ISBN: 978-628-95207-7-4. ISSN: 2414-6390. Digital Object Identifier: https://dx.doi.org/10.18687/LEIRD2023.1.1.217

Service Model Based On Lean Service And Agile Methods To Increase The Service Level In A SME In The Mining Sector

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***Abstract*– Mining is one of the most important sectors in Peruvian economy, due to its large percentage contribution to GDP (Gross domestic product) and the large amount of resources existing in the territory. In this paper, we identified that one of the most outstanding problems in SMEs (Small medium-sized enterprises) that provide consulting services in this sector is the low level of service offered to clients due to the high demand and low capacity to respond inconveniences during the process. As a possible solution, we designed an improvement model that will allow raising this indicator using Lean Service tools, such as 5S and work Standarization, and agile methodologies, such as Scrum and Kanban, to reduce the existing gap..**

***Keywords*—Lean Service, agile methods, Sme's, mining sector, service level.**

I. Introduction

Mining is a highly important activity in our country due to its impact on the economy and the great geological potential that exists in our territory, generating a contribution to the GDP of 14%. According to the Peruvian Institute of Economics (2018), for each direct job in the mining sector, 6.25 job are generate in the other sectors; this represents an estimate of direct and indirect employment of 4.6 million. Some of the problems identified in this sector, specifically in the consulting firms, are the insufficient capacity to attend to projects and the failure to meet established deadlines.

The service companies have problems with the service level indicator, that is, they do not have the capacity to meet all the requirements or projects that are present (Chinchay, G. et al, 2022). This is either due to the lack of standardization in their process or their low organization of the projects on which they are already working on; not taking into consideration reduces the margins of profitability that could be achieve at an optimal service (Campos, G. et al, 2021). Therefore, it is important to reduce the gap between the reference value and the current value of the indicator in the company in order to increase revenues and profitability. Likewise, in the United Kingdom, Lean tools are having a very positive impact on the service sector not only in manufacturing (Almani, A. et al, 2012). In addition, it would be possible to the efficiency of the organization in terms of the attention to the projects that are being carry out.

With the aforementioned, it is necessary that Peruvian companies in the mining sector need to reach the industry's standards of the sector in terms of service level for the project attention. For this reason, a case study was chosen to work on this identified problem. Among the sub problems that were find are the lack of standardization of work, low daily organization at the workstations and the failure to meet the deadlines established with customers. For this reason, to solve the above-mentioned problems, the continuous improvement model with lean service tools such as work standardization and agile methods like Scrum and Kanban.

The scientific articles reviewed contain little information on the use of Lean service tools to increase the service level; therefore, the need to carry out the present research. In order to make our proposal known, this paper has been divided into the following sections: Literature review, in which the background will present the point of view of other authors; Contribution that will explain the theory of the model and its indicators; Implementation, which describes pre-intervention data, pilot implementation and post-intervention results. Finally, discussion, conclusions and recommendations for future research.

II. Literature Review

A. Service Level

The service level is the percentage of orders that a company is able to fulfill within a given period. Therefore, it can be considered a measure of customer satisfaction. With the present research, we seek to increase the level of service in a SME by 70% using lean service tools and agile methodologies (Alvarez Bautista, Maradiegue and Padilla, 2019).

B. Work Standardization and 5S

Digital Object Identifier: (only for full papers, inserted by LEIRD).
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Lean tools are becoming more and more relevant in the service sectors, not only with a focus on manufacturing, and with the review of the literature show that positive results are obtain. In this case, for the research will make use of the 5S tool and the work standardization, which have shown to be able the service level of a company by 15% (Campos, G. et al, 2021). A second article indicates that through the implementation of these tools it has been possible to optimize processing times, thus increasing its capacity to attend to jobs and with it the company's level of service (Carrillo, A. et al, 2020). Finally, one last article that also claims to increase order fulfillment by the implementation of 5S and work standardization, allowing to increase its service level by 44,48% by reducing cycle times and the amount of defective or reprocesses.

C. *Kanban and Scrum*

Agile methodologies are an innovative approach that help to organize and adapt the way of working to the conditions of the project achieving flexibility and doing them in less time. For this research, we will use some of these methodologies such as Scrum and Kanban; we were able to demonstrate that their use and adaptation were fast and intuitive. In addition, the team members were keep organized and informed of the project progress (Cabrera, M. and Yacelga, A., 2022).

All the lean service tools and agile methods mentioned above have no precedent of having been implement together in the service sector or in any other types of industry. However, there are studies of some of these boards, such as Kanban and Scrum, and it is mention that there are usually changes or setbacks along the way. But the use of these tools has allowed them to meet the deadlines established with customers, even if they have had changes in what was planned in advance (Cabrera, M. and Yacelga, A., 2022).

III. CONTRIBUTION

A. *Model foundation*

This proposed model presents the union of lean service tools, work standardization and 5S methodology, in addition to Kanban boards and Scrum. This seeks to strengthen the daily work organization with both. In addition, it would be improving the work environments and the organization, making them more orderly and efficient. During the systematic review of the literature, the benefits of the models based on lean tools and agile methods, these can increase the level of service of SMEs in the mining sector.

B. *Comparative table of causes vs state of the art*

In the following table (Table I), there's the comparison of the causes versus state of the art.

TABLE I
COMPARATIVE TABLE OF CAUSES OF THE ART

Scientific Articles	Objectives		
	Reduce the waiting time	Continuous improvement	Reduce defective products
Bustillos, Rojas & Quiroz	Kanban + work standardiation		
Carrillo, Tarazona, Quiroz & Viacava		Kanban + work standardization	5S
Laura, Chinchay & Quiroz	Kanban	Kanban	5S
Krishnaiyer & Chen	Kanban		
Zamalloa, Flores, Collao & Manani	Kanban		
Proposal	Kanban	Work standardization	5S

C. *Proposed model*

Work standardization is a model that seeks the standardization of daily work or process, thus achieving an order in the work and allowing then to make a better analysis to apply continuous improvement.

On the other hand, the 5S is a tool that seeks to reduce costs and waste, and by strengthening the participation of the entire work team, it increases the productivity of the team environment.

Finally, the agile methodology Scrum in conjunction with Kanban boards seeks to improve the daily organization of the work and the future planning of the projects, considering that during the progress of the project, changes may occur, thus allowing for greater adaptability.

To the development of the proposed model, it´s been made the design of the 3 components for the implementation, to sum up in the following figure (Figure 1), y and more detailed in the next chapters.

C. *Model components*

- Component 1: Identification of the improvement aspects of the proposal

  For the development of the proposal, an analysis and diagnosis of the company's current situation must be made, as well as the time of operations. In addition, the root cause of the present technical gap and its causes. Finally, these results will be communicated to the employees and explained to them.

- Component 2: Intervention development and implementation

  In this phase, the tools 5S, work standardization, Scrum and Kanban will be implemented.

  First, the 5S methodology will be implemented to increase order and cleanliness in the employee's work area. In addition to this, Kanban will help the employees to perform their tasks in an effective and efficient way. Finally, the work standardization will standardize the process of receiving an order, which will reduce time.

- Component 3: Implementation review

For the review, a checklist will made to measure each 5S module to determine which one needs improvement; the classification of tasks in the use of Kanban boards will also be review.

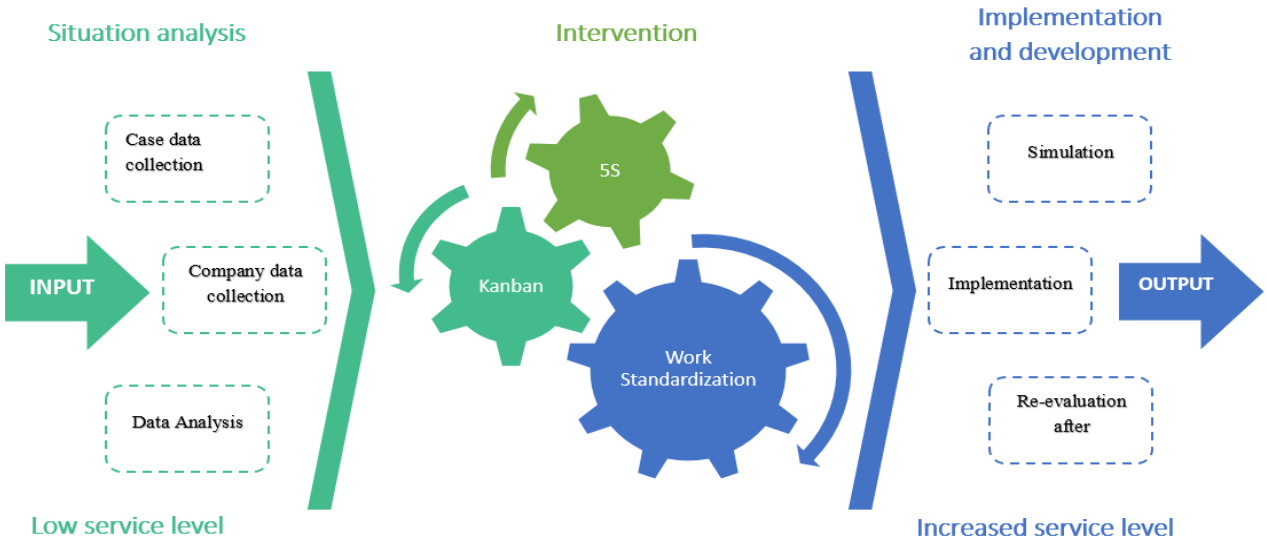

Fig. 1 Proposed model of improvement.

III. Contribution

For this Project, three indicators will be used to impact of the model base on the results obtained and the objectives to achieve.

A. Service level

It allows determining the level of service, the objective of which is to increase by almost 10%

$$\frac{Total\ orders\ handled}{Total\ orders\ quoted} \times 100\%$$

B. Fulfillment of the planned tasks

It allows determining the percentage of planned tasks completed, the objective is increase by 12%.

$$\frac{Total\ tasks\ completed}{Total\ planned\ tasks} \times 100\%$$

C. Productivity level

It allows us to determine the level of productivity that exists in the company and the improvement target is 8%.

$$\frac{Total\ orders\ fulfilled}{Total\ hours\ worked} \times 100\%$$

IV. Validation

A. Description of the scenario

In this section we will present the validations and results of the proposed tools to improve the situation of the company as mentioned above, two methods will be applied, the first one will be the pilot test and the second method will be a simulation. (a) The first method is the pilot test for the demonstration of two of the tools shown in the previous chapter. The proposal includes the validation of the use of 5S tool and Scrum to reduce the lack of organization in daily tasks. (b) The second validation method is simulation, which will help us to simulate the standardization of the sample analysis process in the laboratory. Finally, the impacts that these proposals have generated in the company and in the productivity of collaborators are mentioned.

B. Design and results

5S

As a first phase, all the objects were removed from the work area to know each of elements found in it, and we proceeded with the classification of the different materials found in it, such as filing cabinets, office supplies, etc. For this purpose, everything found was separate into three groups, which were: objects of frequent use, objects of recurrent use and objects to be discarded; the designated supervisor approved this classification, so that this process is further optimized, and the classification of the elements is carried out correctly.

For the second phase, once all the elements found are organized in these three groups, we proceeded to give a specific place for each one, prioritizing that the frequently used objects are more within reach than those of recurrent use. On the other hand, the objects to be discard are move to another area of the company and if they have not had any type of rotation in the last month, they will be discarded.

For the third phase, a cleaning area was installed to provide employees with easy access to cleaning products and additionally, a weekly review by the supervisor was schedule to verify that employees maintain order and cleanliness of their respective desks. These weekly reviews were carried out during the five weeks of the pilot test, but it is intending that

supervision will not be necessary for employees to maintain order and cleanliness.

At the end of the period for the implementation of the tool, the internal audit was carried out again to evaluate and verify the improvements compared to the results obtained in the initial audit.

In the figure 2 and 3 there's the evidence of the state of the workstations before and after the implementation of 5S.

Fig. 2 Workstation before 5S

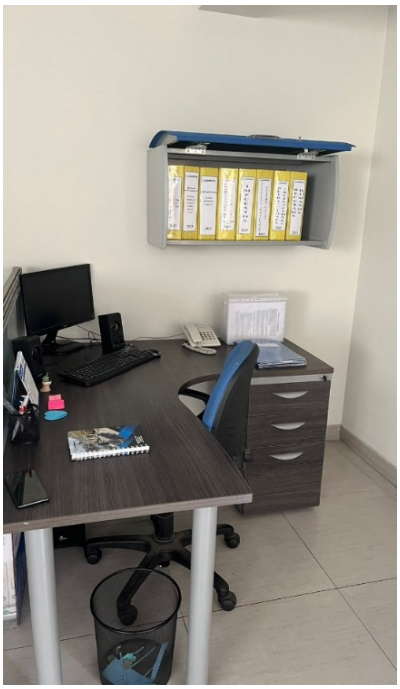

Fig. 3 Workstation AFTER 5S

Scrum and Kanban

As a first phase, to start the pilot test of Scrum and Kanban methodology, the roles of the work team were defined, where the mining engineer was designated as Product Owner, due to his extensive experience in the processes and projects carried out in the company. On the other hand, other collaborators such as geologists, geology technicians, maintenance technicians, electricians, and administrative staff, specialized in their respective fields, were define as team members, giving diversity to the team. Due to internal company issues, it was not possible to assign a Scrum Master, however, as a team we have followed up on compliance with the Scrum rules. Additionally, the team received training on Scrum events, the rules to follow, roles and the use of the Kanban board in the Trello platform.

In the second phase, for the development of the backlog, a team meeting was organized to define all the tasks to be performed during the established time of the pilot test. In addition, the collaborators were registered in the Trello platform (Figure 4), and the work board was created.

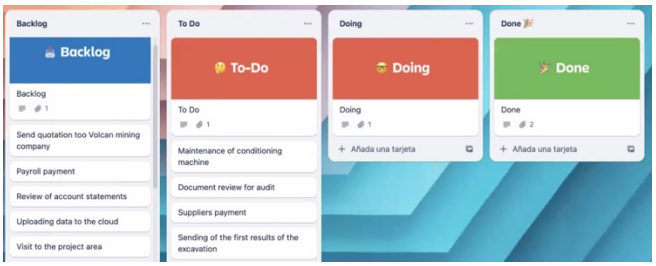

Fig. 4 Implementation of Kanban

In the third phase, the first Scrum event is the Sprint Planning in which the team assigns to each member the prioritized tasks of the backlog to be performed during the first Sprint. Additionally, as a guideline for the assignment of tasks, each task was given an average weight depending on its level of difficulty, in this way it is possible to have a control that all team members can have the same amount of difficulty in their assigned tasks. During the Sprint execution time, the members should hold daily meetings in which the assigned tasks will be reviewed, the board will be moved, and the impediments will be lifted by dependencies from other areas. In addition, at the end of the sprint, review meetings will be held with stakeholders and feedback with the internal team. Each sprint lasts approximately a week and a half to complete the pilot test period.

The SPI (Schedule performance index) was used as an indicator, which gave us a result of 1.23, which means that we are having a weekly project progress of 11.07%, being our target to grow from 10-12%. In addition, with the use of the Trello tool that connects the company's collaborators, we have been able to improve communication between areas, thus achieving a better response to impediments due to dependencies between areas, reducing delays due to lack of coordination from 2 days to 1 day.

Work Standardization

For the design of the simulation (Figure 5), the area of the laboratory where the soil samples are analyzed, from the moment the samples are received until the information of each sample is loaded into the system, is the scope of the simulation.

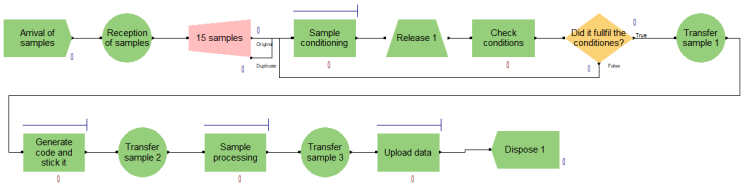

Fig. 5 Improved model of process

Finally, it was possible to confirm that the implementation of work standardization improved the initial time of the process from 7.26 hours to 6.35 hours and with the results seen there´s an improvement of 12.53% in the reduction of the time used for the analysis of the samples of soil, validating the application of our simulation.

V. Discussion

A. *Scenario vs Result*

For this section, three scenarios will be shown, in which a comparison of the current simulation with each scenario will be made, which will be equivalent to one moth of work. For the first scenario, the results obtained in the first simulation (first month) will be used, for the second scenario the data obtained when simulating the second month will be used and finally the third scenario will be performed with the data from the previous scenario. In this way, the comparison of the simulation used for validation and 3 other simulations will be made.

TABLE II
SCENARIO 1

Indicators	Scenario 1	Variation %
Time of sample test	6.42	11.57%
Number of activities	9	10.00%

With the results obtained for the simulation of the first scenario (Table II), the sample testing time was increased, reducing the improvement percentage from 12.53% to 11.57%. The number of activities remains at nine, as it was reduced to nine due to the implementation of the standardization of the work.

TABLE III
SCENARIO 2

Indicators	Scenario 2	Variation %
Time of sample test	6.31	13.09%
Number of activities	9	10.00%

In the second month, the results of this scenario (Table III), the testing time of the samples was further reduced to 6.31 hours thus raising the percentage improvement from 12.53% to 13.09%.

TABLE IV
SCENARIO 3

Indicators	Scenario 3	Variation %
Time of sample test	6.27	13.64%
Number of activities	9	10.00%

Finally, for the third month this scenario (Table IV), further reduces the testing time of the samples in the laboratory to 6.27 hours raising the percentage difference from 12.53% to 13.64% improvement.

Reviewing the results of the three scenarios, we can be noted that, in all three-simulation runs, the indicators confirm the improvement in testing times. In all scenarios, the process times and the number of activities are educated, as well as the

percentages of improvement in time reduction increase, compare to the first simulation. As can be seen in the table above, an average improvement of 12.76% is maintained and with the improvement results in the third scenario with 13.64%.

B. *Analysis of Results*

At this point, the results obtained from the 3 simulated scenarios are visualized. The following table (Table V) shows the percentage difference obtained in each scenario compared to the current situation of the company, in order to clearly identify how much improvement was achieved.

TABLE V
PERCENTAGE OF VARIATION

Indicator	Variation		
	Scenario 1	Scenario 2	Scenario 3
Improvement in time of sample test	11.57%	13.09%	13.64%

As can be seen in the indicator studied, through the simulations of the implementation of the improvement, the indicators remain positive. The improvement in sample testing time in the laboratory remains above 11.5% improvement in the three scenarios and have an average of 12.76% in the total reduction of process time.

C. *Future work*

This research involved an investigation on the implementation of lean methodologies, 5S, work standardization, Scrum and Kanban, considering both advantages and limitations. Considering that for the execution of the validation and the proposed scenarios the Arena software was used, so depending on the characteristics of each company, there may be variations in the results.

In addition, due to the company's particularity of belonging to the mining sector, but providing consulting services, this study can be used as a basis for a guide for the implementation of the tools mentioned above.

It is recommended to validate the implementation of the model with different scenarios, such as the use of different sample types or analysis machinery. Because sample test results may vary by characteristics such as soil type, sample treatment or processing.

It should be noted that, for this case study, the data of the intervened company were taken in a period of recovery after the Covid-19 pandemic. Therefore, there are factors such as the reactivation of mining projects generating an increase in demand, but it is also a sector highly affected by social and political conflicts.

VI. CONCLUSIONS

After this study, we concluded that the application of Lean Service tools and agile methodologies in the administrative area of an SME in the mining sector leads to an improvement in the level of service. The results show an improvement in the indicators proposed to detail the situation of the company.

After a deep study of the main causes, we were able to observe that the lack of organization, especially in the administrative area of the company, generates delays in ongoing projects, so it was decided to implement the 5S methodology and the kanban board to have a better control of both the company's facilities and the activities already carried out.

By correctly implementing the 5S methodology and the Scrum and kanban tools in both administrative and operational areas of the company, we were able to improve critical points such as the percentage of non-compliance with established deadlines and the insufficient capacity to attend to projects; and consequently, we were able to raise the level of service offered by the company from 76.82% to 93.70%.

Using a simulation in the Arena program, changes were made in the classification, part of the sample processing, to reduce the amount of time spent and seeking to eliminate downtime. It was possible to reduce the time of the whole process from 7.26 hours to 6.35 hours; and consequently, to improve the attention of projects.

The simulation model was validated through 3 different scenarios in different time periods. From the results of this simulation, which are favorable, we can conclude that this project is viable for this company.

Finally, to maintain these changes over the time, it is important that the team is motivated and committed. This can be achieved by maintaining good communication, good leadership, and incorporating these tools progressively to avoid drastic changes.

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