

CHALLENGES AND IMPORTANCE OF HUMAN BEINGS WITHIN THE LAST PLANNER SYSTEM IN COLOMBIA: A CASE STUDY

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ABSTRACT

The Last Planner® System (LPS) is a system that optimizes the workflow through the measurement of the reliability of commitments made by workers on a construction site. This system has achieved various benefits in the control of production in construction projects, such as minimizing execution times, reducing variability and uncertainty. However, when applied, obstacles have arisen, which leads to a revision of the methodology and/or partial implementations. In 2021, an update of the system was made in order to expand the scope of the system and respond to doubts and concerns. Therefore, this article seeks to identify the main challenges and give a proposal to solve them from the implementation and use perspective, according to the Colombian context through the identification of the possible causes of these difficulties found during the literature review and interviews to construction professionals. In the investigation, it was found different challenges consisting of 13 main obstacles in terms of the implementation and use perspective (divided by user type), and 8 needs which can be solved with the LPS update and other proposed solutions that holds the organization transformation (human perspective) and a detailed explanation of the whole process (practical perspective).

KEYWORDS

Last Planner® System, Culture, People, Implementation, Case study.

INTRODUCTION

Last Planner® System (LPS) was developed as a system to control the production of construction projects and overcome the variability and uncertainty that leads to cost overruns, higher execution times and disarticulation between project actors (Botero & Álvarez Villa, 2005; Durdyev & Hosseini, 2020; Viles et al., 2020). Although LPS defines a series of principles, indicators, and process to manage and use the system, a series of obstacles and challenges have arisen. These problems do not allow people to know the system correctly and do not implement some specific elements required of each project. 7advantage of it and to improve the quality of production on a construction site (Ballard & Tommelein, 2021). Consequently, in 2021, an update was developed with the aim of resolving the obstacles and difficulties presented and to adapt LPS to the actual environment.

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The Colombian industry, like many other construction industries, has faced cost and time overruns, delays, or variability. These problems have been improved by the implementation of technology, new methodologies, in process and, in some companies, by the implementation and use of the Last Planner System, and as other companies around the world, the Colombian industry has faced obstacles and challenges with the system.

Nevertheless, some guides have been developed which explain each step of the system as well as the indicators and planning around the world (Ballard et al., 2007; Daniel & Pasquire, 2017; Davidson, 2015; Ebbs & Pasquire, 2019), in Colombia there are not many guides. And, considering the world guides and others, no one has evaluated the new approach of LPS, which can be called Last Planner System 2.0. Therefore, this case study makes a complement to what is proposed (propose solutions to the challenges) considering all the factors from the social transformation and preparation a company may go through to adopt the system, the details of every process and the new elements of the system.

LITERATURE REVIEW

Research on LPS shows evidence of other studies that have found problems which are specific to certain contexts, such as the study of “Last Planner System: Experiences from pilot implementation in the middle east” (Alsehaimi et al., 2009), “Collaborative implementation of Lean planning systems in Chilean construction projects” (Alarcón et al., 2002) or “A survey on the Last Planner System: impacts and difficulties for implementation in Brazilian companies” (Viana et al., 2010), and others have found problems that are persistent in various places, but there are not many studies that identify the problems in the Colombian industry and they do not explain if the Colombian industry also faced the same problems or if it has new ones that can enhance the perspective of the system and bring new ideas and solutions to other contexts.

On the literature review, 41 articles were revised including guides, implementations, metrics, key factors, and case studies were found. Based on this, the main obstacles of both perspectives (implementation and use). These obstacles were grouped according to their description and meaning, so in the end fourteen challenges were identified and selected (See table 1).

Table 1. Obstacles found in the literature review about LPS implementation and use.

Challenge	Papers	No. Times
Lack of training (Social Skills and knowledge)	(Hamzeh, 2011); (Alarcón et al., 2002) Fernando solis et al (2013); (Fernandez-Solis et al., 2013) (Dave et al., 2015; Mejía-Plata et al., 2016; Porwal, 2010; Porwal et al., 2010; Viana et al., 2010)	9
Resistance to change	(Alarcón et al., 2002; Alsehaimi et al., 2009; Dave et al., 2015; Fernández-Solís et al., 2018; Mejía-Plata et al., 2016; Porwal, 2010; Porwal et al., 2010)	8
Partial Implementation	(Dave et al., 2015; Fernández-Solís et al., 2018; Fernandez-Solis et al., 2013; Mejía-Plata et al., 2016; Perez & Ghosh, 2018; Porwal et al., 2010)	6
Lack of support and leadership	(Alarcón et al., 2002; Fernández-Solís et al., 2018; Fernandez-Solis et al., 2013; Mejía-Plata et al., 2016; Perez & Ghosh, 2018; Porwal et al., 2010)	6

Time of execution	(Alarcón et al., 2002; Brady et al., 2011; Dave et al., 2015; Fernández-Solís et al., 2018; Porwal et al., 2010; Viana et al., 2010)	6
Compromise	(Brady et al., 2011; Dave et al., 2015; Fernández-Solís et al., 2018; Fernandez-Solis et al., 2013; Porwal et al., 2010; Viana et al., 2010)	6
Information	(Brady et al., 2011; Dave et al., 2015; Fernandez-Solis et al., 2013; Perez & Ghosh, 2018; Viana et al., 2010)	5
Role definition	(Brady et al., 2011; Dave et al., 2015; Fernández-Solís et al., 2018; Fernandez-Solis et al., 2013; Porwal et al., 2010)	5
Visualization	(Alarcón et al., 2002; Dave et al., 2015; Fernandez-Solis et al., 2013; Porwal, 2010)	4
Strategy	(Alarcón et al., 2002; Dave et al., 2015; Fernández-Solís et al., 2018)	4
PPC Misinterpretation	(Alarcón et al., 2002; Fernández-Solís et al., 2018; Perez & Ghosh, 2018)	3
Contract	(Fernández-Solís et al., 2018; Fernandez-Solis et al., 2013; Porwal et al., 2010)	3
Standardization and guides	(Brady et al., 2011; Dave et al., 2015; Perez & Ghosh, 2018)	3
Lack of experience	(Fernández-Solís et al., 2018)	1

RESEARCH METHOD

To proceed with the investigation, the case study method developed by Robert Yin (Yin, 2017) were used in two Colombian construction companies that use LPS. The steps were:

1. Find the obstacles and barriers.
 - a. Review the obstacles and barriers from the literature.
 - b. Identify the obstacles and barriers in Colombian construction companies through interviews to construction professionals.
2. Relate and find solutions to the main challenges
 - a. Compare and integrate the barriers to find the main challenges.
 - b. Seek solutions and improvements on the update of LPS.
 - c. Literature review to find solutions not covered on the update.
3. Conclusions
 - a. Conclusions on the update of LPS.
 - b. Presentation of the solutions.

The first step was the revision of the bibliography between 2010 and 2021, specifically on subjects related to implementation of LPS, adoption's obstacles, critical success factors and uses found in: IGLC conference papers; LCI Congress; Journals such as ASCE Library; Engineering, construction and architectural management; Journal of Construction Engineering and Management; and others like Harvard Business Review; Lean Project Delivery and Integrated Practices in Modern Construction Book; The Lean Builder and Lean construction; investigation center such as (P2SL) Project Production Systems Laboratory.

The second step involved guided interviews to professionals of the Colombian industry such as general contractors, construction managers, Senior project managers and

Project administrators from construction companies that built high-rise residential projects and that had implemented LPS in their projects. In these interviews, it was inquired about knowledge, perception, and experiences with LPS, from the implementation and use perspective.

For the identification of solutions, a review of the bibliography with emphasis on case studies was done. Additionally, it was analysed the Benchmark developed in 2020 by Glenn Ballard and Iris Tommelein and published by P2SL, to define the new proposals and solutions they presented. From the next figure (See figure 1), the grey squares are the first stage, which is the collection of information; the blue squares are the integration with the update of the Last Planner System; the orange squares are the conclusions.

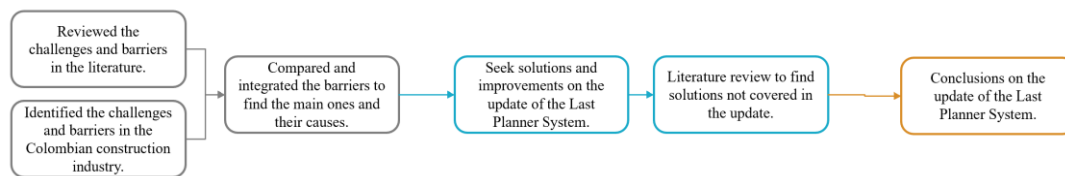


Figure 1. Research process method.

RESULTS

The results were identified and reviewed the challenges on the literature and in the interviews in order to find the main obstacles in the implementation and use of LPS and present the main obstacles and needs found in the Colombian construction industry.

REVIEW OF THE OBSTACLES IDENTIFIED

As mentioned above, a review of different documents was carried out to find the obstacles that the industry has faced. This information was related to the obstacles found in the guided interviews to find the most significant challenges of the Colombian industry. In total, 41 obstacles were found in the two stages; 20 in the implementation stage and 21 on the use stage (See Figure 2).

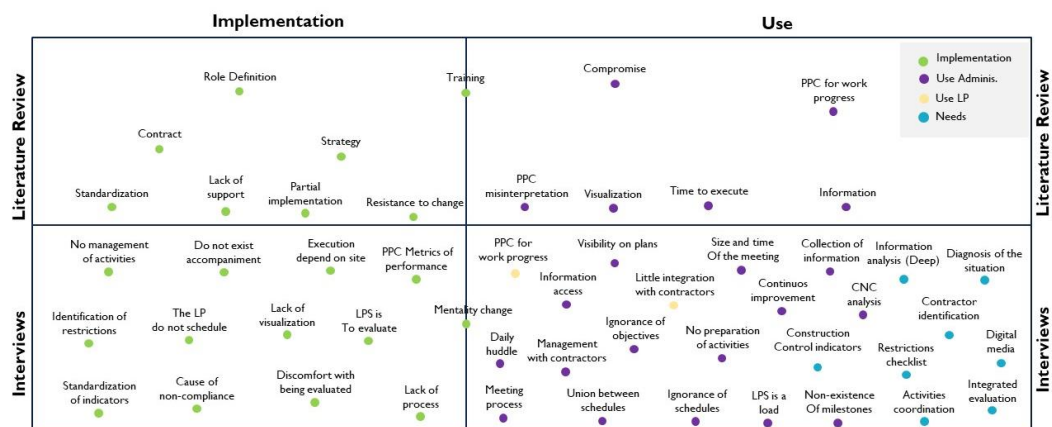


Figure 2. The 41 challenges found on the literature review and Literature review.

Nevertheless, when we began to analyse the obstacles, it was detected that some of them were similar or were a consequence of another, so it was decided to relate and combine them to find the main challenges. For example, the obstacles “lack of support” (from the Bibliographic review) and “do not exist accompaniment” (from the interviews) mean the same. At the end, thirteen challenges were selected. The Figure 2 shows the

source of information of each obstacle and the stage of the Last Planner System it belongs. So, the stage of LPS (Implementation and use) is on the X-axis and the source of the information (Bibliographic and interviews) is on the Y-axis.

Another significant finding which was possible due to the interviews, was not only to determine the Colombian obstacles, but also to determine the obstacles experienced by each user of LPS; Also, during the interviews, the needs of the industry were found, which it will be explain below.

Obstacles identified by user type in LPS

The first findings of the interviews were the obstacles faced by each type of person in LPS. First, there are obstacles faced by the people who implement the system in an organization, then the obstacles faced by the people who execute the system in the construction projects, and finally, the obstacles faced by last planners. In the beginning sixteen obstacles were found, but when combined them, the case study ended up with thirteen (See Table 2).

Industry needs

The other interesting finding of the interviews were the factors that the administrative staff and construction contractors (Last Planners) require and consider appropriate for a better application, use and usefulness of the system. This information could help to overcome some challenges in use and be the key factors in the adoption (See Table 3).

MAIN OBSTACLES AND NEEDS

In the development of LPS it was found two moments in which challenges could appear. The challenges associated with the implementation of the system, which are challenges related to the administrative, strategic and management part at an organizational level; and the challenges of use that are associated with the use of the system on the construction site, which means at an operational level. Despite both challenges being different, it is important to consider that some challenges encountered during the use phase are due to gaps in the implementation phase. Therefore, to overcome them it is important to create a work plan that establishes the goal and objectives of the implementation, the phases, processes, methodology and steps to follow to know and establish LPS in an organization.

Moreover, it is important to understand the human context in which LPS is going to be implemented. When implementing LPS, work must be done to train the team with skills that allow them to overcome the change in the way they work, to coordinate with the other actors and to understand how the social network within the team is, in order to identify possible leaders in the process. At the same time, work needs to be done with the administrative staff to manage conversations, in which through negotiations agreements are reached. On the other hand, it must be understood that this process is iterative and that it depends on the collection of data to propose improvement plans.

So, the main challenges in implementation and use by user type in LPS are:

Table 2. Final challenges identified by user in LPS on each stage of the Last Planner System after literature review and interviews.

Stage	Challenges
Implementation	Partial implementation, Strategy, Lack of support, Culture, Contract
Use - administrative	Training, Visualization, Information, PPC Misinterpretation, Standardization, Self-management

Use – Last Planner

Training, Teamwork

Moreover, the needs found in the Colombian industry are presented below. It is important to point out that the needs are those elements that the users expect of the LPS system. These are also divided by needs of administrative staff and needs of Last Planners.

Table 3. Second finding of the interviews, the needs identified by user in LPS.

Staff	Needs
Administrative	Construction control indicators, Detailed checklist of restrictions, Deep information analysis, Contractor identification, Digital media
Last Planners	Integrated evaluation, Coordination of activities, Diagnosis of situation

A total of thirteen challenges and eight needs were found, for a total of 21 elements to find solutions.

DISCUSSION

Based on the challenges found, the next step was related them to the Last Planner System 2.0 to find which one it covers and propose solutions to the challenges that were not covered or developed in the LPS 2.0.

RELATIONSHIP WITH LPS 2.0

LPS 2.0 through its five research points (The five base papers for the benchmark 2021) broadened its scope, deepened the relationship between schedules and solved some obstacles presented by users (Ballard & Tommelein, 2021). However, the update only managed to present solutions to six and a half of the challenges out of the thirteen found.

When analysing the challenges solved, they are challenges that address the proper use of the system, that is, its operation. However, challenges associated with the intangible part such as the human and social organization part (culture, diagnosis of the environment, teamwork, etc) have not been addressed yet since this new update. These challenges, which are not an explicit part of the operation of the system, prepare the organization and people to address the change and the new working method.

For all the above, it was considered pertinent to emphasize that LPS is a system that proposes production control in the construction industry, through three plannings (Ballard & Tommelein, 2021) that modify the way people usually work. Now, when any tool (in this case system) intrinsically seeks to modify the way people work, what it is doing is modifying the organizational culture. For this reason, it is necessary to understand that culture is not only who we are or how we behave, but culture considers all the patterns of experiences that people develop over time as they face and overcome obstacles and difficulties day by day (Christensen & Shu, 1999; Tushman & O'reilly, 2002). For this reason, although LPS is a system that helps us control production, it also involves modifying the organizational culture of the organization where it is implemented.

Therefore, although the found solutions in the update, these solutions are mostly related to the practical part of the system (its use), for example, new metrics, how to visualize the information or how to standardize it, but they are not totally focused on preparing people and teams to work under this new way of doing things, such as how to develop a strategy and objectives or how to coordinate teams to work towards a common goal. These can be seen on the figure 3, on the right side the challenges that LPS 2.0

addressed and proposed solutions; on the left side, challenges that are still not resolved on the update.

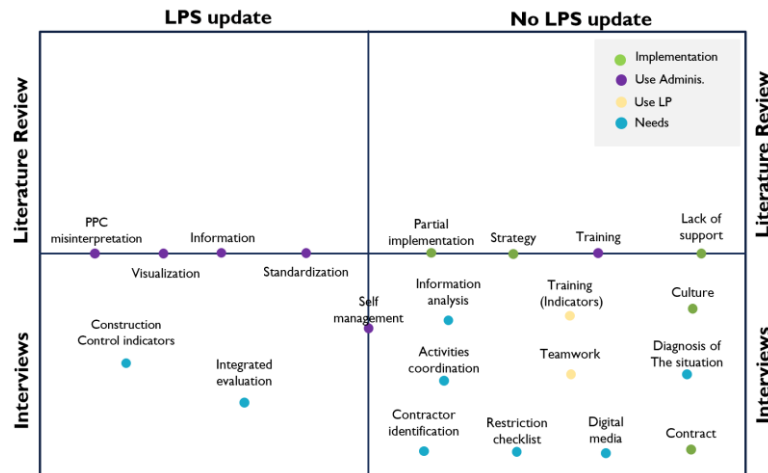


Figure 3. Figure about which challenges (by user type) are addressed in the LPS 2.0 version and which ones are not.

PROPOSED SOLUTIONS

The solutions to the challenges which were not developed in the LPS 2.0 version, cover the human and social part of the system. These are solutions that invite to know and prepare the organizational environment, and from this finding the best strategy to implement and use LPS.

Implementation challenges

1. **Partial implementation:** The partial implementation is the adoption of certain elements of the Last Planner® System. However, LPS must be understood as a holistic system, in which, if one of its parts is missing or is overlooked, the process has a high probability of failing. For this reason, the propose is to emphasize the least implemented elements of LPS, create a leadership team(Ibarra & Lee Hunter, 2007), standardize guidelines and formats, and for the implementation to be gradual.
2. **Strategy:** This challenge refers to the lack of planning and creation of a plan for the implementation and execution of the system. So, the solution is to create an action plan based on the desired objectives developed by the organization, which is the reason why the company wants and needs to implement this methodology. Once the objective is set, it must be communicated it to all the members of the organization and to the last planners.
3. **Culture:** This challenge refers to the resistance of change or predisposition to the adoption of the system by people, for which it is proposed to do a diagnosis of the current situation of the organization, in which it can be identified how the processes occur, who the people that communicate the most are, what the behaviour of the staff is like and also to know the organizational network. With this information, a work plan is created according to the organizational culture (Christensen & Shu, 1999; Tushman & O'reilly, 2002).
4. **Lack of support:** The challenge refers to the lack of accompaniment by the organization towards the people who are implementing and using the system. Hence, it is proposed that in order to get the team to adopt this new methodology

it is necessary to train them with theoretical and social skills. In addition, it is important to make them participate in the achievement of the organization's objective, creating a supportive and safe work environment in which people can express themselves and share their concerns, doubts, and observations (Wilkinson et al., 2020)

5. Contract: Due to the traditional form of executing the construction projects, each participant thinks first about how they can carry out their own activities and then, how to collaborate and work with the other coworkers, so instead of the project being a work composed by several parts, it becomes a project made up by different parts that are uncoordinated, leading to delays, failures in the executions and reprocesses (Porwal, 2010). Therefore, it is proposed to include within the employment contracts, a clause related to the use of LPS by each last planner, in which the rights and duties that they have are specified.

Administrative challenges

6. Training: This challenge refers to the lack of training received by the team to use the system and see its benefits. Lack of training that is not only theoretical but also human, therefore, its solution is to approach the training of the work team from two perspectives. The first from the theoretical perspective, which begins from understanding the Lean principles, through LPS, until knowing what indicators use, and the second perspective is from the human and social side to be prepared for change and new challenges.
7. Self-management: it refers to the ability of the team to self-know its activities and schedule them. Therefore, what is sought is to develop skills that allow the last planners to identify their future activities, possible inconveniences and create commitments. For this, it is proposed to have parallel meetings with each contractor, in which the administrative staff teaches how to visualize future activities, the flow of these is evaluated and restrictions are identified. The duration of this accompaniment will depend on the adaptability of the contractor.

Last Planners' challenges

8. Teamwork: Teamwork has two sources, the first is the teamwork of the administrative group, and the second is the teamwork by the contractors. As for the first team, this is addressed by working on the transformation of the processes and the way of executing the activities, from a cultural perspective. For the second team, networks of trust and communication must be identified and created to allow integration and cooperation between them; in this way, the point of view of the last planners changes from being a stand-alone entity to being an entity that is part of a workflow.
9. Training: Contractors are the last planners and are an essential part of the system because they are the ones who execute the activities (Ballard & Tommelein, 2016). However, sometimes they do not participate in the entire process and only know or are integrated in the result. This disconnection with the organizational change (that the company is undergoing) creates confusion and disorientation at work. Therefore, to address this challenge, it is sought that the last planners be invited to the training sessions so that they can learn what the new system is, how the organization is going to evaluate them and resolve their concerns and doubts in time. This integration, in turn, goes hand in hand with the strategy, lack of support

and training. It should be noted that this training is about understanding the system and the meaning of the metrics, it is not a training on how to calculate or carry out the processes.

Administrative needs

10. Detailed checklist: Restrictions are actions that are required to be solved so that an activity can be scheduled and executed. These are identified in the lookahead schedule and must be managed to prevent delays in activities and, therefore, in the project. So, to identify them, it is suggested to propose a checklist that facilitates and reminds the administrative staff as well as the last planners about the minimum requirements to start an activity.
11. Deep information analysis (restrictions and CNC): This challenge addresses the issue of how to analyse the information that is collected in the schedules to improve the workflow in the construction site. For which it is proposed to create a table that allows knowing in detail the causes of the restrictions and the causes of the CNC. This table that is developed seeks, in turn, to standardize the information and allow a common language between the teams of the organization.
12. Contractor identification: The identification of contractors for the execution of activities in a construction project is related to the process of selecting and awarding contracts for each company. Therefore, it is a unique and independent process that cannot be standardized nor provide a general solution for this need. However, the following recommendation is, in case the contractor is not available at the time of scheduling the work: carry out an analysis of the execution times of this activity in other similar projects to know an estimated performance, time and schedule; once the contractor is known, negotiate with him about the planned time and agree on the new schedule.
13. Digital media: To allow collaboration and transparency in the flow of work and information, it is proposed to implement and use digital tools that will allow access to information at any time by all the people involved in the work. The ideal is to move the physical LPS board to a digital board. However, it is recommended that before adopting these technologies such as digital boards or specialized software, there is a training and time to use the system in a physical way, to empower the last planners and administrative staff.

Last planners' needs

14. Activities coordination: The coordination of activities allows to improve the workflow and be efficient in the processes. However, this requires the team to be willing to share their way of working, needs, obstacles and requirements to modify them and create a new efficient way of working for everyone involved. That is, a change in the way of thinking about work, from individual to teamwork. Part of this process is carried out in the training and education sessions that the contractors receive, both for the system and for the human and social part.
15. Diagnosis of the situation: LPS proposes continuous improvement in its processes and operations, however, to be able to observe what the changes and improvements have been in a quantitative and not qualitative way from the point of view of the last planners, an initial diagnosis of its situation is proposed in which the team writes down the workflow, performance, and times of the contractor before LPS is implemented. In this way, the last planners can observe

the changes and improvements in their processes, and in this way find the system useful not only for the company, but also for them.

CONCLUSIONS

Last Planner® System is a system that provides tools for workflow optimization in construction projects, however, for it to work properly, it must be understood as a holistic system that, due to the interconnection of its parts, manages to cover the entire production control process and improve its performance. LPS is not just a sequence of steps to optimize the workflow, it is an organizational transformation process that, if it does not have a strategic route, it can have results that generate bad experiences for people and organizations.

To be able to develop an adequate route for organizations, it is not only necessary to understand the process of the system, but also to identify the obstacles that are found in the environment, analyse how LPS can address them and thus create a route of action that is adequate and prepare the environment in which it will be implemented and used, and at the same time the staff. In this way, the system is shaped and adjusted (without losing its essential elements) to the organization and the people.

In this case study and because of the bibliographical research and the interviews addressed to professionals in the field within the Colombian context, it was possible to identify the main challenges presented by professionals in two moments, implementation and use of the system, fourteen in total. These challenges in turn responded to administrative challenges (processes) and social challenges (human management).

Additionally, new needs were identified that presented an opportunity to expand the range of action of the system, and to model it to the Colombian environment and its expectations, in total eight needs. Part of these needs were identified in the group of last planners or contractors.

Based on these obstacles and needs, the next step was to analyse the general framework of Last Planner System 1.0, with the new solutions and ways of approaching the system developed in Last Planner® System 2.0, to find solutions to the challenges and needs found. However, of the fourteen identified challenges, a solution to six and a half challenges were found, and in terms of the needs of the other eight identified, a solution to two were found in the update of the system; that is, part of the challenges and needs were not solved or addressed in the update of the system. Thus, a second bibliographic review was carried out to provide answers and generate a framework adapted to the context.

It should be noted that, as the Benchmark 2020 states, this process is unique, iterative, and evolutionary, for which, although this case study proposes solutions, it is pertinent for each organization to discover and test what solutions and steps are the appropriate ones according to its structure, environment, and way of working (culture and objectives).

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