

A Conceptual Model That Identifies Mathematical Models and Lean Techniques for Problem-Solving at the Different Decision-Making Levels of Service Companies

Zaida E. Alarcón Bernal^{1*} , Ricardo Aceves García² , Arturo Fuentes Zenón² 

¹Department of Biomedical Systems Engineering, National Autonomous University of Mexico, Mexico City, México

²Department of Systems, National Autonomous University of Mexico, Mexico City, México

Email: *aceves@unam.mx

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Abstract

In this research, a decision support model was developed for micro, small and medium service enterprises (MSMEs). Using the systemic approach through the diamond model, it was possible to conceptualize with precision the variables that determine the closure of MSMEs in Mexico. Using this methodology, a conceptual model was formulated that contextualized the variables in a set of problems. Then the problems were defined and placed in the different decision levels of a company; finally, through the solution process, mathematical models and lean tools were identified for their resolution. Consequently, the model developed in this research classifies the variables that cause the failure of Mexican MSME service companies into groups of problems, formulates and locates these problems in each of the strategic decision levels, and shows the different tools useful for solving these problems.

Keywords

Systems Theory, Formal Model, MSMEs, Service Companies

1. Introduction

Today, services play an essential role in the economy of society. Transportation, infrastructure, and government are the main services of an advanced society, creating personal services that allow a better quality of life. The nature of the service sector is explored in terms of employment opportunities, contributions to economic stability, and source of economic leadership. Therefore, the idea

that a new experience-based economy will replace post-industrial society is considered, referring to a society that defines life quality through services such as health, education, and entertainment.

Service companies charge primarily for memorable customer contact. Experiences are characterized by the environment and user participation in them. Consequently, innovation and social trends based on changing demographics create demand for new services. Globalization and the current pace of life mean that services are considered standard, making the difference with the excellence with which they are delivered. When a customer buys a service, they need to satisfy an essential need and demand to go beyond it. In other words, what they need is a *shopping experience*.

Considering that services are ideas and concepts, and their products are sensations and experiences, service innovations are not patentable, so service companies must continuously optimize their processes and innovate. This intangibility also brings problems for the user because when you buy a product, you can see it, feel it, and test its performance before buying it. Meanwhile, for a service, the user must trust the company's prestige that sells it and its experience with it.

The combination of the service's intangible nature and the user's participation in the service delivery system results in a variation of the service from user to user. Therefore, for companies of this type, the process is the product, and the development of standards, performance measures and employee training in the procedures are a way to ensure consistency in the service provided.

In service companies, a distinction must be made between inputs and resources. For services, inputs are the users, and resources are the value proposition being delivered, the employees' work, and the capital in command of the service administration.

The world economy is increasingly characterized as a service economy. This is mainly due to the growing importance and participation of the service sector in the economies of most developed and developing countries, so that service sector growth has been considered an indicator of a country's economic progress.

In Mexico, of the total number of companies that exist, 85.8% are service companies and provide 63.9% of the jobs, contributing 62.9% of the country's gross domestic product (INEGI, 2019). In terms of size, micro-businesses represent 95.8%, small businesses of 3.5%, medium businesses 0.6%, and large businesses, which are at a rate of 0.1%. This implies the importance of SMEs for development and employment in Mexico (INEGI, 2019).

However, in Mexico, service companies have a high mortality rate, establishing that out of every ten companies that are opened, three die in the same year, six in the second year and seven in the fourth, and only three survive to the fourth year (INEGI, 2019). According to (Dávila et al., 2014), the most common causes of death for these companies are poor location, no market study, poor planning, excess operating expenses, no analysis of their processes, and lack of performance indicators, among others.

Another important aspect to consider is the educational level of the owners or managers of MSME, which according to (Peña et al., 2017), 47.5% only have some primary and secondary education, 24.8% have a higher technical level, and only 23.7% have a high school education considering that the rest do not have any type of studies.

On the other hand, according to Santander MSME-México (Santander, 2019), in its article “Mejores ideas para franquicias exitosas en 2019” it is established that this type of business has a higher degree of durability. It establishes that franchises have a survival rate of at least 8.5 years, much higher than traditional MSME. Raising the question: why do franchisees get such good results? Furthermore, the answer they established was because they have: training and assistance, constant evaluation, marketing, networking, operation, and location manuals. Consequently, and in general terms, these aspects make the franchises a very profitable MSME service model.

In consequently and due to the information presented above, entrepreneurs and administrators of traditional MSME must have some alternative that provides them with the knowledge, the necessary tools, and technical support so that they can develop their work and this type of company can survive for a longer period and be a profitable business.

Therefore, this work seeks to develop an alternative that serves as a guide and training for managers and entrepreneurs of MSMEs to solve their problems at the three levels of decision: strategic, tactical, and measurement.

One of the reasons is because of the great opportunity. Empirical data has shown that the cost of services is inflated by 30% - 80% waste, i.e., processes are plagued by activities that add no value from the customer’s perspective. Our article on Lean Models and Tools for Service Businesses is needed because service functions need tools like mathematical models, Lean Six Sigma, data skills, and process thinking.

2. Literature Review

The interest and generation of knowledge about service businesses is a very recent field of research and application, which began in 2004 under IBM’s tutelage under the concept of Service Science (Barile & Polese, 2010b). The concept of a Service System has provided the stakeholders in this field of knowledge to visualize services as a set of interactions between suppliers and consumers that together create value for themselves, i.e., as a system—considering as a final objective, to apply scientific knowledge in the design and improvement of service systems for business and social purposes (such as efficiency, effectiveness, and sustainability).

Through the literature, the use of lean tools and mathematical models has been identified to provide the necessary basis for Service Science (Barile et al., 2010) in general and service systems in particular. Under this perspective, the vast majority of authors have limited themselves to expressing the application of

some lean tool or mathematical model in the field of knowledge of services, without offering precise guidelines to guide the analyst in defining the tool or model of interest for decision making.

In this context, the term “service” covers both service organizations (health care, banking, government, retail) and the service infrastructure of service and manufacturing organizations (marketing, sales, accounting, contracting, production control, engineering, research, and development, etc.). That is, everything except “the manufacture of goods and articles by hand or especially by machinery” (i.e., direct manufacturing processes).

There is little information in the literature about the range of mathematical modeling applications and the use of lean tools in different service topics, the most frequent being those related to health systems (Healthcare). There is literature where it is presented together with mathematical models and lean tools for solving problems in different topics about services, being mainly books, being the most focused on service topics, the following.

Bordoloi, S., Fitzsimmons, J. A., & Fitzsimmons, M. J. (Fitzsimmons et al., 2008) raises service management to obtain a competitive advantage and provides an approach to each management issue. It recognizes that integrating technology, operations, and human behavior is fundamental to the effective management of services. It emphasizes the need to continuously improve quality and productivity to compete effectively in a global environment. Process improvement, tools, and programs for continuous improvement are described, and service productivity is measured using data envelope analysis. The strategic importance of service facilities’ location is presented with analytical models dealing with queue management from a psychological point of view. The fourth part is dedicated to quantitative models for service management, addressing capacity planning using queue models, and addressing service demand forecasting using exponential smoothing models, concluding with service inventory management.

Michael L. George (George, 2003) indicates that the paradigm that translating methods into service environments is more difficult than it needs to be is broken. Almost all Lean and Six Sigma applications are for services and transactions. The case studies presented show how Lean Six Sigma can be used in service organizations effectively as in manufacturing and with even faster results. This reference establishes how classic Lean tools, for example, “drive systems” and “configuration reduction,” are used in procurement, call centers, operating rooms, government offices, R & D, etc. This book provides real-world examples of situations where the critical determinants of quality and speed are the flow of information and the interaction between people. In Part I: Lean Six Sigma is used for strategic advantage in service. Part II: Lean Six Sigma is implemented in service organizations and describes successful implementations’ basic elements. Part III: Service Improvement shows how Lean Six Sigma methods and tools work in real-world service applications.

Locher, D. (Locher, 2011) aims to provide a guide for students and applicators

of Lean Six Sigma methodologies and tools. The book is designed to engage the reader by allowing hands-on experience with real-life Lean Six Sigma projects in a safe environment, where experienced Black Belts and Master Black Belts can help guide students in Lean Six Sigma. The case studies are designed to allow the student to work through the exercises and provide enough background information to apply the tools as if they had collected the data themselves. Case study discussions provide questions that allow students to compare their solutions to actual results obtained by similar students struggling to learn and apply Lean Six Sigma. The reference provides an overview of Lean Six Sigma and the DMAIC methodology and problem-solving tools applied to transaction-based services and processes and an overview of Design for Six Sigma and the IDDOV design methodology applied to transaction-based services and processes.

Haksever, C., & Render, B. (Haksever & Render, 2013) covers a wide range of topics in managing service organizations and their operations. It focuses on value creation and customer satisfaction. Therefore, the book is designed to provide comprehensive coverage of topics relevant to that end. Its content is quite different from traditional operations management textbooks, although we have also included some of the topics covered in those books. The discussions are based on the knowledge and experience of various business areas and non-business disciplines. For example, discussions are often based on strategy, marketing, international management, human resources, management science, economics, psychology, and sociology. It is hoped that this multidisciplinary and multifunctional approach will help managers and future managers develop a thorough and solid understanding of the complexities of services and their management. It begins with an introduction and focuses on developing a thorough understanding of services. It discusses the nature of services and service encounters. It also examines clients and their needs and the factors that influence their decisions in purchasing services. It addresses issues related to value creation and service strategy. Finally, it presents various quantitative and technical tools for managing service operations, such as selecting the right service site and internal design.

At Furterer, S. L. (Furterer, 2016) states that it goes beyond the basic tools, deepening in the key concepts of lean as they are applied in offices and services. First, value flow management is presented, followed by chapters on Standard Work, flow, pull level, and visual management. Next, several of the most important lean tools are covered, such as 5S and error proofing. These are applied while implementing the key concepts covered in chapters 1 through 5 to maximize benefits. The following chapters present a function-by-function review of the lean application. Does lean apply to sales and marketing? What about accounting? S cover functions commonly found in most service organizations and the administrative areas of manufacturing companies. The examples provided should be applied in the context of the value stream Management to maximize profits.

Regarding the production of articles on health service topics, we have considered the following literature reviews, conducted for Mexico by Peimbert-García

et al. (Peimbert-García et al., 2019) and a more general by Vaishnavi, V., & Suresh, M. (Vaishnavi & Suresh, 2020), in which a panorama is presented for the application of Lean Six Sigma (LSS) in health care organizations.

Peimbert-García, et al. (Peimbert-García et al., 2019) presents an article that provides an overview of the penetration of LSS management practices in the Mexican health care system, through a survey of 30 hospitals in six states of the Republic, to which N = 258 responded, including senior management and frontline staff. It was found that the penetration of LSS initiatives in Mexico's health care system is still in its infancy since only 16% of those surveyed had participated in an LSS initiative, and these were used equally in public and private hospitals. Also, it was found that while not many respondents had participated in the LSS project, the practice is not necessarily new to those who have. However, the sustainability of LSS as a management system in the Mexican health system is questionable since the practices and tools for managing LSS in existing initiatives have not become systematic in daily operations. Looking ahead, LSS initiatives that emphasize improvements in the quality of patient care delivery are more likely to be adopted by health workers. Perhaps one of the reasons for the poor spread of LSS is that the country is not experiencing hyper-growth in health expenditures as many high-income countries are, even though it accounts for 6 percent of national GDP, and the industry is not then as regulated as in developed countries such as the nearest neighbor, the United States.

Nevertheless, the national health care system needs re-engineering interventions that will allow hospitals to be more efficient productive to improve their costs and the quality of care. For LSS experts and consultants, the Mexican health system represents a blue ocean full of departments and processes waiting to be improved. However, its importance lies in the fact that it is the first research work that evaluates the use of LSS management practices in a Latin American country, and the article is the first to focus on LSS in health care in Mexico.

Vaishnavi, V., & Suresh, M. (Vaishnavi & Suresh, 2020) work aims to identify, analyze and categorize the main factors of readiness for applying Lean Six Sigma (LSS) in health care organizations, using the technique of total interpretive structural modeling. The readiness factors are identified and will help managers recognize areas that lack value and place importance on the successful application of LSS in those areas. The paper also aims to understand the hierarchical interrelationships among readiness factors identified using dependency and momentum. There are 16 readiness factors identified from the literature review, and expert opinions from hospitals are collected. The scheduled interview is conducted based on a questionnaire survey in hospitals in the Indian context to determine the relationships between preparedness factors. The experts' opinions are used in the initial accessibility matrix and the interpretative interaction matrix. The crossover impact matrix applied to the analysis from classification (MICMAC) uses the dependence and momentum engine to understand the hie-

rarchical relationship between preparedness factors identified.

The result indicates that the culture of client orientation and management of objectives are the key factors of preparation for the LSS. The execution technique and training are given according to the clients' current demand and the change of objectives of the organization. The manager should focus more on readiness factors to formulate the LSS implementation process to improve the health care organization. The level of readiness helps the manager identify the target area for LSS implementation. The article's importance is that although many research studies have been conducted on the success and failure rate of implementing the factors, the importance of the document is that it identifies and will address the readiness factors related to SLE, especially for the health care industry.

Regarding other topics such as financial services, public services, repetitive processes in service companies, problem-solving in service companies, it is not very abundant, and the following articles were found.

Cuatrecasas, L. (Cuatrecasas, 2004) establishes that lean production philosophy has allowed reaching very high levels of efficiency in many of the dimensions related to production systems, both in industry and services. This article describes a methodology for evolving from a classical model of a production system's behavior to one of lean production; this methodology is quite flexible and can cover a very wide spectrum of production systems. Since service companies are often among those who would benefit from such an evolution, the methodology described here will be applied to a case in the service sector (the check-out service of a hotel-type establishment). The methodology also includes a system for calculating the main magnitudes relating to the efficiency of operations and their optimization, step by step. According to the principles of lean production (and even, in another order, those of Just in Time), the system implemented is highly efficient and balanced, and it also solves the dynamic assignment of tasks to each job (thus introducing flexibility). The author states that it has achieved the optimization of service speed, efficiency, and competitiveness and the elimination of queues, downtime, and other types of waste; we have also achieved all the flexibility we need.

Kung, D., et al. (Kung et al., 2008) work with the installation of water and sewage services is an essential element of many construction projects. With an increasing number of construction projects being undertaken in metropolitan areas, delays are no longer affordable. To increase productivity on these types of construction projects, the workflow must be improved. This paper describes the application of "lean planning" principles to improve water and wastewater facilities' productivity. To illustrate this, a case study is presented that applies these principles to water and wastewater service facilities conducted by the City of Edmonton's construction teams. This document also outlines a study that applies recommended lean thinking procedures within a queuing theory model to validate the effect of proposed productivity improvements.

Setijono, D. et al. (Setijono et al., 2012) introduce a value improvement model

(VIM) for repetitive processes applicable to any company where people and/or the company provide a service to support the overall business objective. Arguing that competitive advantage can be realized through different amalgamations of productive and strategic resources, the introduced VIM focuses on resource groups' alignment, influencing factors to create efficient processes, efficient and effective applying Lean thinking and Six Sigma tools and techniques in a more holistic way. The article introduces the concept of MIV management that develops the "state of the art" and "future state" MIV for a repetitive process específico. The conceptual framework presented was put into operation and tested in a case study based on improving the efficiency of asset management of an interterminal transport system at a busy international airport. About the application of MIVs in the current state and the future, the Plan-Do-Check! The process was established, and the case study presented showed how an analysis method could be applied to reduce the number of alarm events in the systems. Finally, in this work, the management VIM has been introduced as a visual and systematic framework that allows managers to understand, evaluate, and improve the repetitive processes within their companies to complement Lean and Six Sigma's existing conceptual frameworks. Once the research's potential limitations have been overcome with the single case study presented, future research should seek to further develop the approach in other business environments, such as manufacturing and other service industry applications.

Vlachos, I., & Bogdanovic, A. (Vlachos & Bogdanovic, 2013) evaluate waste management practices using a sample of small and medium-sized hotels in 19 European countries. Seven value stream maps were evaluated, namely Mapping of process activities, Supply Chain Response Matrix, Production Variety Funnel, Quality Filter Mapping, Demand Amplification Mapping, Decision Point Analysis, and Physical Structure, with particular reference to guest booking and reception, and hotel procurement systems. The hotels were found to apply value mapping techniques, and similarities were found in hotel operations, regardless of location. It is suggested that all value stream mapping techniques (except the production variety funnel and supply chain response matrix) can significantly impact waste detection and disposal both upstream and downstream of the value chain. The paper concludes with a discussion of management and research implications.

Lin, J. H., & Chiu, M. C. (Lin & Chiu, 2015) consider that the health system plays an important role in our daily life. A well-operated health system can save lives and provide a good working environment for medical personnel. However, most health systems suffer from a high workload of medical staff and low client satisfaction. Also, the stochastic nature of health services is difficult to evaluate performance. Therefore, this study aims to implement lean management in the health system with lean techniques and a stochastic model to simultaneously achieve client satisfaction and waste reduction. The first step is analyzing the current process and data collection to clarify the current status by quality management practices and lean tools. Besides, a stochastic mathematical program-

ming model is developed to optimize the performance of this health care system. The simulation results show that efficiency of the process flow after leveling is improved by about 19.97%, the proportion of workstation downtime is improved by about 41.64% and 22.47%, and the average flow time is improved by about 4 minutes. A case of the health examination center is applied to demonstrate the benefit of the proposed method. This study could be the first study that implements the health system's lean and stochastic characteristics in a mathematical model. This model can serve as a decision support system and can be applied to other lean improvement service systems.

Vashishth, A., et al. (Vashishth et al., 2019) establish as the purpose of this article to explore the trend and most common issues in the application of Lean Six Sigma (LSS) in the sector financiero, and also to identify the gaps in issues that may be preventing organizations from identifying benefits of their LSS strategy and develop an agenda for future research on LSS issues. The research is based on a systematic literature review of 30 articles were published on LSS in the sector finance, from 2005 to 2015. Many important themes and issues have emerged through this review, which is from beneficio, motivational factors, constraints, and reasons for implementing LSS in organizations from financieras. The review identifies many gaps and limitations that need to be explored as future research since little has been written about LSS as a holistic strategy for business improvement. Practitioners need to know the benefits of LSS, its limitations, and the motivational factors before beginning the implementation process. This paper is based on a comprehensive review of the literature that allows LSS researchers to understand some common issues about LSS implementation. Also, highlighting gaps in the current literature and proposing an agenda for future research saves time and effort for readers seeking research topics within LSS.

3. The Service Companies in México

In Mexico, the total number of existing companies (INEGI, 2019) is 4,773,995 (2018 figures), of which 85.8% correspond to service companies. These give jobs to 63.9% of a total of 26,561,457 people, and their contribution to the national GDP in 2018 corresponded to 62.9% of 23,524,509.6 million pesos.

If only service companies are considered, out of a total of 4,096,051 existing in 2018 (INEGI, 2019), micro represents 95.8%, small 3.5%, medium 0.6%, and large 0.1%. As for the employment they generate in the country, out of 16,972,183 jobs, the micro ones occupy 50.3%, the small ones 17.0%, the medium ones 15.4%, and the large ones 17.3%. Therefore, their economic and labor contribution is of great importance for the country's development. In addition to the above data, service companies have a high rate of failure, establishing that a service company's life expectancy is 0.33 for one year, 0.31 for two years, and 0.29 for four years. In other words, out of ten companies that are opened, three die in the same year, six in the second year, and seven in the fourth year; only three survive the fourth year.

Based on the analysis made by (Dávila et al., 2014), the most common causes

for business failure are insufficient income to subsist; lack of performance indicators, lack of an analysis process, poor planning, problems in execution, poor location of the company, weak market research, and excess operating expenses. It is clear from this study that 70% of the companies that were not successful were service companies.

The study carried out by (Peña et al., 2017) analyzes the main factors that determine the closure of micro and small enterprises in Mexico, being these: financial, market, personal and management, external and technology. Also, when considering the level of education of business owners and managers, we have to, 47.5% have some primary or secondary education, 24.8% have a higher technical level, 23.7% have a bachelor's degree, and the rest have no studies. This study was applied to 24,867 active companies, 8430 inactive companies, at municipal level.

In another study (Hernández & Gómez, 2011) documentary research is carried out on authors who indicate the main factors that cause companies to fail. They conclude that the main reasons are: lack of business experience, lack of capital, poor location, unplanned growth, inadequate or non-existent planning, high initial costs, confusing cash with profits, poor selection and management of personnel, failure to keep accounts, low sales, excessive competition, failure to offer added value and poor marketing.

In consequence and because of the information presented, service companies currently represent an open field for research and solving their problems, in particular for MSMEs. Therefore, in this paper, our purpose is to develop a conceptual model through which entrepreneurs, managers, and employees, identify mathematical models and lean techniques for problem-solving at different decision-making levels: strategic, tactical, or competitive and measurement or operational.

4. Strategy for Solving Problems in Service Companies

The purpose of this section is to address the main problems affecting micro, small and medium-sized enterprises (MSMEs) in Mexico through a process that allows them to be identified and organized logically and coherently. The objective is to propose accessible and understandable solution alternatives for managers, entrepreneurs, and employees, through different planning actions that can be implemented at each of its decision-making levels (strategic, tactical or competitive, and operational or measurement).

Moving from the abstract to the concrete is essential to apply the theories on a practical level and make them viable for empirical studies, that is, to make them operational. To do this, we started with a general perspective to solve problems, using the Diamond Model developed by (Sagasti & Mitroff, 1973).

Systems approach: The Diamond Model

The model represents a problem-solving process, which despite its simplicity, will be useful to develop the strategy that we will use to address logically and ra-

tionally, the different problems that arise in micro, small, and medium service enterprises, and for which they fail.

Diamond Model is understood as a system with a set of interconnected elements that form the whole and is characterized by the following properties:

- The attributes or performance of each element affect the attributes and behavior of the whole.
- The effect of elements, on the whole, depends on attributes or performance of at least one element of the whole.
- All existing element subsets have the above characteristics.

The whole is more than the sum of its parts, so its separation is only for conceptual purposes from a structural perspective (Figure 1).

The model process is established through the following subsystems:

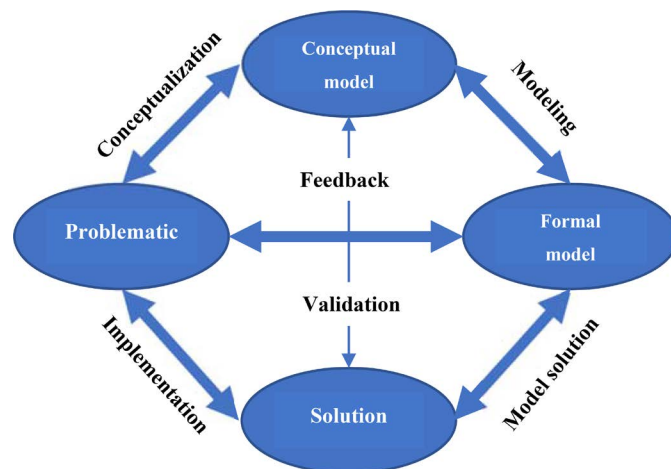
Problematic situation. Every form of problem-solving begins with a problem situation or reality, through which a vague recognition that things are wrong is raised.

Conceptual Model. The elaborated graphic, written, or mental representation is used as a support frame to locate and order the perceptions, determine some structure of the problem, define the area of interest, and decide which aspects are relevant and which are not.

Formal model. Once the conceptual model has been established, we use abstraction to elaborate on one or several formal models. The formal model generally consists of rules and symbols emanated under a particular theoretical system, which require analytical and abstraction skills to establish significant relationships and variables.

Solution. In this activity, we intend to deduce the consequences of choosing different courses of action, supporting decision-making, and integrating change strategies. The solution is intended to explain the phenomenon, in congruence with the ideas that the conceptual model has of the problem and solutions.

Although this systemic model represents the process of problem-solving,



Source: Own elaboration based on (Sagasti & Mitroff, 1973).

Figure 1. The model of the diamond.

which is understood as a set of interconnected elements that form the whole, it is possible to start the process of problem-solving from any subsystem since each one underlines a part of the process followed to solve a problem and highlights that there are different ways to investigate. Therefore, it is possible to use some of the subsystems as a reference framework.

Formal solution process as a methodological strategy for solving the problems of service companies

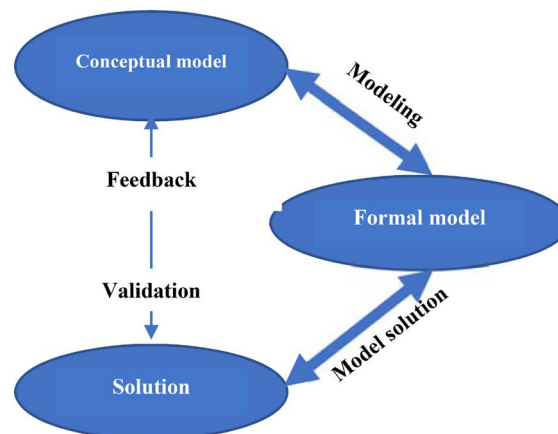
Because different individuals are at different levels of decision making in the company and face different kinds of problems, through the diamond model, it is possible to identify several starting points and choose different sites to complete a solution process.

For our analysis, and given that the set of variables by which MSMEs fail has been identified, it is possible to establish, about the Diamond Model, that the subsystem of the formal solution process (**Figure 2**) is the one that we establish as a methodological guideline to follow in this work. This process begins with defining an established and structured *conceptual model* (proposed problem) and modeling according to a particular theoretical system, which requires analytical skills and power of abstraction to establish the significant relationships and variables (modeled problem). It proceeds to its solution with some technique or tool.

Formulation of the conceptual model: definition of the variables in five groups of problems.

The conceptual model is defined as the mental image that an individual creates about reality. It provides an ordered scheme to locate all his pertinent perceptions about the problematic situation he faces, where he identifies the structure of the problem and decides which aspects are relevant and which are not. Therefore, the conceptual model represents one more degree of abstraction from reality and can generate one or more formal or scientific models.

To generate a conceptual model to start the formal solution process, five groups of problems were established, through which the different variables by



Source. Own elaboration based on (Sagasti & Mitroff, 1973).

Figure 2. Formal solution process (formal model).

which Mexican companies fail are related, knowledge is ordered, and a support framework is available through which it is possible to determine some structure of the problem and define an area of interest. Consequently, the conceptual model that we formulated and will use as a reference framework for our analysis is established in the following way:

- *Trouble selling.* Resistance to comply with customers' preferences, poor orientation and service to users, poor location, lack of focus on precise market segments or niches, lack of formal marketing and sales plans, lack of systems to detect market opportunities, reluctance to invest in advertising and promotional activities, inadequate training of the sales network, failure to consider customers' complaints, lack of knowledge of what is sold and to whom it is sold, ignorance of the competition, lack of knowledge of one's competitive advantages and the like.
- *Problems with production and operation.* Lack of technical capacity to manage production and operations, lack of knowledge of the sector in which you operate, negligence and little interest in the business, supply difficulties (raw materials and materials), high operating costs, poor management of purchases, little previous experience with the products managed, lack of adequate information systems, severe deficiencies in internal processes, high levels of waste, poor time management, error in calculating the dead center or balance, operating in a sector with a dead center or very high balance, lack of knowledge of the life cycles of each activity and similar.
- *Control issues.* Inadequate handling of credits and collections, fraud, lack of knowledge of the real financial state of the company, unnecessary expenses, severe errors in security, bad handling of inventories, severe failures in internal controls, deficiencies in budgetary and management control, bad management of debts and liquidity, inadequate management of funds and the like.
- *Problems in planning.* Severe deficiencies in establishing strategies, lack of alternative plans, unrealistic objectives and expectations, lack of a business plan, inadequate planning, unplanned growth, lack of foresight, lack of pre-investment studies, and related issues.
- *Management problems.* Inability to surround oneself with competent personnel, lack of experience, excessive investment in fixed assets, deficiencies in personnel policies, absence of continuous improvement policies, lack of training of the company's top manager, deficient systems for decision-making and problem-solving, unprofessional management, resistance to change, reluctance to consult outsiders, using business resources for personal expenses, poor partner selection, negative attitudes towards collaborators, nepotism, poor risk management, failure to comply with tax and labor obligations, lack of entrepreneurial leadership, unclear definition of objectives, discouragement at the first major obstacles, poor entrepreneurial culture, lack of experience in the administrative side of the business.

Formulation of the Formal Model: classification of problems by decision levels

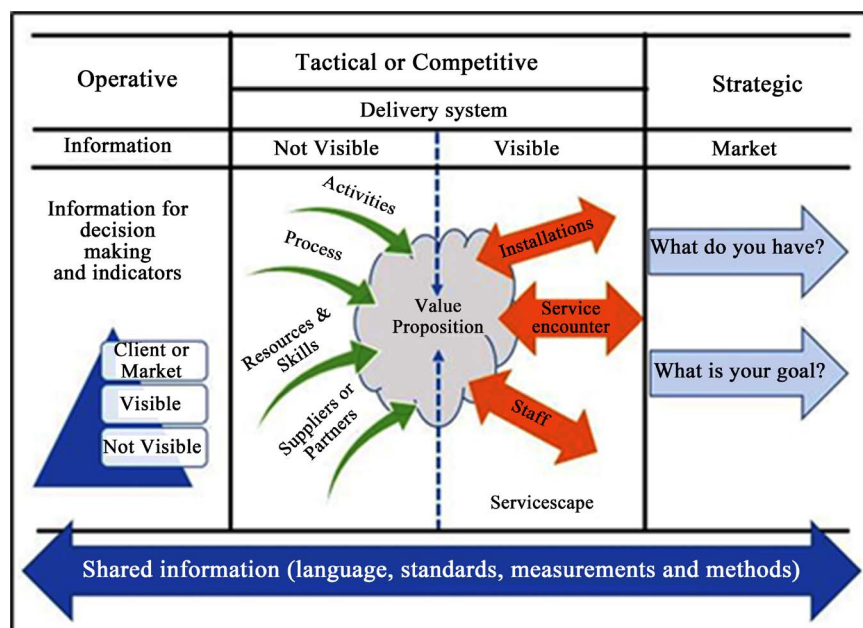
The process called the *formal model* is a structured representation of reality supported by the conceptual model. The correspondence between them is the most critical link in the problem-solving process. In its transition, the controllable and non-controllable variables must be identified, defining them in operational terms.

Based on the conceptual model for the service enterprise developed in (Alarcón-Bernal et al., 2019), in which the main components of a business model for service enterprises are identified (Figure 3), it is feasible to identify the different problems for which MSMEs in services fail at each level of decision and to suggest alternatives for their solution.

Based on the structure of the conceptual model for service companies developed by (Alarcón-Bernal et al., 2019), the next stage is to categorize the set of problems for which Mexican service companies fail at different decision-making levels, which have been integrated into five major problem groups: *sales, production and operation, control, planning, and management*.

Although the scheme presented here for the solution of problems is not the only way to study a solution process, this one allows us to identify the central ideas, which will provide the possibility to operate.

The matrix shown in Table 1 associates the various problems identified in MSMEs with service companies' decision levels. However, before making this association and according to (Churchman, 1971), concerning the vision of reality, it is important to establish that: “different observers can see different realities, and that the concept of reality itself contains value judgments and does not exist independently of the observer.”



Source: (Alarcón-Bernal et al., 2019).

Figure 3. Conceptual map of the service company and its decision levels.

Table 1. Problem assignment at decision levels.

Categories of the causes of failure	Type of problem	Decision-making level		
		Strategic	Tactical or Competitive	Operational or Information Generation
Problems selling	Reluctance to comply with customer preferences		✓	
	poor customer orientation and service		✓	
	bad location	✓		
	lack of focus on precise market segments or niches		✓	
	no formal marketing and sal			
	Thenot having systems in place to detect market opportunities	✓		
	reluctance to invest in advertising and promotional activities		✓	
	poor sales network training		✓	
	market shortsightedness		✓	
	ignorance of what is sold and to whom	✓		
	ignore the customer	✓		
	ignore the competition	✓		
ignorance of one's competitive advantages	✓			
Problems with production and operation	Lack of technical capacity to manage production and operations		✓	
	lack of knowledge of the sector in which we operate	✓		
	negligence and lack of interest in the business		✓	
	supply difficulties (raw materials and materials)		✓	
	high operating costs			✓
	shoplifting		✓	
	little previous experience with the products managed		✓	
	lack of adequate information systems			✓
	serious shortcomings in internal processes		✓	
	high levels of waste and misuse		✓	
	time mismanagement		✓	
	error in the calculation of the dead center or balance			✓
operate in a sector with a very high dead center or balance		✓		
ignorance of the life cycles of each activity			✓	
Problems to control	improper handling of credits and collections		✓	
	lack of knowledge of the company's real financial status			✓
	unnecessary expenses			✓
	serious security errors		✓	
	inventory mismanagement		✓	
	serious internal control failures			✓
	shortcomings in budgetary and management control			✓

Continued

	poor debt and liquidity management	✓	
	mismanagement of funds		✓
	Serious shortcomings in the establishment of the strategies	✓	
	no alternative plans	✓	
Problems in planning	set unrealistic goals and expectations	✓	
	lack of a business plan	✓	
	inadequate planning	✓	
	unplanned growth	✓	
	lack of foresight	✓	
	lack of pre-investment studies	✓	
		Inability to surround yourself with competent personnel	✓
	inexperience		✓
	overinvestment in fixed assets	✓	
	shortcomings in personnel policies	✓	
	lack of continuous improvement policies	✓	
	lack of training of the company's top manager	✓	
	inadequate systems for decision making and problem-solving		✓
	unprofessional management	✓	
	resistance to change	✓	
	reluctance to consult outsiders	✓	
	take a lot of personal spending money out of the business		✓
Problems in management	poor partner selection	✓	
	not knowing oneself	✓	
	get sucked into the nice part of the business	✓	
	have negative attitudes towards employees	✓	
	nepotism	✓	
	risk mismanagement	✓	
	failure to comply with tax and labor obligations		✓
	lack of entrepreneurial leadership	✓	
	unclear definition of objectives		✓
	discouragement at the first major obstacles		✓
	poor business culture		✓
	lack of experience in the administrative part of the business	✓	

Source. Own elaboration.

From this analysis and classification, it can be seen that among the main problems identified, it can be considered that 27% are strategic, 54% are of a tactical or competitive nature, and 19% are of an operational or decision-making information nature. These percentages may differ depending on the observer, but we can say that problems will always be associated with each of the three levels

of decision-making regardless of this.

With this classification matrix, we have developed a formal model through which problems can be identified as part of the strategic, tactical, or functional decision level and by either measurement or operational level, to clarify what is to be studied, solved, and measured. With this modeling process, a better determination of the areas of interest is achieved and the definition of the relevant problems that cause MSMEs' failure and the verification of their correspondence with reality to avoid being out of the practical level.

5. Solution Approach: Mathematical Models and Lean Techniques for Solving Problems at Different Decision Levels

According to (Mitroff, 1977) with the solution approach, one can derive (deduce) significant conclusions from some important model, trying to determine the consequences of choosing different courses of action to support decision-making and integrate the strategies of change.

Consequently, the solution attempts to give a single explanation of the phenomenon congruent with the ideas that the conceptual model has of the problem. It can be seen as the output of the formal solution process (Figure 2) and constitutes the basis of the recommendations that our research work can provide to the decision-maker.

Considering the *formal solution* process used here as a methodology to implement a conceptual model to classify the variables that cause the failure of MSMEs in groups of problems, as well as the formulation and location of these problems in each of the decision levels, what is left is to generate the output (solution of the problem) to indicate the different mathematical models and lean tools that are useful for the solution of the problems in each decision level.

This output from the formal solution process proposed is the main outcome of our research and is the basis for the recommendations and advice it provides to decision-makers.

The scheme or assignment model presented in Table 2 establishes the mathematical models and lean tools that we have considered useful for providing solutions to the problems posed at the different decision-making levels.

This article does not develop the mathematical models and lean tools mentioned because it would be out of its scope and extension. We only present their generic names. We have left the development of these tools for more detailed work, which is already in progress. Likewise, we do not consider this approach to be exhaustive, much less unique, "since the interpretation of reality can be different depending on the observer" (Churchman, 1971).

Mathematical Models and Lean Techniques by Decision Level for Problem-Solving

The following is a more detailed description of our proposed model (Table 2) to clarify its content and identify the proposed mathematical models and lean

Table 2. Mathematical models, lean techniques, and heuristic methodologies by decision level.

Directive Strategy	Competitive or Tactics Strategy				Operational or Measurement Strategy (information for decision making)
	Not Visible Facilities	Visible Facilities or Servicescape			
		Installations	Service Encounter and Customer Relationships	Personal	
Mission	Inventory Management and Policy	Distribution of goods on shelves or racks	Personal contact, self-service, or automated	Selection	Price estimation
Vision	Area allocation	Area allocation		Development, incentives, and benefits	Productivity analysis
Opportunities and threats	Waiting for management	Waiting for management		Training	Evaluation of efficiency
Strengths and weaknesses	Process flow and design	Process flow and design			Process flow and design
Growth and diversification	Waste identification and disposal	Waste identification and disposal			Waste identification and disposal
Supplier development	Quality and price improvement	Quality and price improvement			Quality improvement and control charts
Market analysis	Capacity and demand management	Capacity and demand management			Analysis and estimation of the demand
Advantage competitive	Adaptation of space and equipment to improve performance	Adaptation of space and equipment to improve performance			Maturity assessment
Value proposal	Time determination for basic activities	Time determination for basic activities			Analysis of income and expenditure
The geographical location of the business	Identification and management of restrictions	Identification and management of restrictions			Performance indicators
Communication channels	Communication channels	Communication channels			Communication channels
Technology and equipment	Technology and equipment	Technology and equipment			Technology and equipment
Performance indicators	Performance indicators	Performance indicators			Performance indicators
Business plan	Route design	Vehicle programming			Performance indicators
	Route design	Routing and collection			Performance indicators

Source. Own elaboration.

techniques for solving problems at each decision-making level.

Management strategy.

It indicates the issues that a service company must consider to find a way to compete, establish its course of action, take advantage of opportunities, and deal with threats. From this perspective, service MSMEs must have a mission and vision to determine the purpose or reason for the business and what it aspires to. Make clear and explicit what is wanted, what is expected, and what is possible to do.

A second aspect is the need to know how to anticipate and respond to future challenges. In a dynamic context, organizations' success or failure is conditioned, to a high degree, by the ability to take advantage of opportunities or face threats. Therefore we need both an internal analysis to assess the response capacity and determine the strengths and weaknesses to respond to such changes. External analysis to understand the changes that are expected and how they may affect the organization, are essential actions to raise the response strategies and take advantage of opportunities or avoid threats.

A third point is a market formed by a set of actual and potential buyers of a service. The business's success depends significantly on the knowledge of the market, which is why it is often described as the main source of opportunities. Knowledge in this field is intended to provide a broad view of the services offered, buyers' main groups, and marketing ways.

Another aspect corresponds to value proposal, which could be the directive strategy axis and is given by the characteristics of the service that is put on the market. It is the factor that makes a customer choose one company or another; its purpose is to solve a problem or satisfy a customer need, and it constitutes a series of advantages that a company offers to customers.

The model proposed to establish a strategy to generate value in the service from the customer's point of view is the one proposed by (Zeithaml, 1988). This model considers as components of the perceived value: quality, intrinsic attributes, extrinsic attributes, monetary price, and non-monetary price:

Quality. Defined as "customer satisfaction." The importance of quality in the customer's perception, and the customer is the final judgment must be emphasized. It is clear that if the customer's perception of the service's quality matches or exceeds his/her expectations, he will be satisfied, and then the value will be created by the customer. Consequently, the higher the perceived quality, the higher the perceived value of the service. It is important to know the customers' opinions.

Essential attributes. These are the client's benefits and can be considered in two groups: *those of the main service and complementary services.* The main service is the minimum that a client expects to receive when acquiring the service. Complementary services are also provided and that for certain services are necessary to deliver the main attributes. Companies that fail to deliver the essential attributes of the service will survive for a short time, so delivering the service with the basic attributes without failure and as expected by the customer is the fundamental stage in creating value. However, this is not enough to be competitive.

Complementary attributes. These types of attributes are related to the service but are located outside the service package. They are all those psychological benefits associated with the service. In effect, a service business does not have direct control or immediate influence over certain attributes, but others can shape them and create value for its customers in the short and long term. Service businesses can create more value for their customers by increasing the variety of

complementary services appreciated by their customers and delivering them as well as the customer expects.

Price. These are the expenses incurred by a customer to obtain a service and include the purchase price and the expenses that a customer must make to access the site where they purchase the service. Price is, in general, the key factor in purchasing decisions. Consequently, a service company can create significant value for its customers if it can lower prices without deterioration of its other attributes.

Time. Time plays an important role in creating value in the service. It is everything that the customer must do to access and receive the service, which implies time.

A fifth aspect to consider in the management strategy is the geographical or virtual location of the business. One of the most important decisions for a company is selecting the site where it will develop its operations, which has effects on time, cost, demand, and profitability. The selection of the location for a service business depends on several factors and the comparison between benefits and costs. However, there are many dominant elements: customers or market segment, cost, competition, support systems, environmental or geographic factors, security, communication systems, and transportation.

The sixth aspect is the possibility of analyzing feasibility of growth and diversification in portfolio or group of services, in which of these to invest and not to do so. An alternative used to analyze the various services and decision-making performance is to compare them based on their relative growth rate and market share and categorize them in a BCG matrix (Henderson, 2012). This analysis helps to decide which entities in your portfolio are profitable, which are not, which you should focus on and which give you a competitive advantage over others.

Finally, the service company must have a business plan written in a clear, precise, and simple way due to a planning process or the motivation to participate in the service business. Because this describes the basis on which a company creates, provides, and captures value.

Tactical or competitive strategy

The external effectiveness or strategic strength is given by the degree of what is done and corresponds to requirements or opportunities offered by the environment in which business operates. In contrast, the internal effectiveness or tactical or competitive strength is related to the ability to do well what the business proposes. Often some importance is attached to one form of effectiveness or another.

Both positions make no sense isolated since success requires both clear strategies and effective tactics. Good business performance not only depends on these two elements, but it must be supported by an appropriate structure and reinforced by commensurate leadership, skills, and attitudes.

While a business must have a clear tactical or competitive strategy for its per-

formance, in the case of service companies, this level of decision making includes the non-visible or backside as support to the service, the visible or front side formed by the personnel that attends the service, the visible part of the facilities or servicescape, the processes, the values and the so-called *moment of truth*. Therefore, its structure, strength, integration, communication, and capacity, constituted as a delivery system, are fundamental to the business's success.

Service delivery system

The objective of the service design is to determine the benefits to be offered to the client. The delivery system's design aims to determine where, when, and how these benefits are provided. A service delivery system consists of: physical equipment and facilities, personnel, processes, and information.

The service delivery system can be considered in two parts: the front room and the back room. The front room is part of the delivery system that is visible to the customer. Here is where the customer interacts with the service providers and comes into contact with the facilities and processes, and is where the so-called "moment of truth" is primarily considered to take place.

The backroom is usually invisible to the customer and consists of all the personnel, facilities, equipment, and processes that support the frontline personnel and processes. An imaginary *line of sight* separates the two parts of the delivery system. What happens below this line usually does not concern the customer. However, failures in the back room can seriously affect front end activities and customer satisfaction. Consequently, this dependency between the front and back of the business must be kept in mind when designing the service delivery system.

For most services, processes in the backroom are very similar to manufacturing operations. The priority for operations in the back room is that they must be designed to make the front room work smoothly. Once this has been established, operations management techniques can be used to optimize activities and operations. In this context, mathematical models are useful for analyzing and optimizing: inventories, waiting for lines, area distribution, capacity, demand, times and movements, and processes. There are lean and quality tools to eliminate waste, avoid errors, improve performance, identify constraints, and establish communication channels and performance indicators.

Supply and demand management

For service businesses, balancing demand and capacity management is difficult because of the perishable nature of services. However, this balance is very important for reasons of cost and customer satisfaction. According to (Mudie & Cottam, 2010) how service businesses deal with this problem depends on fluctuations in demand and the degree of supply constraints.

As in most organizations, it can be difficult to match supply and demand in service companies, and it is not an issue they should ignore. If demand is far below capacity, costs are added to each sales unit, and your profitability will be eroded, and the service may even become non-competitive. On the contrary, if

demand exceeds capacity, the service suffers changes that detract from its quality and customer satisfaction (Mudie & Cottam, 2010).

To have appropriate strategies to balance demand and supply, an organization needs to know and understand its capacity constraints and demand patterns. Therefore, knowing and using tools for the analysis and behavior of the demand and alternatives for managing it are competitive tactics for management and fundamental for the company's survival. Two other issues that also affect service demand and supply are service pricing and performance management. Therefore, using equipment and technology, having performance indicators, and quality linked to price are basic considerations for having a competitive advantage.

Personal

For (Mudie & Cottam, 2010), the frontline employees who provide the service are of key importance to the customers they serve and to the business they represent. Their ability and willingness to satisfy, their attitude and appearance, play a role in determining how satisfied the customer will be with the service encounter. Those who deliver the service can be the success or failure of the business.

Although the main participants in the service meeting are the frontline client and the server, other groups can influence such meetings to varying degrees: management, co-workers, and other workers. Each of these participants is more or less important in the service meeting's various phases, but their actions must be well coordinated to ensure customer satisfaction. Consequently, the selection, training, and development of all staff, regardless of the degree of their involvement, must be a basic part of the competitive strategy, including those in the back office.

Visible Facilities or Servicescape

According to (Bitner, 1992), although not a participant, the general environment also has a strong influence on personal interactions at service meetings. Service escape refers to the man-made physical environment (as opposed to the natural or social environment) that affects customers' perceptions of the service and can lead to their satisfaction or their withdrawal from it. Its dimensions are generally described as the environmental conditions, spatial arrangement, functionality, and the signs/symbols and equipment present, which affect the customer's perception of the quality of the service and the company, which can lead to their satisfaction. (Collett, 2009) suggests that servicescape has particular relevance in the service industry due to the intangible nature and relatively short-term services. Consequently, models for the area allocation and the adaptation of space and equipment to improve performance and the distribution of merchandise on shelves, are highly recommended for the service company and its management. Not to mention painting, lighting, comfort, music, etc.

Service Encounter or moments of truth

An encounter with service is also known as a *moment of truth*. The moment of truth is defined as any episode in which the client comes into contact with any aspect of the organization and gets an idea of the quality of its service (Normann,

1991). The term was introduced in service management literature to dramatize the importance of a customer's encounter with a service company.

It should be emphasized that an encounter with the service can occur at any time and in any place. When a customer is not treated well by an employee, he does not think that he has come into contact with a rude person working for the company, but he is dealing with a rude company. Most customers equate service failures or quality problems with the organization responsible for the service.

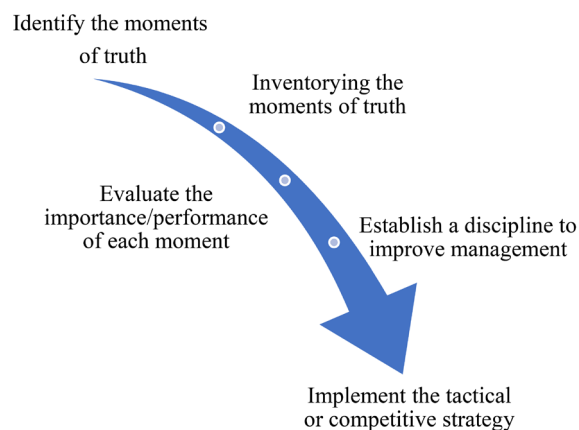
Consequently, the quality of these service meetings is often determined by frontline staff's actions, whose experience and commitment may be limited and whose attitudes may vary from meeting to meeting.

Recognize the moments of truth and establish actions to improve their management.

Most clients do not think about the service or the organization outside the meetings, and when they do, it is for a limited time. Consequently, a service company has short opportunities to make a good impression on the customer. The organization cannot leave these service meetings to chance to keep its customers satisfied and keep them coming back. These meetings must be carefully designed and managed.

Of course, these events need to be understood long before they are designed and managed, and it is critical that the service business successfully manages its meetings, particularly those in the front or front row, as customer satisfaction is at stake in the short term and the company's perceived reputation in the long term. Therefore, the continued success of service meetings will determine the survival of the organization.

For a service business, managing the moments of truth may provide a review of service quality and the definition of a strategy or tactic to improve it. In the model of the five steps towards service excellence (Cina, 1990), a structured and systematic process of management actions that focus on moments of truth is proposed. We have adapted this process to give it the sense required in our research, as shown in Figure 4.



Source. Own elaboration, adapted from (Cina, 1990).

Figure 4. Models of the five steps to improve service.

For an organization, knowing the moments of truth and evaluating their importance confirm the first stage they must develop for decision making to improve the delivery and quality of service.

Analysis of service encounter

According to (Bitran & Lojo, 1993) service meetings have been described as a set of stages and elements. The delivery of any type of service, in general, has the following stages: *contact, entry, analysis, service delivery, exit, and follow-up*. There are certain requirements and expectations from the clients in each of these stages, so different skills and tools are demanded from the managers and employees, or specialized business infrastructure. As for the basic elements that occur in each of the six stages proposed in (Bitran & Lojo, 1993), the following are established: *waiting time, personal interactions, and expectations and perceptions*. It should be noted that the sequential analysis of these stages and the elements for their intervention should be a basic part of the company's competitive strategy.

The use of mathematical models, lean tools, methodologies for the analysis and administration of waiting times, identification and management of restrictions, identification and elimination of waste, error-proof actions, among others; deserve special attention by managers as part of their competitive strategy, since these basic elements are closely linked to quality.

Measurement or operational strategy (information for decision making)

Most organizations have performance measures to monitor, analyze, and evaluate their efficiency and progress over different periods. These measures can be used to determine the expected results and help the organization understand its processes, ensure that its decisions are based on facts, and check whether the planned improvements materialize.

The measurement or use of performance indicators within an organization should be seen simply as tools for more effective management and not as an end in itself. It should also be recognized that measurements do not tell why things happened or what to do about them since the results only indicate what happened. (Johnston & Clark, 2008) that an organization is effective, to the extent that it can transition from measurement to management, and there is a connection to management strategy since measurement affects what people do. (Johnston & Clark, 2008) identify that there are four main reasons for measurement: *communication, motivation, control, and improvement*.

On the other hand, according to (Watts et al., 2009), the model for measuring performance called Comprehensive Performance Management System (CPMS) can be modified to be used in small service companies (micro, small and medium) to have a basis for monitoring and growth, control and improvement, communication and motivation of organizations; based on the complexity and sophistication of a formal measurement system. With the modified model, only the three primary dimensions that many researchers point out as key to the survival and growth of a small business are considered (Preda & Watts, 2004),

(Orser et al., 2000) and (Meredith, 1988). These three dimensions extend to a set of measures or indicators that allow the entrepreneur to plan and control the operational process that connects the small business with the client. The scheme developed for small businesses is a pyramid-shaped model of control that can be adapted to any organization and shown in **Figure 5** Small Business Performance Pyramid.

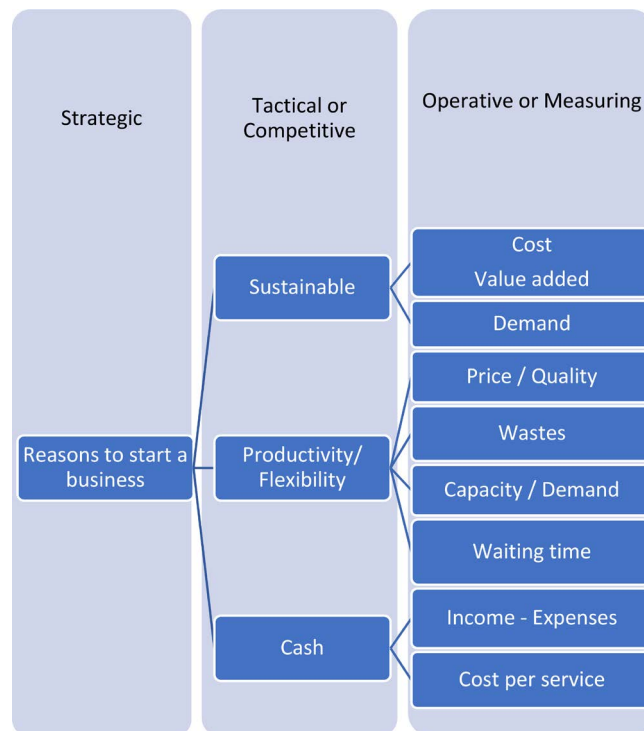
While these three dimensions at the tactical level are critical to all organizations, the Key Performance Indicators (KPIs) proposed for small businesses also consider meeting the client's needs, as the client is close to the operational process. Furthermore, remember that in small businesses, customer value is always created from the bottom up.

6. Limitations

As we have said before in this article, we do not intend to develop the mathematical models, lean tools, and heuristic procedures that are enunciated due to the scope and extension of our work, so we leave the development of these tools, models, and methodologies for a more detailed work, which is already underway. Moreover, as it is established in (Churchman, 1971), "the interpretation of reality can be different according to the observer who carries it out."

7. Conclusion and Extensions

To move from the abstract to the concrete, it is essential to apply the theories at



Source: Own elaboration, adapted from (Hudson et al., 2001).

Figure 5. Small business performance pyramid.

a practical level and make them operational, so we use the systems approach, through a general theoretical-methodological perspective called the Diamond Model, to address the objective of this research logically and coherently.

The formal solution process of the Diamond Model was used as a methodological framework in this research to analyze the information generated by different authors, to conceptualize it in a problem structure (conceptual model), and to develop a higher level of abstraction.

The conceptual model developed defines the variables by which MSMEs fail in Mexico, in groups of problems, establishing them in: problems to sell, problems to produce and operate, problems to control, problems in planning, and management problems.

Through the modeling, following the formal solution process of the Diamond Model, an association matrix (formal model) was built, in which the 67 problems identified in the conceptual model are related, integrating them to the different strategic levels of a decision of a company: managerial, tactical and measurement. As a result, 27% of the problems are strategic, 54% are of a tactical or competitive nature, and 19% are operational or information nature. These percentages may differ depending on the observer who analyzes them.

For the solution of the formal model, a model or scheme was developed through which mathematical tools and lean techniques are assigned to each of the strategic decision-making levels (managerial, tactical, and information), which will make it possible to provide solutions to the problems established at these decision-making levels in the formal model. This solution scheme can be considered compatible with the nature and needs of MSMEs and a support and guidance tool for managers, operators, and employees of service companies, allowing them to have alternatives for solving problems associated with the different decision-making levels.

The solution model obtained consists of indicating, from each level of decision (managerial, tactical or competitive and operational or measurement), the type of mathematical model and/or lean tool used to improve the business. Therefore, this model can help guide the need that entrepreneurs, managers, operators, and employees of MSMEs have for training in key aspects of the management of their companies. This situation cannot be overlooked, given the employment figures, the number of companies, and gross production generated by service companies in Mexico.

As extensions, we consider that it is required: to develop each one of these tools, models, and methodologies in a detailed way and establish spreadsheets in some spreadsheet, to facilitate their use, as well as to test and compare the operation of our proposal with other models.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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