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Integration of Lean Six Sigma with Value Stream Mapping and Simulation to increase Productivity in a Gelatinized Maca Production Plant: A Case Study

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Integration of Lean Six Sigma with Value Stream Mapping and Simulation to Increase Productivity in a Gelatinized Maca Production Plant: A Case Study

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***Abstract*— The DMAIC (define-measure-analyze-improve-control) method of Lean Six Sigma is one of the most widely used because it allows the development of initiatives aimed at quality and continuous improvement in all types of manufacturing companies. The objective of this research is to design a model based on the integration of Lean Six Sigma (DMAIC) with Value Stream Mapping (VSM) and simulation to increase productivity in a gelatinized maca production company. The methodology of this research follows the sequence of the DMAIC method with the integration of VSM based on the production process of gelatinized maca and then simulate it in FlexSim software. The results obtained in the research show that there is a significant improvement in productivity of an additional 5.18% at the time of the simulation, since the production increased from 270 to 284 bags of 200 grams of gelatinized maca and this would lead to a reduction in the amount of material discarded in the activity of sorting maca.**

Keywords—DMAIC, lean six sigma, productivity, simulation, Value Stream Mapping

I. Introduction

The consumption dynamics of the food industry are increasing [1]. Likewise, it is important to understand that consumer attitudes tend to vary constantly, which leads to mass customization and product diversification [2]. Also, Peru's food processing industry is one of the national economy's most dynamic sectors, representing nearly 28% of the industrial Gross Domestic Product GDP, worth $9.1 billion at the end of 2021. The development of the food retail and food service sectors is increasing [3].

It should be noted that Peru has become the world's leading exporter of maca [4]. That is why the production of maca flour in Peru is an industrial activity that adds value and exports large tons of flour worldwide, in a context of competitiveness in which it is necessary to overcome productivity problems and deficiencies that generate delays in their productions [5].

This situation leads several industries to adopt paradigms or methods such as Lean Six Sigma, Lean Manufacturing or Lean Agile to achieve process improvement and response time reduction [6]. Many authors have identified the benefits of combining tools such as lean six sigma and simulation, since they allow the evaluation of decisions regarding improvement proposals for existing problems in manufacturing [7].

This paper presents a study in a gelatinized maca production company that presents inefficient times. Therefore, the objective of this research is to design a model based on the integration of Lean Six Sigma (DMAIC) with Value Stream Mapping (VSM) and simulation to increase the productivity of this company.

II. Literature Review

A. Lean Six Sigma (DMAIC Cycle)

Lean Six Sigma is an approach that relies on data, the use of tools and methodologies for fact-based decision making. Likewise, it is characterized by proposing continuous improvement that allows granting variability to the processes and eliminating any type of waste [6]. Likewise, it should be noted that the DMAIC methodology (define, measure, analyze, improve and control) is the central part of Lean Six Sigma that serves as a basis for reducing defects or improving processes [8].

1) Define (D): Is the first stage of the DMAIC methodology, where terms such as opportunities, scope, goals or objectives of the improvement proposal must be established and determined [9]. As part of this stage, tools such as SIPOC, Gantt Diagram, Project Charter and others can be used [10].

2) Measure (M): This stage is based on establishing reliable and applicable metrics that allow monitoring the key characteristics of the process [6]. As part of this stage, tools such as current VSM, statistical graphs and others can be used [10].

3) Analyze (A): This stage is focused on identifying the problem through data analysis. Through this approach, it is possible to prioritize and validate the causes of a company's problems [11]. As part of this stage, tools such as Pareto analysis, cause and effect diagram (Fishbone diagram), 5 whys and others can be used [10].