by matrices for the proper management, evaluation and selection of suppliers along the supply chain.

II. STATE OF THE ART

Supplier management for micro and small enterprises in developing countries can be a great challenge during, especially, the communication process in a purchasing relationship, even more so when negotiating with leading suppliers, since this relationship can affect the operation of the company, as the same objectives are not pursued. For this, it is recommended to use networking to improve your disadvantaged position [4]. Also, supplier flexibility decants positively on the innovation performance of a product, it is recommended to invest in the relationship with suppliers [5]. Collaboration with suppliers can also generate new product development projects, which has a positive impact on the innovation performance of companies, however, the contribution of both parties should be recognized in such a way that they work together and in a complementary way [6].

In order to establish a guideline for supplier evaluation and selection criteria, and to measure their performance under cost and distribution performance criteria is used the SCOR model [7]. The SCOR model is a framework for defining evaluation standards and bases for negotiation with the supplier. Also, a hybrid decision making model based on the mentioned model to review the final selection of textile suppliers was developed [8]. They also indicate that in the textile industry, the supplier management process for the logistics area is necessary due to competition. In addition, the willingness to change suppliers decreases. Long-lasting relationships with suppliers depend on compliance and satisfaction of performance standards set by the company [9]. The Supply Chain Council suggests that at least one metric per attribute should be considered in order to improve the decision-making process. Likewise, it is possible to analyze SC from different perspectives because level 2 metrics serve to analyze level 1, then, improvements or gaps in level 1 performance can be explained by analyzing the performance achieved with level 2 metrics [7].

A. SCOR Model

The purpose of applying the SCOR model is to have a guide to be able to structure a model adapted in such a way that is simple, easy to understand, so that an association of people, microenterprises, understand these guidelines as a basis in their organization can have high benefits as it grows in the market. Likewise, it will allow these entrepreneurs to connect with suppliers and to follow up with them to fulfill their orders on time. The SCOR model is based on a hierarchical structure of performance metrics related to 5 attributes [9]; Reliability, Responsiveness, Agility, Cost and Efficient asset management.

B. Suppliers Potential Matrix

One of the first studies in this area is the classic work of Kraljic, which is known in the literature, in the purchasing and supply section, as the "purchasing portfolio matrix" (PPM), this matrix has a focus on supply and has been used as a decision tool by many organizations over the years.

However, purchasing and supply management plays a more strategic role if you want to manage supplier relationships, you need to include supplier characteristics and relationships. [10] This new approach brings a new proposal for supplier segmentation, called Supplier Potential Matrix (SPM), which focuses on these relationships by including two main dimensions, "supplier capabilities" and "readiness", proposing different strategies to manage different supplier segments based on these two dimensions. While PPM focuses on supply characteristics, SPM focuses on the supplier relationship [11].

III. CONTRIBUTION

A. Description of the Contribution

This study proposes and designs a management model for the selection and evaluation of suppliers, which aims to address the identified causes of the latent research problem of the company under study, the inefficient management of suppliers.

It is observed in Fig. 1, the Supplier Selection and Evaluation Model is divided into four (4) phases, the first, introspection in the supply chain, the second is the matrix design phase, the third phase is defined as selection and evaluation, while the fourth phase is the monitoring and improvement phase.
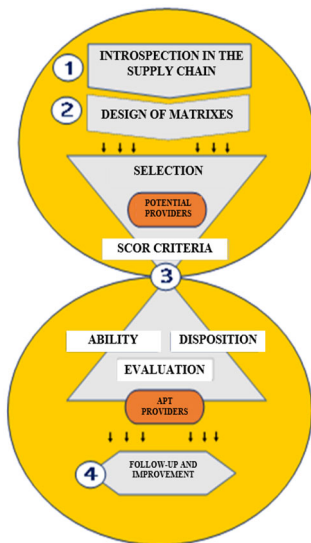

Fig. 1. Supplier selection and evaluation model.

B. Description of the Implementation Model

The first stage of introspection is shown in Fig. 2. The team is committed to an internal analysis of the company, which is carried out to take into account the starting point of the project. From this analysis, we proceed to establish the parameters that allow us to identify which agents are putting at risk the agility of the organization's supply chain and the quality of the finished product.
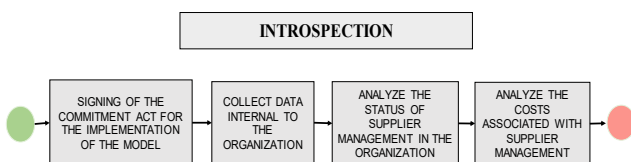

Fig. 2. Activity flow of the introspection phase.

The second stage, design, is shown in Fig. 3, requires the greatest planning effort, since it is here where the matrices will be designed or restructured from scratch based on the metrics of the SCOR model and the SPM. Phase two begins by identifying current suppliers and simultaneously searching for new ones. In this case, the research is focused on the company's strategic supplies.
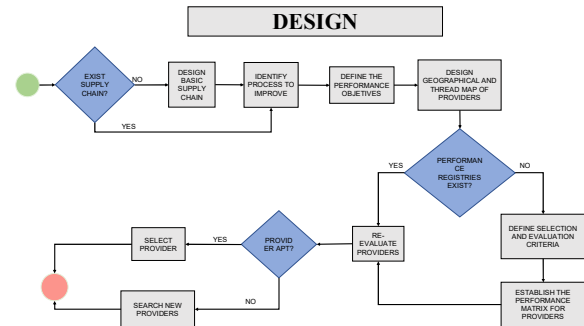

Fig. 3. Flow of activities in the design phase.

In the Fig. 4, the selection and evaluation stage, the performance of new or existing suppliers are evaluated and those considered APT are ranking, and a diagram is developed to locate them on a geographical map and Thread Diagram, and most important in the Supplier Potential Matrix.
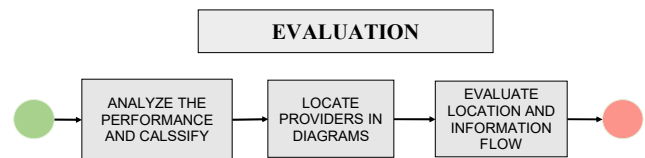

Fig. 4. Flow of activities of the Evaluation and Selection stage.

The last stage, follow-up, is shown in Fig. 5, the feedback is obtained from previous work; locate providers in the SPM, evaluating the position and establishing strategies. Also, improvement depends on the frequency that the supplier management process will be monitored through internal audits. The flow of activities in this stage is as follows:
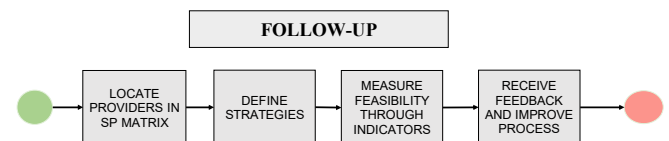

Fig. 5. Flow of activities in the follow-up stage.

IV. VALIDATION

In order to validate the proposed solution, the implementation method is used, and a series of deliverables have been defined for each of the phases.

A. First Phase

The Act of commitment is the first document of the project, it identifies the project team, the scope and restrictions defined by the interested parties, the implementation risks, and the most important milestones of the project. For its development, the PMBOK charter can be used as a guide.

The supply chain is one of the most important deliverables in the first phase, which should outline how the organization is viewed globally.

The next step in the first phase is the design of the objectives and final indicators. For this purpose, a technical sheet is used to consolidate the behavior of the indicators in order to follow their performance. The training program closes the first stage; however, it has been deployed since the beginning of the model, since it is focused on training the people who will use the tools of the supplier selection and evaluation model.

B. Second Phase

This phase is focused on determining the criteria with which suppliers will be evaluated; for the selection of new suppliers, as it is observed in Table 1, 2 and 3, the metrics used by the SCOR model, responsiveness, cost and reliability, are used. While for the supplier performance evaluation criteria, the two variables of the SPM are used, supplier capability and readiness [11]. For both criteria to be aligned, it is necessary for the team to define which are the most relevant, before the transaction and when it is already a regular supplier. This phase also includes the search for new suppliers and the identification of current suppliers, furthermore, identifying the old criteria used to measure supplier performance and comparing with the new ones can give you important feedback.

● Evaluation criteria for new suppliers:

Table 1. Criteria for new suppliers

CAPACITY CRITERIA	WEIGHT%	DEFINITION
Quality	20%	This is the most important criterion as it ensures that standards are met to create competitive advantages.
Delivery Time	15%	Impacts the agility of the supply chain.
Price	15%	Impacts on the direct cost of production of the product
Payment Term	10%	Facilitates the payment chain and creates reliability between both parties
Response Time	10%	Allows to know even more how important the organization is to the supplier
Location	8%	Allows to reduce delivery time
Inventory	8%	The supplier's stock speeds up the response to the purchase order issued.
Warranty	5%	It is the treatment provided by the supplier and its anticipation to the needs of the organization.
Service Level	5%	It is the supplier's experience in the market, its reputation based on its products.
Time in the market	4%	It is the experience of the supplier in the market, its reputation based on its products.

● Evaluation criteria for existing suppliers:

Table 2. Criteria for measuring the capacity of existing suppliers

CAPACITY CRITERIA	WEIGHT%	DEFINITION
Compliance with supply specifications	20%	Refers to the quantity of supplies provided by the supplier.
Delivery Time	15%	Impacts the agility of the supply chain.
Payment	15%	Facilitates the payment chain and
Time		creates reliability between both parties.
Price	15%	Impacts on the direct cost of production of the product
Response Time	10%	Allows to know even more how important the organization is to the supplier
Location	8%	Allows to reduce delivery times
Inventory	7%	The supplier's stock speeds up the response to the purchase order issued.
Service Level	5%	It is the treatment provided by the supplier and its anticipation to the needs of the organization.
Warranty	5%	It is the supplier's experience in the market, its reputation based on its products.

Table 3. Criteria for measuring readiness of existing suppliers

CAPACITY CRITERIA	WEIGHT%	DEFINITION
Commitment to quality processes	25%	Evaluates how willing the supplier is to comply with the evaluation processes implemented by the organization.
Long-term relationship	22%	It is focused on the experience that has been had negotiating with the supplier over time.
Willingness to audit them	20%	It is the willingness of the project to visit its facilities to observe its production processes.
Level of business relationship	18%	It is the supplier's commitment to continue working with the organization, a close business relationship is the best term.
Communication	15%	It involves the quality of the customer service and after-sales processes to keep track of the status of an order and the management of returns.

C. Third Phase

In this phase, suppliers are evaluated and selected, and a supplier base is formalized for those suppliers that meet the criteria defined above and end up *"APT"*. For the evaluation process of new suppliers, those that obtained more than 4 points were defined as "*SUITABLE*", while those that obtained at least 3.5 were considered for reevaluation, otherwise they were discarded. On the other hand, existing suppliers were considered as *"EXCELLENT" those* who obtained scores higher than 8.5, not lower than 7.45 as "*AVERAGE"*, losing the right to receive purchase orders until their score was raised, and those who obtained lower scores were discarded, since they could present a risk to the organization. The third phase ends with the Geographic Map and Thread Diagram. The first one seeks to identify the exact location of the operation centers, in order to have a more global vision of this part of the company's supply chain. On the other hand, the Thread Diagram complements the Geographic Map, since it allows to know the flow of information, raw materials, finished product and processes by locating them in each of the identified nodes.

D. Fourth Phase

Likewise, Fig. 6, shows the phase of the model is about to identify each of the suppliers in a quadrant within the SPM. Depending on their location, the following strategies are established:

● I Quadrant:

In this quadrant there are strategic suppliers, they are the best suppliers available and willing to cooperate so it is necessary to work with a vision of collaboration and trust [8], since these suppliers can help streamline the supply chain. It is also recommended to form alliances to increase the benefits for both parties in commercial, economic and technological terms to improve processes.

● II Quadrant:

Suppliers in this quadrant have low capacity but are willing to cooperate. In this sense, the organization could help develop the quality and technical requirements of the supply that the supplier produces. However, there is an investment with high risk due to their low capability [8]. It should be considered that if you are looking to work in the long term it is necessary to invest in the relationship with the supplier.

● III Quadrant:

In this quadrant are the suppliers that present a high risk to the company's supply chain. Therefore, the best decision is to replace them, but if the number of suppliers is limited, it is recommended to use tools that increase the performance of the evaluated variables, for example, feedback, supplier incentives, knowledge transfer or physical and financial investment [8].

● IV Quadrant:

The suppliers in this quadrant have great capacity, which makes them valuable, which is why it is recommended to improve the relationship with the supplier in the long term and work on trust with the supplier [8]. This will allow to have a wider base of Apts suppliers, which will allow the organization to respond to different scenarios without sacrificing the agility of the supply chain.
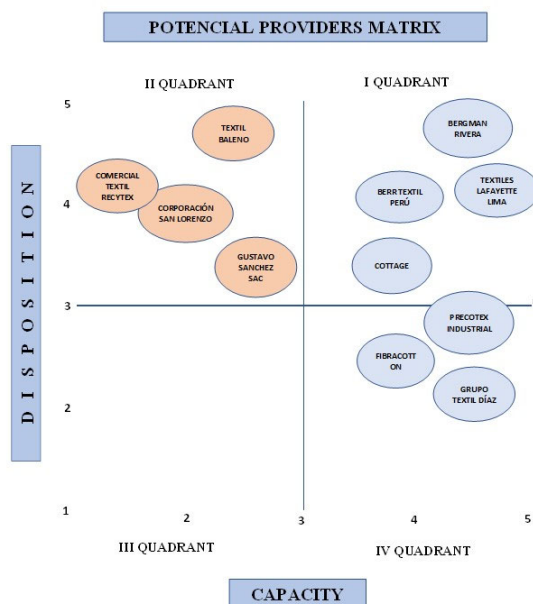

Fig. 6. Suppliers potential matrix.

To measure the feasibility and monitor the results throughout the implementation project, a series of indicators were developed in phase 1, but it is in this phase that the results obtained are analyzed. The indicators are, average response time for new suppliers (a), average response time of existing suppliers (b), cost overrun per month of transportation in the purchasing process (c), Percentage of compliance with technical specifications of supplies (d), Number of eligible suppliers by supply (e).

Equation (1) shows the supplier search time. The calculation is based on effective days performing this activity $(d_1, d_{12}, ..., d_n,)$ and the number of times that the requirement was issued $(r_1, r_{12}, ..., r_n,)$. This indicator measures the time from the start of the process until the supplier responds positively to the purchase order. For the indicator of average response time of existing suppliers (b), works in the same way as (1), it is expected that the behavior will be lower, since the supplier is known, the communication channels with the organization are clear and there are strategic alliances with some of them.

$$a = \frac{\sum_n^1 d}{r_n} \quad (1)$$

Equation (2) is applied to measure transportation cost overruns when it happens ($o_1, o_{12}, ..., o_n,$), the sum is compared per month; it normally raises when the aim is to reduce the time it takes to obtain the input from the supplier's factory or from a distribution agent.

$$c = \sum_n^1 o \quad (2)$$

Obtaining quality supplies is a priority for companies, especially in the textile sector. Equation (3) helps to calculate it base on technical specifications approved $(s_1, s_{12}, ..., s_n,)$ and the total number of technical specifications $(S_y,)$.

$$d = \frac{S_n}{S_y} \quad (3)$$

To ensure the availability of suppliers, it is ideal to have a range of suppliers $(x_1, x_{12}, ..., x_n,)$ for each supply, as this increases the organization's bargaining power.

$$e = x_n \quad (4)$$

E. Analysis of the Results

To validate the results of the implementation of the Supplier Selection and Evaluation Model, the results obtained from the indicators, the analysis of the project in terms of investment and its recovery, and the economic impact after the adaptation of the model's tools must be analyzed.

1) Validation of indicator results

Table 4 shows that the optimistic scenario was matched in (a), since the new suppliers evaluated currently have an average response time of two days, while for (b), the response of the existing supplier is one day. Indicator (c) surpassed the optimistic scenario, with a difference in favor of reducing cost overruns by S/. 247.26 soles. Indicator (d) achieved the

result expected in an optimistic scenario, 90% compliance with technical specifications for supplies. Finally, (e) also reached 6 eligible suppliers, as expected in an optimistic scenario.

Table 4. Comparison of indicator results

		a (days)	b (days)	c (S/.)	d (%)	e (Units)
ITINERARY	Historic – 0	7.2	5.17	S/4595.29	0.8	1
	Pessimist - 1	6	4	S/3950.00	0.83	2
	Neutral – 2	2.5	2.5	S/3395.22	0.88	4
	Optimist – 3	2	1	S/2263.92	0.9	6
STATISTICAL ANALYSIS	AVERAGE	4.425	3.1675	S/3551.11	0.8525	3.25
	VARIANCE	4.94	2.46	732647.27	0.00	3.69
	STANDARD DEVIATION	2.22	1.57	855.95	0.04	1.92
REAL	RESULTS	2	1	S/2016.66	90%	6

2) Validation of project feasibility

Based on the results obtained, it can be verified as is shown in Table 5, that they have been very close to the optimistic, considering that the base IRR is 1.53% and the investment has been S/. 10,456 soles.

Table 5. Analysis of project scenarios

	OPTIMISTIC SCENARIO	NEUTRAL SCENARIO	PESSIMISTIC SCENARIO	REAL SCENARIO
VAN	S/22269.13	S/13915.72	S/10969.41	S/21731.16
TIR	29%	22%	17%	29%
IR	S/2.13	S/1.33	S/1.05	S/2.08

In summary, it can be defined that the project is viable, in the first place, because it has achieved an IRR of 29%, NPV of S/. 21,731.16 And a profitability index of S/. 2.08, which means that for each sol invested a profit of S/. 1.08 soles will be obtained.

3) Validation of economic impact

Another analysis that should be considered is that in 2019 there was a direct operating cost of S/. 78,889.79 soles, and in 2020 it rose S/. 128,836.33 soles. This is considering factors such as the pandemic that increased the large-scale costs of supplies. However, the results of the real scenario and based on what was obtained from January to the projection to December, it is estimated that the direct operating costs will be S/. 77,548.51 soles, which shows that the tools used that have made to negotiate again with suppliers have reduced criteria such as price reduction, the proximity of suppliers, so the impact on transportation costs have also been reduced, and the stabilization of the textile market that have played in favor of reducing the projection of the cash flow of the company.

V. CONCLUSION

Most microenterprises do not have formalized management tools. Therefore, it is important, accompanying and training them in the design and use of tools for managing the supply chain. In this study, the training modules were a critical point to shorten the learning curve of the project participants with the new terms for some of them.

The definition of evaluation criteria for new and existing suppliers must consider not only what is presented in the literature, since each organization, having its own objectives, is more interested in having its suppliers comply with certain aspects that will allow them to further highlight their strengths and work on their weaknesses.

The supply procurement process has a significant impact on the agility of the supply chain, since it is the beginning of the supply chain. Moreover, factors that make the supply chain less agile are the delivery time of supplies, non-compliance with the technical specifications of supplies, which leads to returns and causes delays in production. Also, the quality criterion is the most important in the textile sector, which is why suppliers must be aligned with the standards required by the organization, but it is also necessary for the company to work on identify those standards.

The criterial used in the SCOR model allows to be aligned with global measurement criteria and in long term the organization can measure themselves. In the case of the use of the variables of the SPM, which are also related to the SCOR model, they allow to identify not only the most suitable supplier, but also the one with which a close business relationship can be established, allowing long-term collaboration, improvement of the processes of both parties along quality lines and joint work involving the sharing of information related to achieving higher quality standards and the development of processes. However, the SPM is a key tool to identify what actions to take depending on the score obtained by the suppliers. In addition, it is better to perform it at the end, after the total analysis of the tools to define the impacts that may have to perform certain actions with one of the suppliers.

VI. RECOMMENDATIONS

It is recommended that the first step, after approval of the implementation budget, be made public, as it will benefit the willingness of people in the company to provide information. It is therefore important to develop the Act of Commitment, it establishes the high-level characteristics of the project and lays the foundation so that the main objective is not lost during the implementation of the model. In this sense, it is advisable to carry it out with the participation of the main stakeholders of the implementation project.

The SCOR model is focused on large companies, which is why it is necessary to adapt the information provided by the model when implementing it in a microenterprise. In the same way that suppliers have been evaluated, the organization can be evaluated under the same criteria to measure the agility of the supply chain and the quality of its products, since the quality of the supplier is transferred to the quality of the finished product.

As supplier performance directly affects the Supply Chain, it is necessary to perform at least two supplier evaluations, the first one before starting the business relationship and the other one during the business relationship. The next level of this model is evaluated more than just strategic providers. Also, considered supplier approval, it is recommended to review the subject so that supplier management is not limited to the quality of the supply but extends to the analysis of the supplier's financial capacity, production facilities, technology, etc. This model will also have an impact on the environment, because if an agreement is reached with suppliers to optimize

transportation and supply reception trips, this would reduce the carbon footprint produced by transportation and reduce environmental pollution, thus contributing to the fight against global warming.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

The argumentation had been developed for both authors, Katya Cornejo (author 1) and Ninuzka Muñoz (author 2). First phase of the investigation had been worked by Author 2, the paper research, the analysis of literature by Author 1, and the value definition of a model focus on microenterprises by both. Also, the writing and design of the activity flow and approval of the final version was worked jointly and in equal parts. Finally, Katya C. had focused on structured the methodology to teach entrepreneurs the model proposed, and Ninuzka M. had designed the graphic Model l oriented to a better understanding of readers.

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