King Fahad University of Petroleum and Minerals

COE384

Business Case

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Approvals

This document requires the following approvals. A signed copy should be placed in the project files.

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Executive Summary

Despite the evolving technological advancements in the current era, our factories still conduct manual fruit grading and sorting. Regardless of its simplicity and familiarity, this approach has many serious challenges, including labor-intensive processes, human inaccuracies and flaws, and efficiency concerns. Thus, we have carefully examined three proposed options to address these concerns, namely maintaining the current system, partially automating the process (edible and inedible fruit classification), and fully automating the production lines (Smart Fruit Grading System, AKA SFGS). The SFGS alternative is designed to automate the grading and sorting of fruits into four categories based on their quality: inedible, high, medium, and low. After a comprehensive analysis of the three business options, we found that the SFGS is the most promising alternative. This claim stems from the provided financial analysis; our findings demonstrate significant savings of $1,230 and $1,047 million over a period of ten years compared to the current system and partial automation, respectively. Additionally, with an initial investment of $47 million, our project strives to achieve three fundamental goals: alleviating the need for labor and human inconsistencies and potentially speeding up the process. Our success will position us as market leaders and result in increased productivity and profits.

Reasons

The agricultural sector is on the rise due to a growing global population. This has created a need for more factories and additional workers to meet the demand, ultimately resulting in increased operational expenses. Manual fruit grading and sorting have long been a common practice in the agricultural industry and it comes with inherent challenges such as human error and limitations in speed and consistency. The implementation of an AI-powered grading and sorting system for fruits offers a solution to these problems for many reasons:

1. AI-powered grading and sorting system will bring substantial improvements in efficiency, accuracy, and productivity, enabling fruit producers to streamline their operations and deliver high-quality products more effectively.
2. It will reduce the dependency on manual labor, particularly during peak seasons, which will help in overcoming labor shortages and ensure a seamless supply of fruits to the market.
3. Embracing AI technology empowers producers to adapt swiftly to market demands and stay abreast of technological advancements, fostering their competitiveness in the industry.
4. By reducing production costs, we can effectively lower distribution expenses, which, in turn, enables us to offer more cost-effective products to our customers.

Business Options

1. **Do Nothing (Manual Fruit Grading System):**

This approach involves maintaining the current implementation by relying on manual labor to inspect and categorize fruits. While this method may be familiar and straightforward, it might be prone to inconsistencies, inefficiencies, and potentially higher costs associated with manual labor.

- **Pros:**
  - No initial investment.
  - No need to improve or discard the current machines.
  - No disruption to current operations or workflow.
  - No increase in the unemployment rates.

- **Cons:**
  - Increased risk of falling behind competitors in the industry.
  - Continued reliance on manual labor may lead to inefficiencies and inconsistencies impacting overall product quality.
  - Potential for higher rates of errors in fruit grading, impacting overall product quality.
  - Limited ability to adapt to changing market demands and technological advancements.

2. **Do the Minimal (Automated Fruit Edibility Classifier):**

Opting for a minimal approach involves the implementation of an automated fruit edibility classifying system that focuses on a basic classification, distinguishing between edible and inedible fruits without delving into deep or detailed categorization. This method aims to streamline the grading process, reducing manual effort, and potentially enhancing efficiency while meeting the fundamental requirement of separating fruits based on their suitability for consumption.

- **Pros:**
  - Incremental improvements in efficiency with minimal investment.
  - Partial reduction in manual labor dependency.
  - Limited disruption to current workflow.
- **Cons:**
  - Moderate risk of not fully realizing the benefits of advanced technology.
  - Potential for suboptimal results, as the system may not be fully optimized.
  - Gradual rather than transformative impact on addressing food waste and sustainability challenges.

3. **Preferred Solution (Smart Fruit Grading System):**

Choosing to implement a comprehensive Smart Fruit Grading System represents a proactive and technologically advanced approach to fruit grading. This system integrates cutting-edge technology, such as computer vision and machine learning, to provide a detailed and accurate grading of fruits based on various parameters like size, ripeness, and quality. This not only ensures precise classification but also opens the door to potential optimization, cost reduction, and improved overall efficiency in fruit processing and distribution.

- **Pros:**
  - Substantial improvements in efficiency, accuracy, and productivity.
  - Reduction in manual labor dependency, especially during peak seasons.
  - Long-term cost reduction in production and distribution.
  - Enhanced ability to adapt to market demands and technological advancements.
  - Possible reduction in food waste, contributing to sustainability goals.

- **Cons:**
    - Initial high investment costs for implementing the Smart Fruit Grading System.
    - Ongoing maintenance costs and the need for periodic updates.
    - This may slightly increase the unemployment rate in the agricultural field.

Expected Benefits

1. **Do nothing (Manual Fruit Grading System):**

- Immediate cost savings due to avoiding investment in new technology:

  Quantitative Benefit: 100% cost savings in the short term.

  Qualitative Benefit: Preserves financial resources for other critical needs.
- No disruption to current operations or workflow:

  Quantitative Benefit: 0% disruption in current operations.

  Qualitative Benefit: Ensures a stable production environment.

2. **Do the Minimal (Automated Fruit Edibility Classifier):**

- Incremental improvements in efficiency with minimal investment:

  Quantitative Benefit: 8% reduction in operational costs.

  Qualitative Benefit: Improved efficiency leads to faster processing time.
- Partial reduction in manual labor dependency:

  Quantitative Benefit: 15% decrease in labor costs.

  Qualitative Benefit: A step toward workforce optimization and cost reduction.
- Limited disruption to current processes:

  Quantitative Benefit: 40% reduction in process disruption.

  Qualitative Benefit: Minimal changes preserve workflow stability.

3. **Preferred Solution (Smart Fruit Grading System):**

- Substantial improvements in efficiency, accuracy, and productivity:

  Quantitative Benefit: 35% increase in overall operational efficiency.

  Qualitative Benefit: Enhanced accuracy ensures better-quality products.
- Reduction in manual labor dependency during peak seasons:

  Quantitative Benefit: 85% decrease in labor costs during peak times.

Qualitative Benefit: Improved scalability during high-demand periods.

- Enhanced ability to adapt to market demands and technological advancements:

  Quantitative Benefit: 50% increase in agility to adapt.

  Qualitative Benefit: Better preparedness for industry changes and advancements.

- Possible reduction in food waste, contributing to sustainability goals:

  Quantitative Impact: 45% reduction in food waste.

  Qualitative Impact: Aligns with sustainability goals, promoting environmental responsibility.

Expected Dis-benefits

1. **Do nothing (Manual Fruit Grading System):**

   - Increased risk of falling behind competitors in the industry:
     - Competitors utilizing advanced and efficient grading technology-driven solutions may outpace in terms of accuracy, productivity, and overall quality of their classifications.

   - Continued reliance on manual labor may lead to inefficiencies:
     - Time-consuming and labor-intensive.
     - Inefficiencies in the grading process, especially during peak seasons when the workload is high.

   - Potential for higher rates of errors in fruit grading, impacting overall product quality:
     - Human error is inherent in manual grading processes, and the risk of errors increases with repetitive tasks.
     - Errors in fruit grading can result in inconsistent product quality, which can lead to customer dissatisfaction and potential product recalls.

   - Limited ability to adapt to changing market demands and technological advancements:
     - The fruit industry is constantly evolving, with changing consumer preferences, quality standards, and market trends.

2. **Do the Minimal (Automated Fruit Edibility Classifier):**

   - Moderate risk of not fully realizing advanced technology benefits:
     - Focusing primarily on distinguishing edible from inedible fruits may miss opportunities for optimizing other grading criteria, like size, ripeness, and quality, which are crucial for overall product quality and competitiveness.

- Potential for suboptimal results, as the system may not be fully optimized.
    - The minimal scope of the system might not be fully optimized to provide precise and detailed fruit classification.
    - Lack of optimization can lead to misclassifications, where fruits are incorrectly categorized as edible or inedible, potentially resulting in consumer dissatisfaction and product wastage.

- Gradual rather than transformative impact on food waste and sustainability:
    - While this solution will contribute to reducing food waste and promoting sustainability, it won't result in a dramatic and immediate transformation of these issues.

3. **Preferred solution (Smart Fruit Grading System):**

- Initial high investment costs for implementing the Smart Fruit Grading System:
    - Estimated initial investment of $46,827,800.

- Ongoing maintenance costs and the need for periodic updates:
    - Beyond the initial investment, the Smart Fruit Grading System incurs ongoing maintenance costs. Regular maintenance is essential to ensure the system functions optimally, including hardware upkeep, software updates, and technical support.
    - These maintenance costs can accumulate over time, and organizations must allocate resources to address them. Failure to maintain the system properly can lead to operational disruptions and decreased efficiency.

- This may slightly increase the unemployment rate in the agricultural field.

Timescale

1. **Do Nothing:**

- **Ongoing Operation:** Continuous reliance on manual labor for fruit grading.
- **Short-Term (0-4 months):** Immediate cost savings realized due to the avoidance of new technology investment.
- **Medium to Long-Term (4+ months):** Risks of falling behind competitors, potential inefficiencies, and errors become more pronounced. Benefits are primarily short-term cost savings.

2. **Do the Minimal (Automated Fruit Edibility Classifier):**

- **Phase 1 - Planning (Month 1**): Assess current processes, identify automation needs, and plan.
- **Phase 2 - Development and Testing (Month 2):** Develop a basic automated fruit edibility classifier and conduct testing.
- **Phase 3 - Implementation (Month 3):** Integrate the automated classifier into the existing

grading process.

- **Short-Term (0-3 months):** Incremental improvements in efficiency realized with the new automated system.
- **Medium to Long-Term (3+ months):** Ongoing optimization and potential expansion of the automated system, realizing continuous efficiency gains over time.

3. **Preferred Solution (Smart Fruit Grading System):**

- **Phase 1 - Planning (Month 1):** Detailed planning, including system requirements, resource allocation, and timeline development.
- **Phase 2 - Development (Month 2):** Build the Smart Fruit Grading System, incorporating advanced technologies.
- **Phase 3 - Testing (Month 3):** Rigorous testing of the system to ensure accuracy and reliability.
- **Phase 4 - Implementation (Month 4):** Integrate the Smart Fruit Grading System into the fruit grading process.
- **Short-Term (0-4 months):** Substantial improvements in efficiency, accuracy, and productivity realized.
- **Medium to Long-Term (4+ months):** Ongoing maintenance, updates, and potential further optimization of the Smart Fruit Grading System. Benefits include sustained efficiency gains, a significant reduction in errors and operating costs, and improved adaptability to market demands.

Costs

- **Do nothing (Manual Fruit Grading System):**

The cost of design and implementation will be nothing.

- **Do the Minimal (Automated Fruit Edibility Classifier):**

The total project costs encompass various components essential for the successful implementation and maintenance of the Automated Fruit Edibility Classifier. Key expenditures include the recruitment of four computer engineers, each with an average monthly salary of $3,200, to drive the technological aspects of the system. The mechanical infrastructure is a crucial element, with an estimated cost of $600, providing the necessary framework for the efficient movement of fruits along a 5-meter chain. Other significant costs involve the acquisition of materials such as a 50-meter wire priced at approximately $570, microcontrollers at $26.7 each, motors for chain movement and control at $300 per unit, and a mechanical divider for foods at $100. Additionally, the estimated cost for a meter of fruit chain is $17 for the mechanical line to move food.

Funding Arrangements and Ongoing Maintenance:

- **One-time Costs:**
  - Monthly salaries for four computer engineers: $3,200 x 4 = $12,800.
  - Data Collection and Annotation = $100

- **Infrastructure Costs (cost per line):**
  - 50m wire: $570
  - Motors and control for the fruit chain: 600$ per line
  - Mechanical divider for foods: $100.
  - Microcontrollers: $26.7
  - Mechanical structure: $600.
  - Estimated cost for a 5-meter chain for mechanical line to move food: $17 x 5 = $85.
  - Camera with HD resolution = $300

- **Implementation Costs (cost per line):**
  - 1 Technician = $2000

Total cost per line = $2281 + $2000 = $4281
The estimated number of lines in China is 10,000.
Total cost for all lines = $42,810,000
Total cost for the Automated Fruit Edibility Classifier = Total cost for all lines + one-time Costs
Total cost for the Automated Fruit Edibility Classifier = $42,810,000 + $12,900

Total investment for the Automated Fruit Edibility Classifier = 42,822,900$

- **Preferred Solution (Smart Fruit Grading System):**

The total project costs encompass various components essential for the successful implementation and maintenance of the Smart Fruit Grading System. Key expenditures include the recruitment of four computer engineers, each with an average monthly salary of $3,200, to drive the technological aspects of the system. The mechanical infrastructure is a crucial element, with an estimated cost of $1,000, providing the necessary framework for the efficient movement of fruits along a 5-meter chain. Other significant costs involve the acquisition of materials such as a 50-meter wire priced at approximately $570, microcontrollers at $26.7 each, motors for chain movement and control at $300 per unit, and a mechanical divider for foods at $100. Additionally, the estimated cost for a meter of fruit chain is $17 for the mechanical line to move food.

Funding Arrangements and Ongoing Maintenance:

- **One-time Costs:**
  - Monthly salaries for four computer engineers: $3,200 x 4 = $12,800.
  - Data Collection and Annotations= $5000
- **Infrastructure Costs (cost per line):**
  - 50m wire: $570
  - Motors and control for the fruit chain: 600$ per line
  - Mechanical divider for foods: $100.
  - Microcontrollers: $26.7

- Mechanical structure: $1,000.
- Estimated cost for a 5-meter chain for mechanical line to move food: $17 x 5 = $85.
- Camera with HD resolution = $300

- **Implementation Costs (cost per line):**
  - 1 Technician = $2000

Total investment per line = $2681 + $2000 = $4681
The estimated number of lines in China is $10,000.
Total investment for all lines = $46,810,000
Total investment for the smart Fruit grading = Total cost for all lines + one-time Costs
Total investment for the smart Fruit grading = $40,000,000 + $17,800
Total investment for the smart fruit grading = $46,827,800

Investment Appraisal

- **Do nothing:**

The value of the average labor in China per 9 hours of work (per day) is almost $50. Hence, the price for one labor in a month is 1500$. The assumption is that the number of lines needed in the China market is 10,000 lines. Making a total monthly price of $15,000,000, and a yearly total cost of $180,000,000. The following figure demonstrates the costs for 10 years.

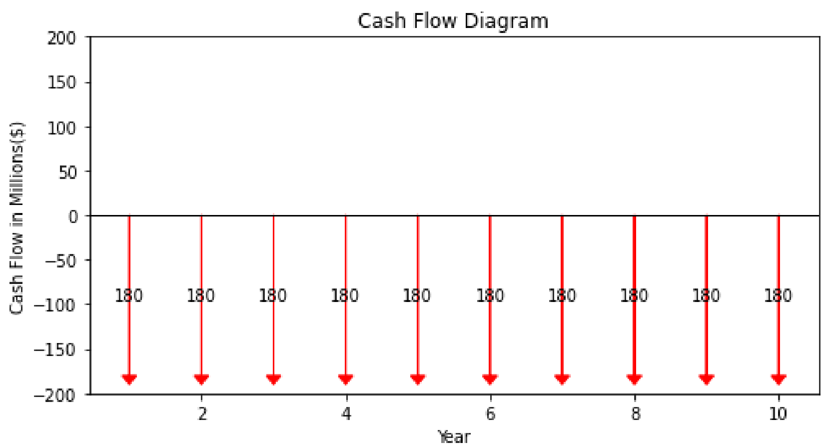

Figure 2. A cash flow diagram depicting the annual cost of the "do nothing" option.

The interest rate of China is set at 3.45%. Thus, the net present value (at year zero) of the "do nothing" option can be calculated using the following formula:

$$P = A\frac{(1+i)^N - 1}{i(1+i)^N}$$

Substituting the appropriate values for A (180), N (10) and i (3.45%) yields the following result:

The net present value = $1,500,000,000.

- **Do the Minimal (Automated Fruit Edibility Classifier):**

As previously mentioned, there are a total of 10,000 lines in China. By embracing this option, we anticipate a 15% reduction in the need for manual operation, leaving us with 8,500 lines that still require manual handling. The annual cost for maintaining these lines would amount to $153,000,000, calculated by multiplying the number of lines (8,500), the cost per line ($1,500), and the number of months in a year (12 months).

The following cash flow diagram incorporates the above cost along with the initial investment of $42,822,900. The first cash flow (at year one) is the sum of $153 million for labor and $43 million for initial investment.

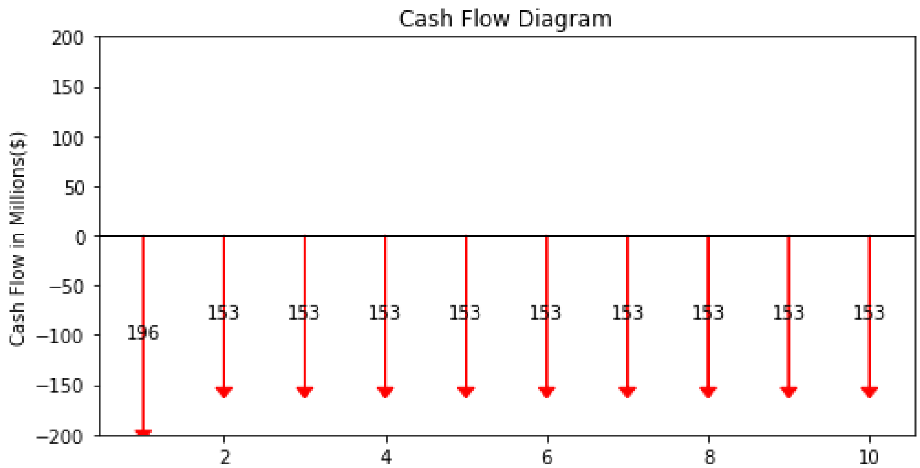

Figure 2. A cash flow diagram depicting the annual cost of the "Automated Fruit Edibility Classifier" option.

The net present value for this cash flow diagram will be:

$$153 \times \frac{(1+0.0345)^{10}-1}{(1+0.0345)^{10} \times 0.0345} + 43 \times (1+0.0345)^{-1} = \$1{,}317{,}000{,}000$$

The net present value = $1,317,000,000.

- **Preferred Solution (Smart Fruit Grading System):**

With the implementation of this option, we anticipate a substantial 85% reduction in the need for manual operation. This substantial reduction will leave us with only 1,500 lines that still require manual handling. The annual cost for maintaining these 1,500 lines is estimated to amount to $27,000,000. This calculation is derived by multiplying the reduced number of lines (1,500) by the cost per line, which is $1,500, and then further multiplied by the number of months in a year (12 months).

The following cash flow diagram incorporates both the initial investment ($46,827,800) and the annual cost of labor ($27,000,000).

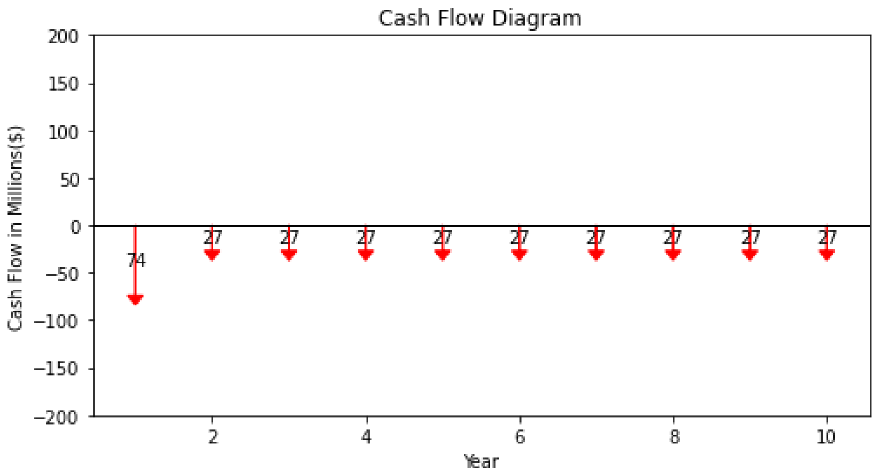

Figure 3. A cash flow diagram depicting the annual cost of the "Smart Fruit Grading System" option.

$$Net\ Present\ Value\ =\ 27 \times \frac{(1+0.0345)^{10}-1}{(1+0.0345)^{10}\ \times\ 0.0345} +\ 47 \times\ (1+0.0345)^{-1} = \$270{,}000{,}000$$

The net present value = $270,000,000.

Table 1. Tabular summary of the net present value of the cost of the three proposed solutions.

Proposed Option	Net Present Value (Millions)
Do Nothing	**$1,500**
Automated Fruit Edibility Classifier	**$1,317**
Smart Fruit Grading System	**$270**

The table presented above provides a concise summary of the net present values for the costs associated with the three projects over a period of ten years. Notably, the preferred solution exhibits a substantial cost reduction when contrasted with both the existing system and the automated fruit edibility classifier. This cost-saving advantage underscores the economic efficiency and viability of the chosen solution. Additionally, the second and third options could bring in more profits due to increased efficiency and reduced food wastage, though these potential profits are hard to quantify at this stage and won't significantly impact the decision-making process. Therefore, we're focusing our financial analysis on the core project expenses. In essence, all three projects have similar profit margins, emphasizing the importance of examining their primary operational costs.

Major Risks

Risk Category	Risk Definition	Likelihood	Impact	Owner / Place	Risk Details	Actions to prevent / reduce
Laws and regulations	Obtain a license to sell the system	**High**	**High**	Government minsters	Failure to obtain necessary licenses will hinder sales and operation of the Smart Fruit Grading System.	- Engage legal experts to navigate regulatory requirements. - Establish clear communication channels with regulatory authorities. - Allocate budget and resources for obtaining necessary licenses.
Market	Limited Market Adoption	**Moderate**	**High**	Marketing Department	The Smart Fruit Grading System may face resistance or slow adoption in the market, impacting the return on investment.	- Conduct market research to understand customer needs and preferences. - Develop a robust marketing strategy to promote system benefits. - Offer incentives for early adopters to encourage usage.
Operational	System Downtime	**Low**	**Moderate**	IT Department	Unexpected system failures or downtime may disrupt fruit grading operations, leading to financial losses.	- Implement regular maintenance schedules. - Have backup systems in place for critical components. - Provide training to staff for quick issue resolution.

Financial	Cost Overruns	**Moderate**	**High**	Project Manager	Unexpected increases in project costs may strain financial resources and impact the overall feasibility of the project.	- Establish a contingency fund for unforeseen expenses. - Conduct thorough cost estimation and risk analysis.
Scope Creep	changes are introduced that were not initially planned.	**Moderate**	**Moderate**	Project Manager	the uncontrolled expansion or addition of project requirements, features, or deliverables beyond the initially agreed-upon project scope	- Make a process that outlines how changes to the project scope will be evaluated, approved, and implemented. - Allocate budget and resources for these changes.