

THE FINANCIAL FEASIBILITY OF MODERNIZING PRODUCTION MACHINERY

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ABSTRACT

The performance of a machine affects production capacity, which is an important part of a supply chain network. This research concerns a fishmeal manufacturer, SJ Company, which has limited resources and capacity. It is faced with machine obsolescence problems: its old machines cause delays in the whole production process. Therefore, a new machine investment project is considered.

There are two scenarios for machine investments for this firm. Scenario 1 is Machine A with a capacity of 34-40 tons per day, which is appropriate for this firm's capacity and has the same capacity as the existing machine. Scenario 2 is Machine B with a capacity of 55-60 tons per day, which is bigger, and performs perfectly with big lots of raw materials.

Financial analysis methodology is applied, to compare each scenario with the other and with the existing machine. The research analyzes the feasibility of purchasing a new machine with regard to financial conditions and the value of changing machines. The results indicate that Machine B is better than the existing one over a long term period. It can make more incremental profit each year with the possibility of even more after completion of the monthly payments period.

บทคัดย่อ

การทำงานของเครื่องจักรมีผลต่อความสามารถในการผลิต ซึ่งเป็นส่วนสำคัญต่อโครงข่ายโซ่อุปทาน งานวิจัยนี้มุ่งกล่าวถึงบริษัท SJ ผู้ผลิตปลาป่น ซึ่งมีทรัพยากรและความสามารถในการผลิตที่จำกัด ปัญหาที่พบคือเครื่องจักรเก่า ส่งผลให้ระบบการผลิตล่าช้า ดังนั้นจึงมีการพิจารณาการลงทุนเครื่องจักรใหม่

การลงทุนเครื่องจักรมีทางเลือก 2 ทาง คือ หนึ่ง ลงทุนซื้อเครื่องจักร A ซึ่งสามารถผลิตได้ 34-40 ตันต่อวัน ซึ่งเหมาะสมกับความสามารถของบริษัท และมีความกำลังผลิตเท่ากับเครื่องจักรที่ใช้อยู่ สอง ลงทุนซื้อเครื่องจักร B ซึ่งสามารถผลิตได้ 55-60 ตันต่อวัน อีกทั้งยังมีขนาดใหญ่กว่า และสามารถรับวัตถุดิบได้มากกว่า งานวิจัยนี้ใช้วิธีการวิเคราะห์ทางการเงินเพื่อเปรียบเทียบเครื่องจักรทั้งสองตัวกับเครื่องจักรที่มีอยู่ มีการวิเคราะห์ความเป็นไปได้ในการซื้อเครื่องจักรใหม่ โดยคำนึงถึงสถานะทางการเงิน ความคุ้มค่า และมูลค่าของเครื่องจักรใหม่ ผลการวิจัยพบว่า ในระยะยาวแล้ว เครื่องจักร B ดีกว่าเครื่องจักรเก่าที่มีอยู่ มันสามารถเพิ่มผลกำไรในแต่ละปี และมีแนวโน้มที่จะทำกำไรให้มากขึ้น หลังจากพ้นระยะเวลาการชำระค่าเครื่องไปแล้ว

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INTRODUCTION

Manufacturing is a major activity in supply chain management. There is increasing need for machine investment to optimize capacity and remain competitive (Kehoe & Boughton, 2001). Modern manufacturing machines can improve capability, speed, and reduce cost. However, high investment costs are required. There is an initial cost for designing the manufacturing process or location to fit the new machine. This is part of the principal investment cost consisting of machine price, shipping, installation and taxes (Cheng, Simmons, and Ritchie, 1997). Therefore, the company has to balance costs against more profits, and the benefits or losses.

Background of the Study

SJ Company is a fishmeal manufacturer in eastern Thailand, established in 1971. It uses fresh fish to produce fishmeal, in five grades of quality classified by two main factors – protein, and total volatile basic nitrogen (TVBN). The firm's main product is in the two top grades of quality (out of five). These top two quality grades have higher profit margins than the rest, and there is higher demand for these two both locally and abroad. The target customers are big local chicken-feed manufacturers, including some exporters. The way for small manufacturing firms to survive in a market is to concentrate on groups of local customers (Mosey, Clare, & Woodcock, 2002).

Thailand's labor costs increase, as the government regularly raises the minimum wage. That necessitates increased productivity to pay for the increase. Also, the planet's climate is changing, which affects oceans. The number of ocean fresh fish is smaller now, and there is aggressive competition. All processes now need to be faster, to increase the turnover ratio. When fishermen have fresh fish they need to sell them fast, to have cash to fish again. Fishmeal firms must have fresh fish but this is perishable: purchases cannot exceed a firm's production capacity. Modern machines could shorten the production process and thus enhance capacity, which is the capability of workers, machines, and processes to produce a specific output per specified period (Blackstone (2008)).

SJ still uses its first machine bought over 40 years ago. Normally, a machine's useful life is around 10-15 years. SJ's machine is too old and no longer performs well. Machine breakdowns mean maintenance and repair costs. New fishmeal manufacturers use modern machine because they are smaller and technologically better, and most old fishmeal manufacturers have already bought new machines.

In addition, there is decreasing availability of experienced specialist workers (e.g. for temperature control). All these factors mean that SJ risks losing to competitors, but it now realizes its precariousness, hence the top management have commissioned this research project (Hacklin & Wollnofer, 2012). Any new machine must be able to produce the top two grades, minimize the worker problems, and pass a financial feasibility test.

Many modern fishmeal machines and cookers are available. SJ is committed to quality products, so the initial criterion for a machine is its ability to produce top grade quality. Some fishmeal cooker machines are deficient in temperature control or cannot achieve high temperatures. Some cooker machines are similar in shape but differ in size. SJ needs to identify how make a good purchase decision.

REVIEW OF RELATED LITERATURE

There are two major literature topics: firstly, the purpose of financial feasibility and analytical investment formulas; secondly, technology acceptance and management change. There is also Thailand's environmental impact on its fishmeal industry, and the increasing daily wage cost.

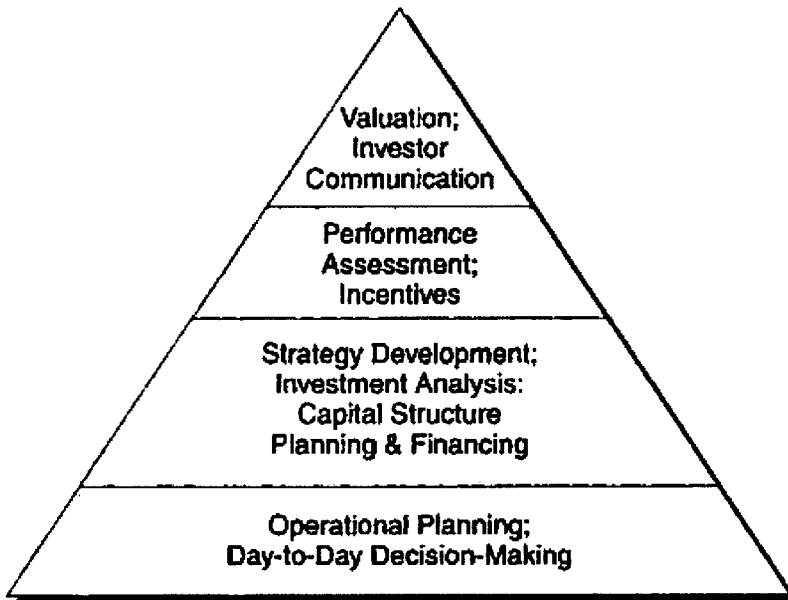
Purpose of Financial Feasibility Analysis

Project feasibility has to test high expectation from an investment, with consequential interest and payback of a loan, i.e. Return on Investment. Machine investments are high cost and risky. Analysis of the investment plan is crucial in assessing the viability of a project. Financial feasibility is ascertained from the estimated revenue less estimated expenses, resulting in a profit or loss (Oprea, 2010).

The financial conditions and operating performance are evaluated at the present time and for the future, to determine and mitigate financial risk. Expected return and expected risk are highly significant, and financial feasibility analysis is a smart tool to examine them (Fabozzi & Petersen, 2003).

Financial feasibility analysis evaluates four project areas, shown in Figure 1. The bottom of the pyramid involves making decisions about daily planning. Higher up, there is more complexity and the analysis becomes more extensive and advanced (Helfert, 2001). This specific research addresses the second level of the pyramid - the investment analysis of the capital structure planning and financing.

Figure 1: Financial Analysis Areas



Source: Helfert (2001)

The machine project should give a satisfactory rate of return, at least in the return on investment requirement. If it does not, the project is not feasible. The feasibility outcome determines whether the investment should be made, or the project terminated (Bennet, 2003).

Lender and Equity: Two Point of View

Oprea (2010) says that financial feasibility has two aspects: lender and equity. The lender's objective is repayment of interest and mortgage debt. The borrower has to generate sufficient cash flow to repay the interest rate and principal, and its capital needs to be of sufficient value to cover mortgage loans in case of forced closure or a project collapse. The lender has two factors as to whether to lend, the debt coverage ratio and the loan to value ratio. The debt coverage ratio is a relationship between expected net operating income and debt obligation payments; the loan to value ratio is involved with a relationship of pledge asset value and amount of mortgage. Regarding equity, the only factor for the investor is identifying the minimum rate of return and whether that is acceptable.

Criteria of Financial Feasibility

Remer and Nieto (1995) classified financial feasibility into five methods, each method having different points of determination, as shown below:

1. Net Present Value
2. Internal Rate of Return
3. Ratio
4. Payback
5. Accounting

Each method has a different role in its calculations.

This research examines the wisdom of the SJ owners investing in new production machines, and therefore investigates the rate of return or profitability from the machine's capacity. Julian and Seavert (2011) state that the net present value and internal rate of return methods are needed to examine costs and return, including the discount rate. These methods evaluate the results of profitability and cash flow revenue and whether they are sufficient to cover the new investment.

Net Present Value (NPV) is the outcome between cash inflows and cash outflows through a project's investment. Cash inflows more than cash outflows satisfy cash generating performance, and indicates project approval. This method is most efficient and thus examines profitability (Remer and Nieto, 1995).

In the calculations, the discount rate is a necessary factor which provides efficiency results. Most have minimum return rates that make any project suspect if it is above the Minimum Attractive Rate of Return (MARR), which represents the minimum rate of return to attract alternative investments of investor funds.

Net Present Value (NPV) Formula is:

$$\begin{aligned} \text{NPV} &= \frac{A_1}{(1+i)^1} + \frac{A_2}{(1+i)^2} + \dots + \frac{A_N}{(1+i)^N} \\ &= \sum_{n=1}^N \frac{A_n}{(1+i)^n} - I \end{aligned}$$

Where

$$\begin{aligned} A_n &= \text{Net cash flow at the end of period } n \\ i &= \text{MARR} \\ N &= \text{Life cycle of the project investment} \end{aligned}$$

I = Initial investment

Normally the project would be approved if the NPV results were positive, which indicates the amount of cash inflow over cash outflow and sufficient amounts of return to reach investor satisfaction. Park (2002) refers to the NPV rules for making decision as follows:

If NPV > 0, accept to invest
 NPV = 0, remain as never invest
 NPV < 0, reject to invest

Park (2002) also recommends that comparing each project: minimizing costs should be the main objective. Although the NPV method is a basic analytical profitability method, that is not the actual result.

NPV can be computed with another formula:

$$\begin{aligned} \text{NPV} &= \text{PV} - I \\ &= (\text{CF} * \text{PVIFA}) - I \end{aligned}$$

Where

PV = Present value of net cash inflow
 I = Initial investment
 CF = Net annual cash flow
 PVIFA = Present value interest factor of annuity

A document by Kasetsart University (n.d.) said that the advantage of NPV is its computation by the ‘time value of money rule’ which directly uses net cash flow data to find actual values. A disadvantage is its over-concern with profitability of present value and under-concern of the time period of the project.

Internal rate of return (IRR) is a value measurement which indicates whether the return rate from the investment is higher than the cost of capital. The IRR concept sets NPV as zero at the current rate of return, according to a zero value equivalent to the break-even point of the capital investment. An IRR result which exceeds NPV will equal profit from the investment (Julian and Seavert, (2011)). As the formula shows, IRR needs to equal the minimum attractive rate of return (MARR) which has a value of zero in this term.

$$\text{NPV} = \sum_{n=1}^N \frac{A_n}{(1 + i^*)^n} - I = 0$$

This decision process is similar to the NPV concept. It is the basic principle in investment, as investors always need a return which exceeds the break-even cost. Therefore:

IRR > MARR (0), accept investment
 IRR = MARR (0), remain as never invest
 IRR < MARR (0), reject investment

As Park (2002) suggests, even though NPV and IRR results are similar, the company should also be concerned with other factors such as size of the investment, scale of the project, or number of comparable projects.

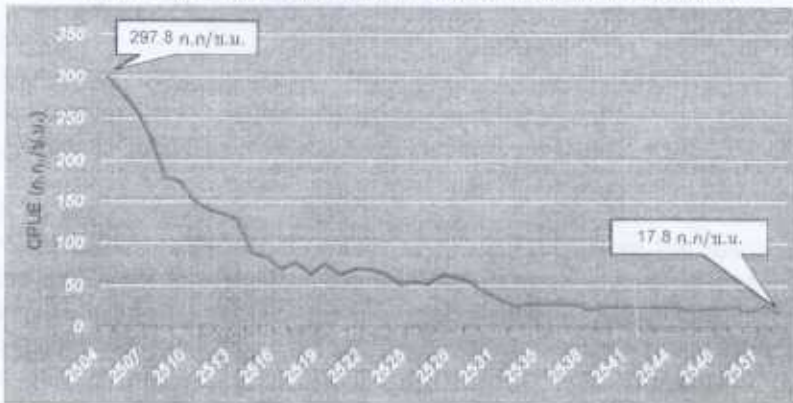
Technology Acceptance and Change Management

The Technology Acceptance Model or TAM is a concept which studies human behavioral attitude to new technology in a group or organization, without enforcement (Davis, 1989). New technology may be acceptable to some people but not others. Davis said that resistance to new technology is an extension of theoretical or reasoned action (TRA), which can be a barrier to an organization's improvement or prove difficult to achieve efficient performance. Acceptance or rejection has to be managed. Lewin's model of change management is useful, making change visible, more clearly understandable and easier to manage (Levasseur, 2001). There are three steps: unfreeze, change, and refreeze to embed the new behaviour.

Environmental Impact on the Fishmeal Industry

Nature is severely challenged by climate change. The volume of sea creatures has been decreasing for many years in the Gulf of Thailand and the Andaman Ocean.

Figure 2: Decreasing Aquatic Animal Count 1961-2008



Source: Marine Fisheries Research and Development

Figure 2 shows the decrease over 48 years. The aquatic animal volume has dramatically decreased from 297.8 to 17.8 kilograms per hour. This is a huge problem for the fishmeal and animal feed industries. In 2012 fishmeal produced was around 600,000 tons, of which more than 500,000 tons went to chicken farms, with about another 63,000 tons exported (worth about US\$70 million). Thus, the decrease affected supply chains (Manager Online, 2012). A connected problem is that fishmeal is produced from little fish (not suitable for human consumption), and overfishing, especially by huge foreign trawlers, causes the ocean ecosystem to collapse (Bunngoag, 2004). All this explains this fiercely competitive industry, and how greater efficiency and capacity from modern machines can be a competitive advantage.

Employee costs in Thailand also affect fishmeal manufacturers. The new minimum wage, from 1 April 2013, was an increase of 40%, with higher paid workers also expecting increases to maintain differentials (Charoensuthiphan, 2012).

RESEARCH METHODOLOGY

This research assesses whether a new machine would meet the tests of advantage and value in financial terms, whether it could make incremental profits above incremental costs: if not,

then retain the old existing machine. The research methodology is to collect data about resources, the company's machine capacity, details of the production process, and the manufacturer's layout information. Analysis is performed of the actual production costs and raw material quantity before computing NPV and IRR. Specifications of the considered machine alternatives are obtained.

Data Needed and Collection Methods

The required data is:

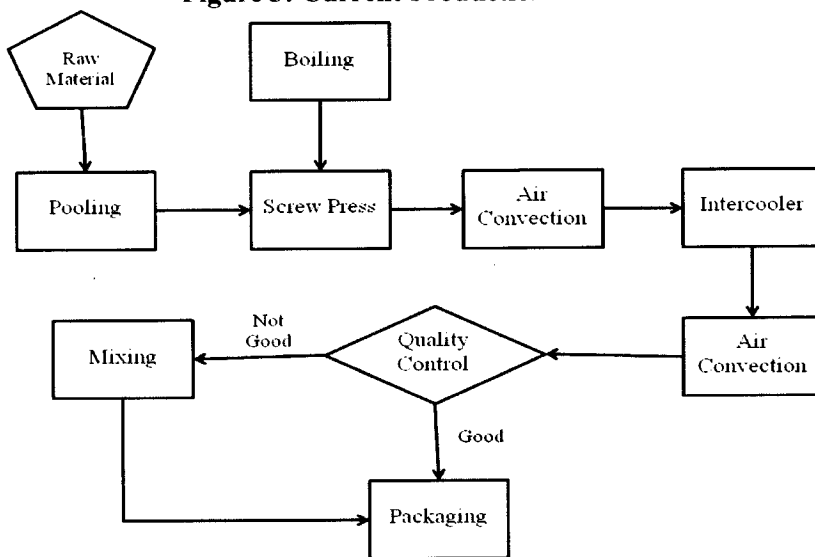
- Current production data: existing machine capacity, sales revenue, purchasing raw materials and production costs.
- Existing machine dimensions and manufacturer's layout.
- Total estimated costs: price, installation, and shipping.
- New machine information: capacity, dimensions, and machine life-time.
- The firm's minimum required rate of return.

The following techniques are used to collect data:

- *In-depth interviews*: with many types of jobholder e.g labor, clerk, technician, machine worker, and the owner.
- *Gather data*: of manufacturing activities, physical data such as plant layout and production capacity.
- *Document Review*: of existing records, e.g. sales revenue, purchasing costs, and utility costs; new machine capacity and cost.

A layout plan was constructed for the current machinery, which involves five cookers, three steam-boilers, a cooler and a mixing machine. This layout is the basis for redesigning the space to accommodate new machinery, but the research is concerned only with the cooker machines as they actually produce the fishmeal (the other machinery supports that process with steam-heat, cooling and mixing). From this layout, the production process can be mapped:

Figure 3: Current Production Process



Source: Author

The process map below shows detailing how fresh fish input is transformed into fishmeal output.

Table 1: The Production Process

Process	Description
Assembling	Receiving raw materials, cleaning, and storage for a while to prepare the condition of raw materials.
Boiling	Using firewood to build steam and release it along the tube which is connected with the cooker machine.
Screw press	The main work of the cooker machine. A big paddle inside spins, to mash and press the fish, using steam from the boiler. Then, the fishmeal is ready.
Air convection	Convect heat from new fishmeal by air though a small paddle roller.
Intercooler	Pass warm finished goods though, to enable test for protein and TVBN.
Mixing	Mix to achieve quality standard.
Packaging	Fill bags of finished fishmeal and seal them.

Source: Author

Data Analysis

Data was collected from company records for 2012, for sales revenue, price of fresh fish, and production costs (wages and salaries, electricity and firewood, and transportation This data is commercially sensitive and therefore cannot be shown here.

Machine Specification and Capacity

The old machine's specifications were collated: dimensions of the machine, capacity for raw fish material input per hour, firewood usage to make steam at 120 degrees Celsius, and electricity power usage. The company's production operates on six days a week, so the boilers are lit 288 times a year (there are four holiday weeks).

The new machine would be bought in Thailand to avoid the problems of high shipping costs, import taxes, and long-term maintenance. The two considered machines (cookers A and B) are guaranteed by international certificates of the British Standard BS/PD 5500 cat.2, European PED, and Australian AS1210. They both have similar rotary disc systems and full-automatic systems but they are different in capacity and size. These new machines need only one rotary disc cooker not five machines as in the old process.

Cooker Machine A

The rotary disc cooker's capacity is a bit smaller than the company's old cooker, but it is probably big enough for the company's need.

Cooker Machine B

This cooker has a higher capacity than the old machine. With a higher capacity, the company can produce in big lots which would reduce lost sales due to lack of capacity.

RESULT FINDINGS

Initial Investment Cost

The new machinery needs a different system from the existing. The firm has to set up the new machine with the existing boiler. There are additional costs of shipping and renovating the work area. The two scenarios have no difference in the machine's costs for adjusting to the existing boiler system, nor are shipping costs and space reconfiguration different. Costs of reconfiguring the working area is only the cost for moving out the old machine and placing the new one. Taking out the five old cookers creates a lot of space as only one modern cooker is needed. The total replacement costs are about US\$ 3,000.

The Two Scenarios

In the first scenario, the price of machine A is US\$ 160,000. The payment is separated by two periods, a deposit payment of 40% of the price; the rest being leased from a financial institution over a five year period (which adds US\$ 10,000 to the total investment cost).

In the second scenario, the price of machine B is US\$ 250,000. There would be a down-payment of 30%, the rest being monthly payments with a 10% annual interest rate³ over a five year period. Therefore, the total investment cost for Machine B would be US\$ 282,000.

Changes in Cost and Revenue from the New Machine Capacity

The changes in capacity directly affect the company's costs and revenue. Both new types of machines have been analyzed as follows.

In the cost and revenue calculations earlier, the company gained 667,300 baht (US\$ 22,200) from incremental output from Machine A (even with A's lower capacity than the old machine). The company would need to increase its working time from 2,592 hours per year to 3,142 hours per year, which requires more firewood, overtime labor costs and electricity. However, the gains from A's incremental revenue are 804,900 baht (US\$28,800) per year.

For Machine B, there is a change in three production factors. Capacity utilization of the new machine system is better than the company's old machine, and revenue increases by 1,504,900 baht (US\$ 50,500) similar to Machine A. But B's capacity per hour could reduce production time from 2,592 hours to 2,074 hours per year, which would reduce annual firewood usage. With the higher firewood consumption of 720 kilograms per hour, the firewood used is slightly higher in consumption but it reduces the number of days when boilers have to be lit. However, firewood costs rise by 204,087 baht (US\$ 6,800) per year. Electricity increases in number of units, with a higher cost of 170,702 baht (US\$ 5,700) per year. However, the increased revenue from B is still 1,130,117 (US\$ 37,300) baht per year.

Financial Analysis

Financial analysis defines whether this project would be financially feasible. The two financial tools as Net Present Value (NPV) and Internal Rate of Return (IRR).

For Machine A, the NPV shows a loss of 554,453 baht (US\$ 18,400). This result is lower than zero which means that this Machine cannot generate revenue to cover costs within the five year period. The IRR results for Machine A are not good enough to justify the investment. The company will receive incremental revenue of about 102,865 baht (US\$ 3,400) per year in the case of a five year period, and the company's minimum attractive rate of return requirement is equal to $MLR+1.75\%$. The results show -14.99% for this project which means that it will not make a profit within a five year period.

Machine B has higher capacity than the company's old machine. That decreases working time from 2,592 hours to 2,074 hours throughout the year, a reduction of 518 hours. Nonetheless, the company is concerned about the amount of capacity left in hand and they do not need to lose sales. The company would need to increase fishmeal production by more than 10% per year to avoid opportunity costs of lost sales. As there is a scarcity of fresh fish in the market, the company would have to source more by paying cash in deals with more suppliers. Normally, the company's suppliers have different credit terms depending on their different levels. However, to attract new suppliers the company would have to use an overdraft loan to be able to be competitive. The company will need to purchase raw fish for producing another 10% of finished goods, paying cash, and at an overdraft loan rate of 8.25%.

For B, revenue would increase by 779,609 baht (US\$ 26,000) per year with increased production. Although the company would need to spend 8.25% more because of the overdraft interest in purchasing raw fish, it would still be profitable. The NPV of machine B is 2,303,800 baht (US\$ 73,400) which is good. The IRR result is 34.76% at the end of the five year period, which shows that B could generate revenue to cover organizational expenses within five years.

Comparison between the Two Machines

From the financial analysis, Machine A's results are not satisfactory and Machine B's results are better. A is not appropriate to the company's requirements: the capacity does not accord with the amount of the company's raw materials and other particulars. So, the company should eliminate Machine A.

By contrast, Machine B shows better results. It has a higher capacity which means there is more opportunity for profit. B's results are quite valuable according to the NPV and IRR. In the five year period, B could cover 10% of the bank's interest and 10% of the company's minimum requirements. Machine B would be very beneficial after the fifth year when all payments had finished. In the sixth year, the company could increase the gap between costs and revenue of around 1,302,000 baht (US\$ 43,400) per year and probably reduce interest from overdraft loans. The revenue would increase by 40% compared to the old machine, with the company producing finished goods at full capacity.

CONCLUSIONS AND RECOMMENDATIONS

Machine B is indicated as the better alternative to B and the old machinery. With A, it would not be possible to complete the machine payment within a five year, period but Machine B could probably achieve that. B's higher capacity could reduce production time and costs. Financial analysis tools, NPV and IRR support the choice of B. The advantages of B are that it reduces firewood consumption per week, reduces lighting boiler frequency, has higher production capacity per day which provides higher revenue opportunity (greater than higher

costs), and makes enough net profit to clear machine costs and the company's minimum rate of return requirement.

Managerial Implication

Machine B is the best scenario to invest in this research after analyzing the financial tools. Factors used in the analysis such as firewood, electricity, labor, and transportation costs are not great and are controllable. However, raw fish varies in quantity because of weather and other natural conditions. B will not be effective if there is insufficient raw fish. Therefore, the company needs to provide sufficient extra raw fish through contracts with suppliers, specifying quantities and quality.

Normally there is no problem with a new machine in its first five years but regular maintenance is needed. Raw fish from the ocean is very salty. The workers should clean and inspect the machine monthly to ensure quality, minimize repair costs, and extend the machine's life expectancy.

Future Research Recommendation

The focus of this research is financial feasibility, and some details are not included - about suppliers and customers. One recommendation for future research is Customer Relationship Management (CRM). Quality raw fresh fish is the essential ingredient for production of fishmeal. To achieve long-term relationships with reliable preferred suppliers could be a competitive advantage. Another recommendation is Material Requirement Planning (MRP). This technique directly benefits the manufacturer by helping it to schedule and plan materials needed. It is very important and useful when exporting products. It reduces mistakes in production planning and actual production.

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