**TRIBHUVAN UNIVERSITY**

**INSTITUTE OF ENGINEERING**

**SAGARMATHA ENGINEERING COLLEGE**

A

CASE STUDY REPORT

ON

# Sujal Dairy

**SUBMITTED BY:**

**NIKHIL KC (SEC078BCT013)**

**SACHIN MAJARJAN (SEC078BCT026)**

**SADIKSHA GHIMIRE (SEC078BCT028)**

**AAYUSHA BHATTRAI (SEC078BCT002)**

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A Case Study Report Submitted for the partial fulfillment of the requirement of **Bachelor of Computer Engineering (Instrumentation II) 5th Semester** of Tribhuvan University

Institute of Engineering Sagarmatha Engineering College

**SANEPA, LALITPUR**

**July, 2024**

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**DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING**

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# ACKNOWLEDGEMENT

Conducting this case study on the Management by Information (MBI) Systems at Sujal Dairy has been a profoundly educational journey, and we are deeply grateful to all those who have supported us throughout this endeavor.

First and foremost, we extend our heartfelt gratitude to Er. Dakshina Shrestha, our principal, for her unwavering support and encouragement. Her belief in our abilities and dedication to fostering an environment of academic excellence provided the foundation for this project.

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We also wish to thank our fellow third-year BCT faculty students for their collaborative spirit and valuable feedback, which helped refine our analysis and presentation.

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Thank you to everyone who supported us on this insightful journey. We look forward to future endeavors filled with learning and growth!

# ABSTRACT

This case study, conducted by third-year BCT faculty students, aims to provide a comprehensive analysis of the Management by Information (MBI) systems implemented at Sujal Dairy, focusing on their ice cream and dairy product manufacturing processes. The study investigates the challenges encountered by the company, the solutions they adopted, and the underlying reasons for the implementation of these systems. First-hand information and insights into the operations were gathered by visiting the company's site.

MBI systems at Sujal Dairy have facilitated numerous advantages. For instance, operational efficiency has improved through process automation. Secondly, quality control is ensured, maintaining consistency in product standards. Thirdly, there are reduced costs of production due to optimization of resource usage. Moreover, data analytics provided by the systems offer valuable insights that aid informed decision-making and strategic planning.

Despite these advantages, there are some disadvantages associated with the implementation of MBI systems. The initial setup cost is high, which can be a significant financial burden for the company. Additionally, these systems require regular maintenance and updates to remain effective, necessitating constant staff training to keep pace with advancing technology. Technical failures may cause production disruptions, highlighting the need for robust IT support infrastructure.

The overall cost of setting up these MBI systems is substantial, encompassing hardware, software, training, and maintenance expenses. While this initial investment is considerable, the long-term benefits, including cost savings, improved productivity, enhanced management control, and higher returns on investment, outweigh the costs.

This case study not only demonstrates the practical applications and benefits of MBI systems in the dairy industry but also underscores the importance of strategic planning and investment in technology to improve overall business operations. The lessons learned from this study may serve as valuable input for other companies planning to implement similar technological advancements.

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# INTRODUCTION

The Pokhara Milk Supply Scheme (PMSS) was established in 1977 AD by the Dairy Development Corporation (DDC) of Nepal. The dairy plant began operations in 1980 AD in Pokhara with support from the Danish Government under the Turnkey Project. During the privatization process in 1991 AD, Sujal Dairy Pvt. Ltd. successfully acquired PMSS in January 2005, surpassing three strong competitors.
Sujal Dairy modernized its operations, enhancing milk collection, processing, and marketing, and introduced world-class technologies and production facilities. The company's products are marketed under the "Safal" brand, which quickly became popular in Pokhara and surrounding areas. Sujal Dairy now produces a wide range of dairy products, including various milk types, sweets, ice creams, yogurt, ghee, and cheese. The company operates over 1,200 milk-selling outlets and 40 milk collection centers, involving more than 20,000 farmers.
A subsidiary of the Laxmi Group, Sujal Dairy is one of Nepal's largest milk processing companies, with a decade of flawless reputation. The company has achieved ISO 22000:2005 certification for its Pokhara factory and is pursuing the same for its Kathmandu factory. Sujal Dairy supplies a comprehensive range of products in Kathmandu and has established itself as a leading brand in Nepal's dairy industry. The company focuses on innovation, quality, and consumer satisfaction, continually striving to improve and expand its product offerings.

## OBJECTIVES OF THE CASE STUDY

We were guided to find any problems in the existing plant and propose a design to solve the problem. So, in our case we propose a design to solve problems related to operation and bulk production of various milk products.
The main objectives of our visit can be summarized as following:

- To visit the chosen organization and learn its operation under supervision of senior engineers and technicians.
- To study the existing management system and technology of the company.
- To be familiar with various engineering aspects demanded by that particular company.
- To learn the vital role of engineers in a particular company.
- To learn about electronics design using microcontrollers and microprocessors in the commercial field.
- To observe the current system carefully and detect any fault in the existing system if any.
- To propose solutions to boost the efficiency of the system.

The processing plant of Sujal Dairy Pvt. Ltd. is located in the heart of Pokhara, equipped with state-of-the-art technology. The facility, which has been operational for several years, is meticulously monitored by skilled Nepali technicians and engineers, ensuring smooth and efficient production. Although company policy prohibited us from taking photos of the plant, we were given an insightful tour. We observed various advanced machinery and tanks in operation, learning about the innovative processes that contribute to the high quality of Sujal Dairy products.

# REVIEW OF INDUSTRIAL PLANT

The processing plant of Sujal Dairy is located in Pokhara, making an onsite study infeasible for us. However, the guides graciously answered our questions about the production process and various other aspects of their operations.

## PROCESS OF MANUFACTURING

**A. Milk Processing:**

1. Milk collection
2. Quality testing
3. Filtration
4. Standardization
5. Pasteurization
6. Cooling
7. Homogenization
8. Separation
9. Storage and distribution

**B. Ice Cream Manufacturing:**

1. Homogenization
2. Aging
3. Churning and Cooling
4. Flavoring
5. Container Filling
6. Hardening
7. Storage and Distribution

## MILK PROCESSING

The dairy plant operates using an automatic method based on a closed-loop system. The plant contains sensors that record temperature, initially setting the required temperature and automatically detecting and correcting errors to maintain the desired level.

1. **Milk collection:** Raw milk is received from dairy farms and transported to the processing plant in refrigerated tanks.
2. **Quality testing**: The milk is carefully tested for quality and safety before processing begins.
3. **Filtration:** The raw milk is passed through filters to remove debris and particles.
4. **Standardization**: Depending on the desired fat content, the milk undergoes standardization to achieve consistent fat levels.
5. **Pasteurization:** The milk is preheated to a specific temperature (usually around 50-65°C). Preheating reduces the temperature difference between the raw milk and the pasteurization temperature, helping protect the milk proteins from denaturation. The milk is then rapidly heated to a higher temperature (around 72°C) for a shorter time (usually 15 seconds).
6. **Cooling:** After pasteurization, the milk is rapidly cooled to around 4°C or below. Rapid cooling prevents the growth of any remaining harmful bacteria and helps maintain the milk's freshness.
7. **Homogenization:** The milk is homogenized to break down the fat particles and create a consistent texture.
8. **Separation:** The milk is separated into cream and skim milk.

9. **Storage and distribution:** The packaging is done in a sterile environment to prevent contamination. Packaged pasteurized milk is stored in refrigerated conditions to maintain its quality and safety. The milk is distributed to retailers and consumers through a well-maintained cold chain.
10. **Additional processes:** Fermented milk products like cultured buttermilk, sour cream, and yogurt are made by allowing milk to ferment with lactic acid bacteria. Liquid milk is converted into a solid mass through coagulation to produce cheese, which is then separated by centrifugation.

## ICE CREAM MANUFACTURING

Ice cream manufacturing at Sujal Dairy is based on an open-loop system and is manually monitored by technicians and engineers. The plant has been operating smoothly.

1. **Homogenization:** For ice cream manufacturing, the milk is pumped through a homogenizer to break down fat molecules, ensuring a smooth and consistent texture.
2. **Aging:** The mixture is cooled inside the cooler and allowed to age for a certain period, usually several hours to overnight.
3. **Churning and Cooling:** The aged mixture is poured into an ice cream machine (freezer), where it's rapidly churned while being cooled.
4. **Flavoring:** Flavorings like vanilla, cocoa, or fruit puree are added to the mixture.
5. **Container Filling:** Once the ice cream reaches the desired consistency, it's transferred to containers. The containers are sealed to prevent freezer burn and maintain freshness.
6. **Hardening:** The filled containers are moved to a blast freezer to further harden the ice cream and ensure its scoopable and firm.
7. **Storage and Distribution:** Hardened ice cream is stored in a commercial freezer at very low temperatures to maintain its texture and prevent melting. It is then distributed to retail stores or other outlets for sale.

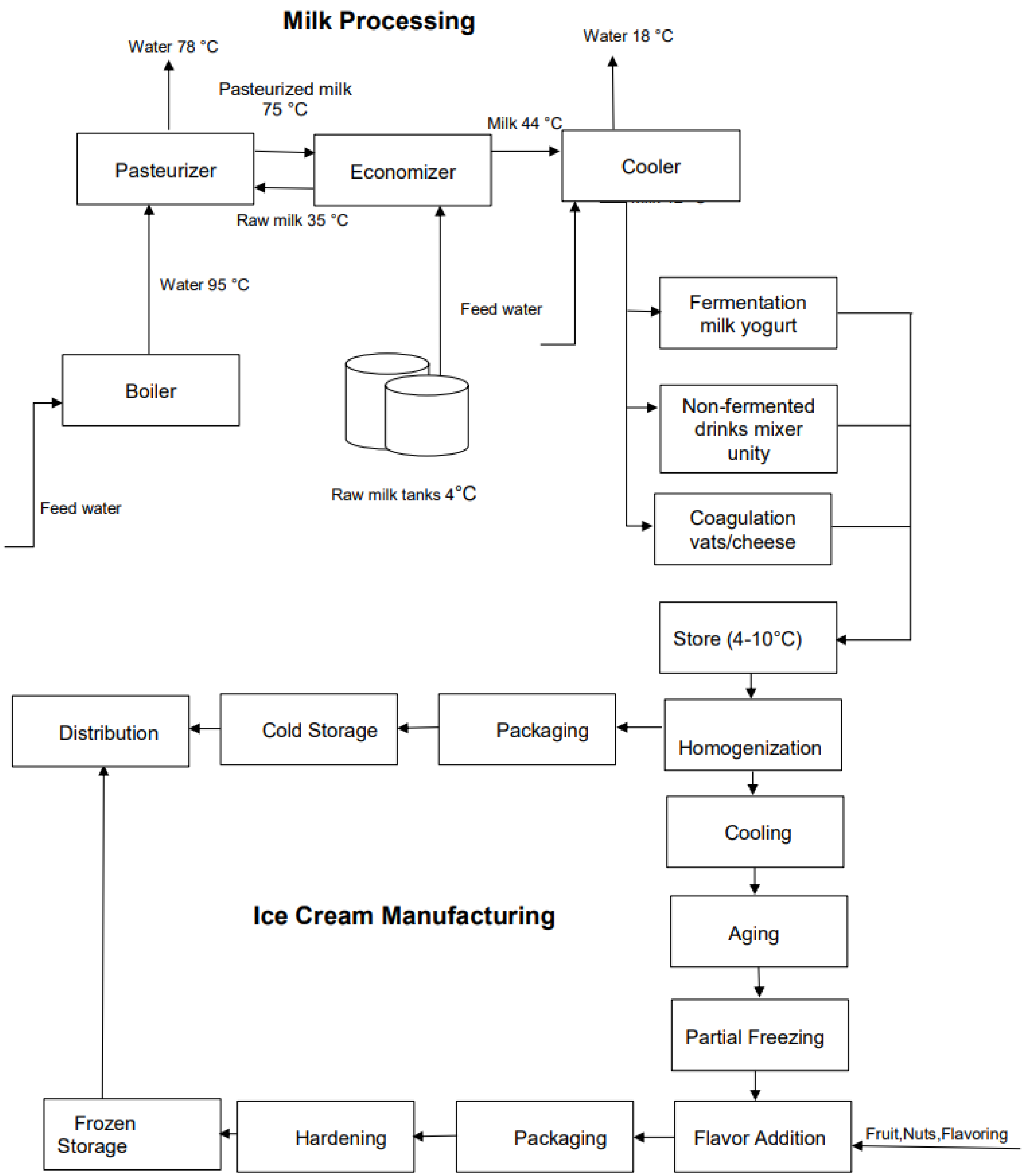



Fig: Block diagram of Existing Dairy Plant

# PROBLEMS REGARDING THE VISITED PLANT

- Packaging needs to be done manually: This labor-intensive process is time-consuming, prone to human error, and limits packaging speed, creating bottlenecks in production and increasing the risk of contamination and inconsistency.
- Slow production rate: The plant's outdated machinery and processes result in a sluggish production pace, hampering its ability to meet market demand efficiently and reducing its competitiveness.
- High expenses: Operational costs are high due to manual labor, maintenance of old equipment, and energy consumption. Additionally, training and retaining skilled labor for manual packaging add to overall expenses, affecting profitability and hindering investment in new technologies.

# PROPOSED MBI SYSTEM FOR THE INDUSTRIAL PLANT

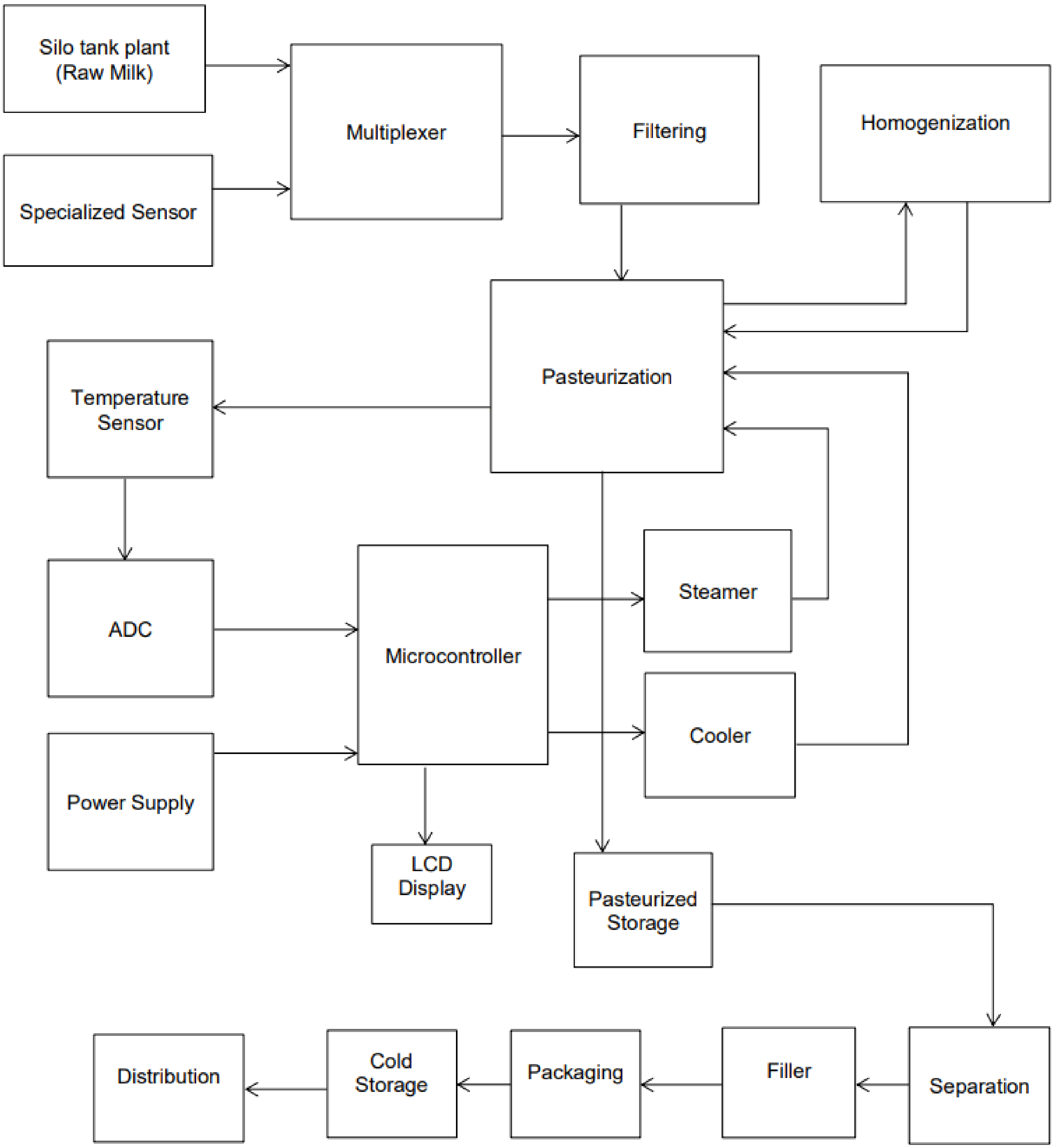



Fig: Proposed idea for automation milk

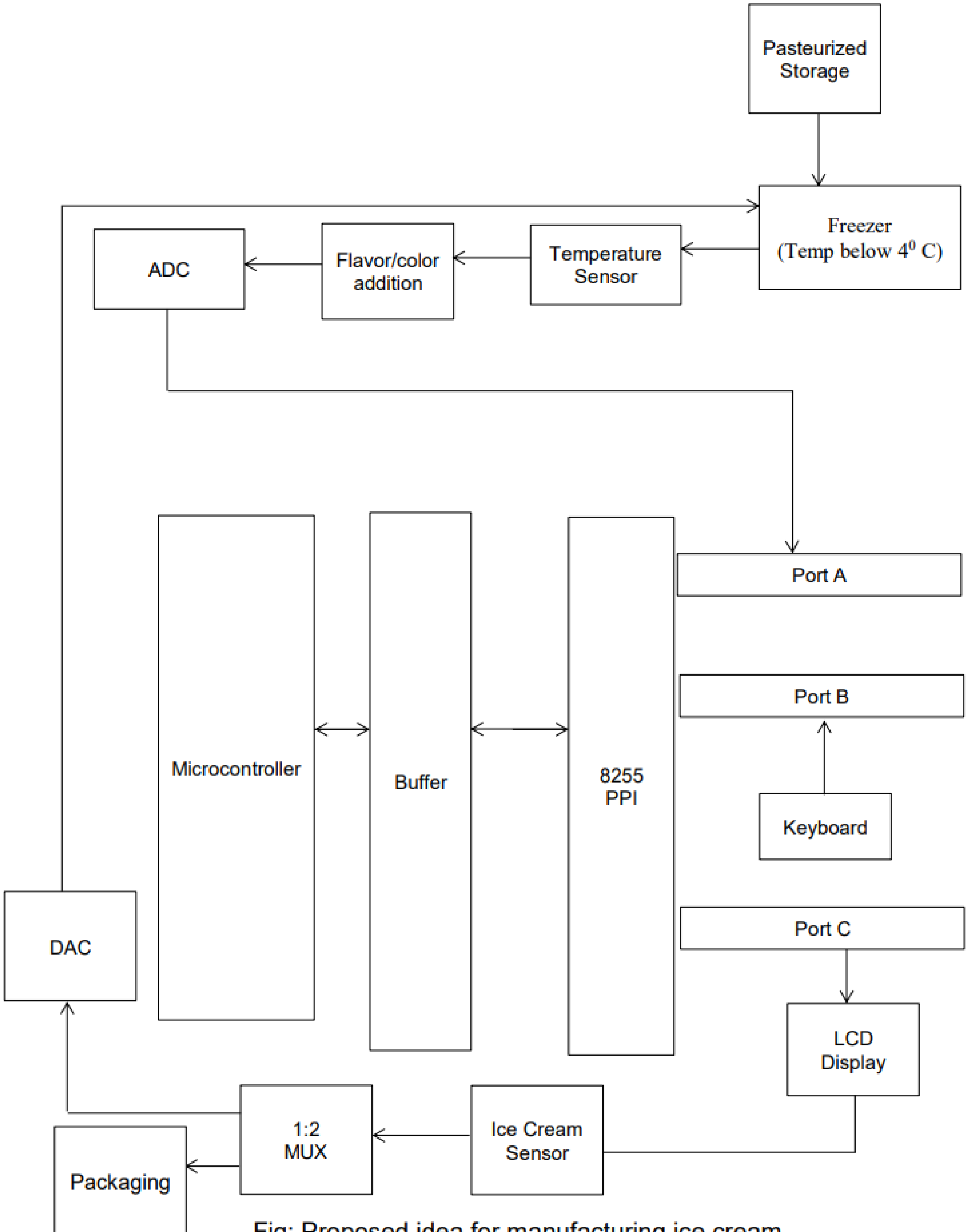



Fig: Proposed idea for manufacturing ice cream

# WORKING PRINCIPLE

A. FOR MILK

1. We tried to automate the task that was manually operated before the implementation with Microprocessor Based System.
2. First, talking about the milk plant, to increase accuracy of the plant we connect raw milk and a specialized sensor (Lactometer) with mux. When both outputs are verified, it is sent for further processing, i.e., filtering.
3. After filtering, the next step is pasteurization which makes raw milk free from bacteria by application of heat. In this process milk vaporizes and fatty residues remain at the bottom. So, we immediately homogenize i.e., mixing the raw milk to regain its original form.
4. During the pasteurization process, we have to be extra careful about heat as overheating can cause the nutrients presence in milk to fade away. So, we have to place a temperature sensor to sense the temperature and act accordingly. When the temperature is high, we have to supply cold water and when temperature is low, we have to supply hot water and water is our source of heat and cooling mechanism is this plant.
5. We need to observe the temperature sensor constantly and act in accordance with it. For this, we need a careful and skilled operator. But the digital system is considered to be more reliable than analog. So, we use microcontrollers for this purpose.
6. External power supply is connected to the microprocessor to operate it. Other peripherals such as keyboards (for input), LCD display (for output) are interfaced using PPI (Programmable Peripheral Interface). As there are limited ports only in microprocessors to interface external hardware.
7. After pasteurization and homogenization, milks are separated to different dairy using a special sensor in a tanker (vat) on the basis of its density i.e., whether it is milk, yogurt, cheese, etc. and their respective packaging is done.

B. FOR ICE CREAM

1. From Pasteurized milk storage, it is brought to another plant through pipes for manufacturing ice cream. Here, the milk is stored in a temperature below 40C. To keep monitoring temperature, we use a temperature sensor which provides its output to the microcontroller by passing through ADC (Analog to Digital Converter) as a microprocessor is a digital data processing device.
2. To keep the temperature constantly at 40 C. We use a cooler to respond to errors, that is, when temperature exceeds 40 C. It is controlled by a microcontroller. If temp less exceeds 40 C, then it provides a signal which is the difference of Measured Value and our required True Value.
3. We interface ADC to microcontroller using port A of PPI. Keyboard for input is interfaced at port B. LCD display is interface at port C. In short, we operate PPI, Port A as input, Port B as input & Port C as output.
4. We monitor the quality of ice cream using an LCD display i.e., the result of testing. It passed through DEMUX (2:1). If output is high, it is clear to be packed otherwise, feedback sent through the DAC of the microprocessor as it indicates fault in our freezer.

# HARDWARE SOLUTIONS

1. **Microcontroller**
   - **Function:** Acts as the central processing unit, controlling all operations within the system.
   - **Example:** Arduino, Raspberry Pi.
   - **Role:** Receives input from various sensors, processes the data, and sends commands to actuators to control different parts of the dairy processing system.

2. **8255 Programmable Peripheral Interface (PPI)**
   - **Function**: Facilitates communication between the microcontroller and other peripheral devices.
   - **Role:** Provides additional input/output ports for the microcontroller to interface with sensors, displays, and other components.

3. **LCD Display**
   - **Function**: Displays system status, data, and alerts.
   - **Role**: Allows operators to monitor the system's performance in real-time, view sensor readings, and receive notifications about system status and faults.

4. **Analog to Digital Converter (ADC)**
   - **Function**: Converts analog signals from sensors into digital data that the microcontroller can process.
   - **Role**: Essential for accurately capturing data from temperature sensors and other analog devices used in the dairy processing system.

5. **Digital to Analog Converter (DAC)**
   - **Function**: Converts digital signals from the microcontroller back into analog signals when necessary.
   - **Role**: Used to control analog devices such as actuators or valves based on digital commands from the microcontroller.

6. **Sensors**
   - **Types**: Temperature sensors, Lactometers.
   - **Role**:
   - **Temperature Sensors**: Monitor the temperature of milk and other products at various stages of processing to ensure they remain within optimal ranges.
   - **Lactometers**: Measure the density and quality of milk to ensure it meets required standards.

7. **Filters**
   - **Function**: Remove debris and impurities from raw milk.
   - **Role**: Ensure that only clean, filtered milk proceeds to the pasteurization stage, maintaining product quality and safety.

8. **Cooler**
   - **Function**: Maintain low temperatures for storing milk and ice cream.
   - **Role**: Ensure that products remain fresh and safe for consumption by keeping them at consistently low temperatures.

9. **Homogenizer**
   - **Function**: Breaks down fat molecules to create a consistent texture in milk and ice cream.
   - **Role**: Ensures product uniformity and improves the texture and quality of dairy products.

10. **Steamer**
   - **Function**: Used in the pasteurization process to heat milk to a specific temperature.
   - **Role**: Kills harmful bacteria and pathogens in milk, ensuring it is safe for consumption.

11. **Storage Vats**
   - **Function**: Store processed milk and ice cream before packaging.
   - **Role**: Maintain the quality of the finished products by providing a controlled environment for storage.

# SOFTWARE REQUIREMENTS

1. **Control Software for Microcontroller**
   - **Function:** Manages data input from sensors, processes the data, and controls actuators.
   - **Role:** Centralizes system control, enabling automated and precise management of the dairy processing operations.

2. **User Interface Software**
   - **Function:** Provides an interface for operators to interact with the system.
   - **Role:** Displays real-time data and system status on the LCD, allows input via keyboards or touchscreens, and facilitates easy operation and monitoring.

3. **Data Logging Software**
   - **Function:** Records process data for quality control and analysis.
   - **Role:** Maintains a historical record of temperature readings, process parameters, and system performance, enabling traceability and continuous improvement.

4. **Temperature Monitoring and Control Software**
   - **Function:** Maintains desired temperatures by controlling the cooler and heater based on sensor inputs.
   - **Role:** Ensures that milk and ice cream are processed and stored at optimal temperatures, preserving their quality and safety.

5. **Process Automation Software**
   - **Function:** Automates tasks such as pasteurization, homogenization, and separation of milk products.
   - **Role:** Increases operational efficiency by reducing manual intervention and ensuring consistent process execution.

6. **Diagnostic and Maintenance Software**
   - **Function:** Provides alerts and troubleshooting information.
   - **Role:** Helps operators identify and resolve issues quickly, minimizing downtime and maintaining system reliability.

# ADVANTAGES OF THE PROPOSED STRATEGY

- **Increased Accuracy and Precision:** Automated control systems reduce human error and ensure consistent product quality.
- **Enhanced Efficiency:** Automation speeds up processes, increasing production rates and reducing bottlenecks.
- **Cost Savings:** Although initial costs are high, long-term savings come from reduced labor costs, lower maintenance needs, and optimized resource usage.
- **Improved Quality Control:** Real-time monitoring and data logging ensure that all products meet stringent quality standards.

# DISADVANTAGES OF THE PROPOSED STRATEGY

- **High Initial Cost:** Significant investment in new hardware and software.
- **Need for Training:** Operators will require training to manage and maintain the new system.
- **Potential for Technical Issues:** Automation systems can fail, requiring robust IT support.

# GAIN IN EFFICIENCY

- **Operational Efficiency:** Automated systems streamline processes, reducing time and resource wastage.
- **Production Rate:** Increased speed and reduced downtime lead to higher production rates.
- **Quality Consistency:** Enhanced quality control mechanisms ensure that every batch meets the required standards.

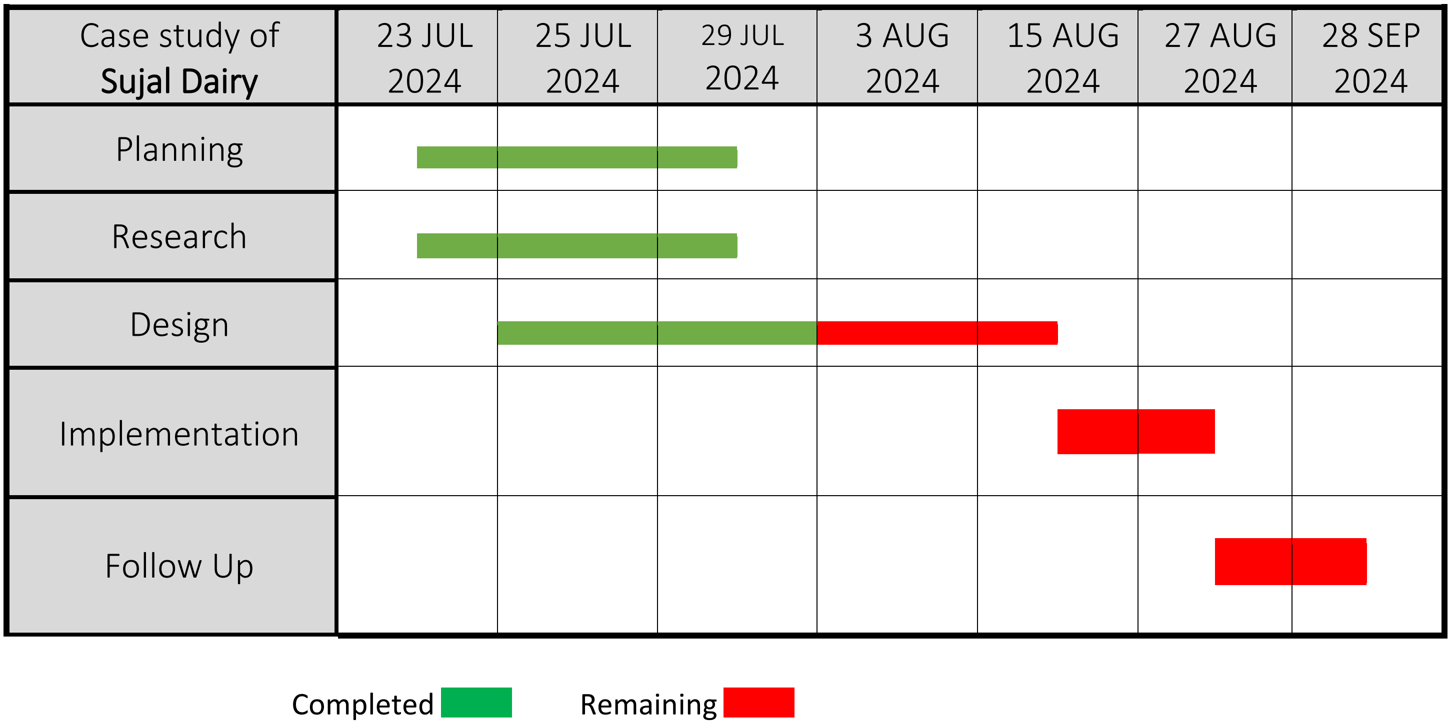
# ESTIMATED COST FOR INTRODUCING OUR PROPOSED MBI SYSTEM

The Proposed MBI system for a Dairy industry needs a microprocessor, 8255 PPI, ADC and DAC.

| Devices | Cost (NRs.) |
|---|---|
| Microcontroller | 66,100 |
| 8255 PPI | 1,20,000 |
| LCD Display | 70,000 |
| ADC | 14,500 |
| DAC | 14,400 |
| Sensor | 1,70,000 |
| Filter | 80,000 |
| Cooler | 1,70,000 |
| Homogenizer | 1,35,000 |
| Steamer | 96,000 |
| Storage VAT | 9,68,000 |
| TOTAL | 19,04,000 |

Hence, the total cost for our proposed MBI System is NPR 19,04,000. This is more expensive than the present system in Sujal Dairy due to the use of microprocessors. However, this will benefit the company in the long run as it is more efficient and accurate.

# ESTIMATED TIMELINE FOR INSTALLING OUR PROPOSED MBI SYSTEM



# CONCLUSION

The main objective of this case study was to identify opportunities for improving the efficiency and productivity of Sujal Dairy's existing plants by introducing a microprocessor-based instrumentation system. Our analysis focused on the current processes, identifying areas for improvement, and exploring how automation can enhance accuracy and precision. The anticipated outcomes include increased efficiency, reduced costs, and improved productivity.

During our study, we observed the use of automatic equipment for milk processing and semi-automatic equipment for ice cream processing. While the plant efficiently produces quality products, we noted the limitations posed by the open-loop system used in ice cream manufacturing. Despite these challenges, Sujal Dairy has managed to maintain high production standards.

Our comprehensive analysis suggests that the current system could benefit significantly from the implementation of a Management by Information (MBI) system. By integrating advanced instrumentation, Sujal Dairy can achieve better control over its processes, leading to enhanced efficiency and productivity. This shift towards automation will not only streamline operations but also position the company for long-term success in the competitive dairy industry.

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