Decision on Switching to Full Color Digital Printing for Billing Application

by
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A Final Report of the Six-Credit Course
CE 6998 — CE 6999 Project

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The Graduate School of Assumption University has approved this final report of the six-credit course, CE 6998 — CE 6999 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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ABSTRACT

Kodak Versamark Inc. is the world's leader providing high-speed, 100% variable data digital color printing solutions. It provides the printing industry with a broad range of award winning hardware and software product for personalized direct mail, transactional documents, books and catalogs, addressing, and lottery applications for customer worldwide.

The current situation in printing industry and print service providers, whether in-house production departments or standalone printing businesses, have faced performance and cost constraints when using digital printing in their transactional documents or commercial printing services. As a result, the number of print service business applications for digital printing remain limited due to the inability of traditional laser (toner-based) technology to efficiently and cost-effectively deliver unique information in color at high volumes.

This project is illustrating the comparison in term of cost effective and productivity of the new proposing high-speed digital printing system based on continuous ink jet form Kodak Versamark versus the competitor, traditional Toner based digital printing system by IBM.

The new proposing delivers state of the art output with relatively higher level on the production capacity. On the aspect of return of investment, the proposing system produces the remarkably better profit percentage at the same competitive condition. Furthermore, with capability of full-color printing, this system will be able to utilized as tools for marketing department in generating other channels of business.

ACKNOWLEDGMENT

This project would not be able to complete without great contribution from the project advisor, Dr. Chamnong Jungtrirapanich, who guided me out of the mess at the beginning of composing this project. Here, I sincerely thanked for his valuable advises and late hours consultancy given to me.

I also would like to thank my company, Kodak Versamark (Asia Pacific) Pte.,Ltd., who led me into the printing industry and explored me to the international market experience in the industry, and all my dear friends and family who supported me physically and mentally throughout the working progress.

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I. INTRODUCTION

1.1 Back ground of the Project

Printing is a means of graphic communications. It is the reproduction of quantities of images, which can be seen or perceived visually. Regardless of the great number and variety of printed products they all have one thing in common; each has the same visibility

Mans's earliest known attempt at a visual record of his life and times dates back 30,000 years. Drawings, were known as pictographs, were superseded by the more complex ideographs of later humans. As the years progressed, the ideographs were replaced by the Persians' cuneiforms, and then by hieroglyphics which were perfected by the Egyptians around the year 2500 BC. Ten centuries later; the Phoenicians used the first formal alphabet. These were all art forms and not printing, which is the reproduction of art forms in quantity.

The first forms of printing started with the printer carving out characters from wood blocks to form printable "plate". The wood block was then inked and the substrate pressed against the wood block. The only problem with this type of process was that the characters within the block could not be changed. After printing with the block, it had to be discarded. As the writings changed, so did the block.

Half a century later in 1440, probably unaware of the crude type developed in the Orient, Johannes Gutenberg introduced to the Western world his invention of printing with ink on paper, using movable type mounted on a converted wine press. Until Gutenberg's invention, all books were laboriously handwritten by scribes. Little

wonder that historians credited his invention of printing as coinciding with the end of the Middle Ages and the beginning of the Renaissance and Modern History.

For more than 400 years after the invention of printing, all type was set by hand. By the 19th century, man began to consider the possibility of creating typesetting machines. Numerous machines intended to replace hand composition were invented. Of all the various types of type setting machines invented only two remained. Machines such as the Linotype, Intertype and Ludlow which cast metal slugs (one-piece fully spaced lines); and the Monotype which cast individual pieces of type in justified lines. The invention of these machines took place in the early 1900". As late as the early 1960", these machines were still considered "state of the art" The machines used hot lead to forge and mold type in slug or individual form. After usage, the lead type could be re-molten to be used again. During the late 1960", computer technology began to take form with the development of the computer/film system. Using an electric typewriter with a special punch tape unit, the punched tape could be taken to a computer controlled processor. Once the tape was fed to the processor, the punched tape would drive individual photo one by one to produce a page of text in another negative form.

The purpose of replacement digital printing is to reduce error and maximize output. As we have seen there are new technology invented into printing process such as movie industry. Movie industry has released hand bill and picture movie board. In the old time, picture movie board has been drawn and colored by hand. Today it has been printed on digital machine on poly-vinyl-chloride material. That would enlarge in size, capacity, speed and cost. The reliable printing machine has come and replaced former system. We also experienced the big advertising along the highway with real photo

picture whereas in the past there has been no any machines could print that size of pictures.

1.2 Objective

This project is constructed on the purpose to support the decision making on switching from Mono-tone digital printing to Full-color digital printing on the billing application. The revolution on this switching makes the possible printing fully variable data and color on the statement.

Apart from the technology of color printing, the report is mainly emphasized on the economic point of view in acquiring a digital printing system. In order to perform an analysis, cases of requirement will be included as a subject to determine

However, with the relatively realistic data to be analyzed, the theories of engineering economics will be employed such as, breakeven analysis and replacement analysis and productivity calculation with the add-on printing theory and some touch of marketing aspect.

The objectives of project are below:

(1) To build the decision support model for acquiring new digital printing system.

(2) To apply the engineering economic theories to determine the investment possibility.

1.3 Scope and Limitation of Work

This project will mainly be emphasized on the economic and financial point of view. As the highly amount of investment involved in this transition, the analysis on the return of investment will be constructed.

The scope of this project is to illustrate the point of breakeven in acquiring the new proposing system. The data and figures used for calculating and analyzing the answer are relied on the actual estimated number. This actual estimated numbers is obtained by machine distributor for the purpose of presenting customer the running cost and the profit if this machine acquired. Therefore, the numbers and figures given in the data are not quite realistic and tend to be optimistic.

The limitation of the project is the accuracy of the delivered outcome. These outcome and the analysis instructions can be used as the model. However, the figures input for calculating and analyzing should be adjusted according to actual available data, market situation and the economic condition currently.

II. LITERATURE REVIEW

2.1 Nature of Printing

To understand printing, one must understand the various printing methods used today to print a product. While there are many different printing methods used today, there are still four main methods:

Letterpress

2) Flexography

3) Gravure

4) Offset Lithography

Table 2.1. Printing Projection.

Distribution by Process
Printing, Publishing and Packaging

	1995	2025"
Offset Lithography	47%	30%
Water-based	46%	20%
Waterless	1%	10%
Gravure	20%	20%
Flexography	18%	20%
Letterpress	7%	2%
Screen & other Plate Systems	3%	2%
Electronic, ink Jet, etc (non-Plate)	5%	26%

* Projections by Mike Bruno, an industry consultant

2.2 Letterpress

Letterpress is the oldest and fastest diminishing method used today. Developed centuries ago by the Chinese it is still used to print newspapers, labels, etc. Its quality, however, is not that of the other main processes and tends to print mid to low quality.

The oldest form of printing, ink is applied to the top surface of the raised image area. This in turn is pressed against the substrate to transfer the image. From the 15th century until the mid 1940's, metal type was the only means for converting reading matter into standard type faces for printing.

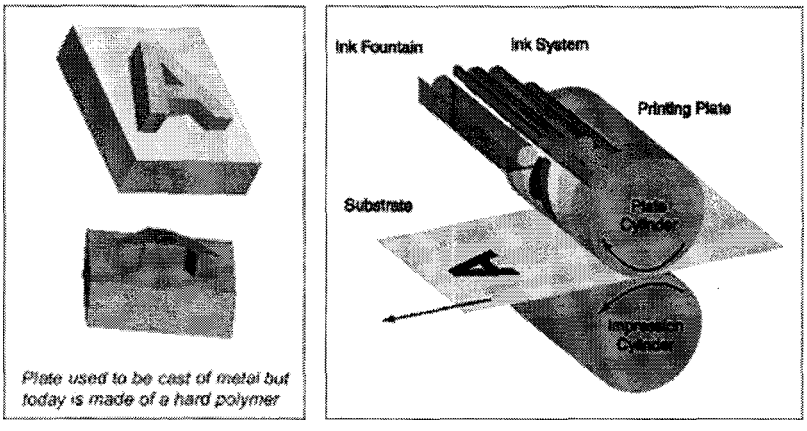

Figure 2.1. Letterpress.

Photographic typesetting and computerized composition developed in the 1960's has almost completely displaced metal liner casting and led to the decline of letterpress, as we know it today.

Ink fountain (reservoir) feed to a fountain roller which is wiped with a fountain blade to reduce film thickness and vary ink flow across the width. The ductor roller transfers ink to the main ink system where the thin ink film that is needed for printing is transferred to the substrate.

Inks used are thick in body, much like lithographic (offset) inks. The majority of printing done today by the letterpress process includes newspapers, labels and books;

however, the process is a slowly dying one as other better printing methods such as Offset and Flexography

2.3 Flexography

Flexography is a newer printing process developed during the mid 1900's. Flexography has found wide application in printing for food packaging with plastics and non-absorbent stock. It is also used to print envelopes, newspapers, pressure sensitive labels, etc.

"Flexo" - A branch of letter press, flexo is a relief process but differs in the composition of the image carrier, ink and the method of ink application.

The image carrier may be a molded rubber plate, a photo-chemically produced photopolymer plastic plate or an image etched into a rubber roller.

Low viscosity inks (both water and solvent) are used in flexo printing. A simple ink metering system is used. An "anilox" roll is a knurled roll with wells carrying a fixed volume of ink to the printing plate. The number of cells per linear inch determines ink carrying capacity. A coarse anilox may have 120 cells per square inch while an anilox roll used for fine halftone reproduction might have 500 cells per inch. Anilox rolls may be chrome plated, ceramic or plasma arc sprayed ceramic for long wear.

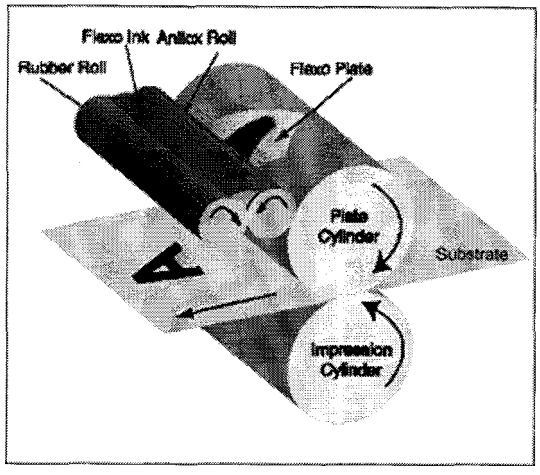

Figure 2.2. Flexography.

In the early 1950's this type of printing was known as Aniline printing since the "inks" were made with aniline dyes. It was found that many of these dyes were carcinogenic. The industry quickly developed pigment based inks but the name stuck. As a majority of printing was done on packaging the buying public did not forget the dye problem and was very hesitant to purchase packages printed with this process. The industry quickly changed the name to "flexography" as the plate was flexible.

Flexo, today, is primarily used for packaging, labels, wall covering, wrapping and envelope printing. Single color book printing is done on a hybrid flexo press that combines flexo with letterpress also is known as the Cameron Book press.

2.4 Gravure

Gravure is another old printing process used to print packaging, magazines, wallpaper, gift wrap, etc. The major advantage of Gravure is that it can print very long runs due to its configuration. Sear advertising, for example, can count into the millions of printed pieces. Unlike offset, Gravure uses a metal printing cylinder can handle these

types of long jobs without wearing out the printing cylinder. Money and postage stamps are also printed using a form of Gravure (Intaglio).

Rotogravure is an intaglio process meaning engraved or carved. The impressions are achieved by the transfer of ink from cells or depressions of varying depths, etched into the print cylinder to a web of paper at high speeds.

The process of printing involves coating the etched cylinder into an enclosed fountain or trough of ink and the etched cells are filled with ink. While the cells fill with ink, the surface of the cylinder (non-image area) also becomes coated with ink. This non-wanted ink is removed by a doctor blade or knife which wipes all of the surface ink from the cylinder. The printing cylinder comes in contact with the paper and the ink which remains in the cells is transferred to the paper.

High cylinder cost generally limits gravure to run lengths of over 1 million impressions, thus, gravure is a long run process. Gravure presses are also much wider than other printing type presses. Unlike Letterpress or Offset, the ink used is very fluid and is usually solvent based which in today's environment is undesirable.

Typical printed products would include packaging, catalogs, Sunday newspaper inserts (K-Mart, Parade Magazine, National Geographic, etc.)

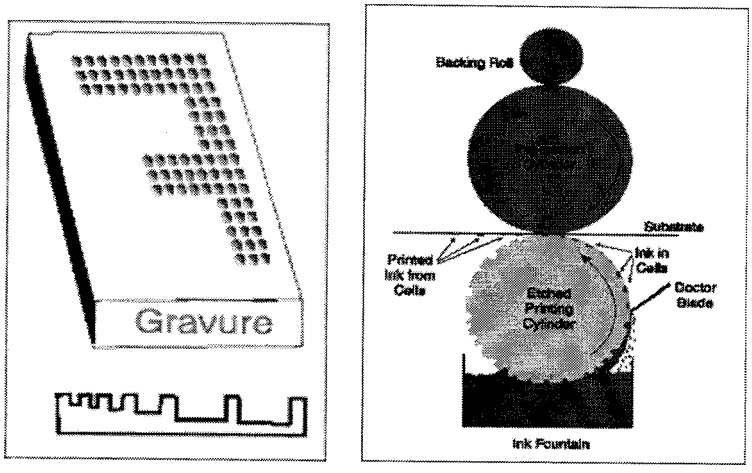

Figure 2.3. Gravure.

2.5 Offset Lithography

Offset Lithography was developed during the late 1800's in Germany and has become a very popular printing process. Offset Lithography is used to print newspapers, magazines, advertising, business forms, direct mail, etc. Offset is the most widely used printing process used today.

Lithography... "writing on stone". Its general meaning is planographic printing, or printing from a plane surface. Lithography is more known by its common name "offset".

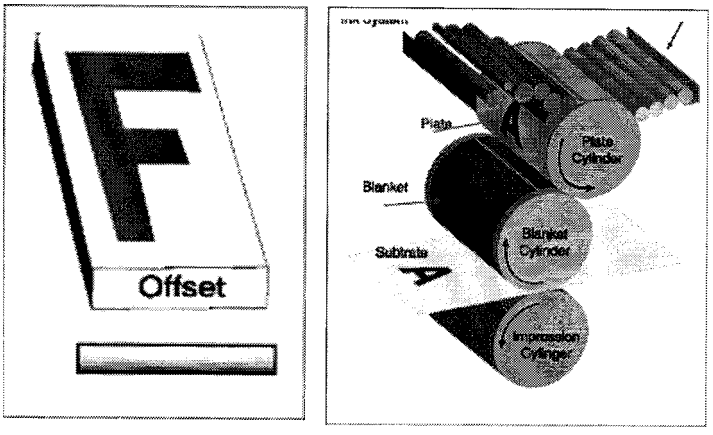

Figure 2.4. Offset Lithography.

Surface chemistry makes the image area water repellent and ink receptive while the non-image areas become water receptive and (as long as water is present) ink repellent. The process is known as "offset" because the ink and watered plate print on a rubber blanket cylinder which in turn, off-sets this ink and water impression onto the paper which is held on a third (impression) cylinder

The ink used is much like letterpress in that it is very viscous. The water used is actually known as "Fountain Solution" which contains special materials such as desensitizing gums, cleaners, buffering agents, etc. The plate is an aluminum base with a special oleophillic (grease loving) coating that becomes the image area. A delicate balance between ink and fountain solution must be achieved during printing. Offset printing accounts for approximately 47% of all printing done today.

The four above mentioned processes dominate the printing industry today. This will, of course, change during the next 25 years as other technologies come into being. Let's now start to explore the various different printing methods including the four main processes used today.

2.6 Printing Process Work Flow

There are three main processes to occur to get the idea to print to the customer:

(1) Press - The process for transferring image to substrate. electronic or conventional

(2) Post Press - final manufacturing processes; folding, die-cutting, etc.

As printing is changing today, the following diagrams depict the flow of a job from various plants; conventional, digital and a combination take over it.

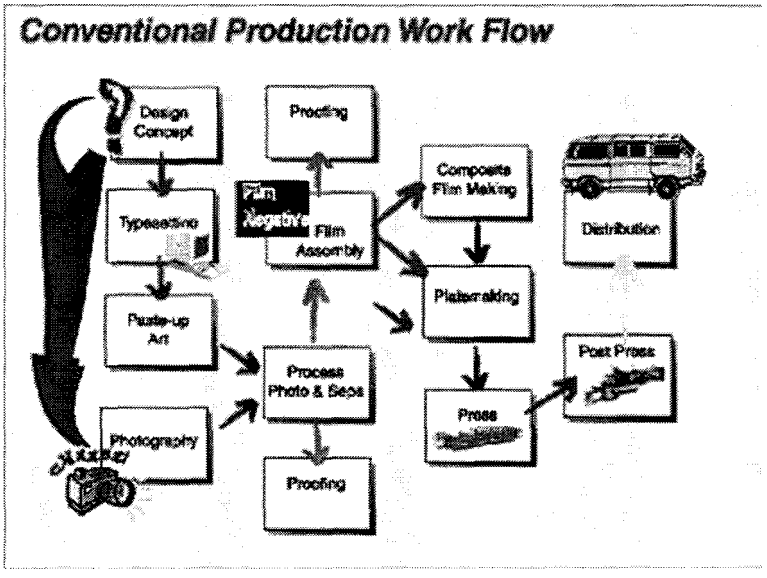

Figure 2.5. Conventional Production Work Flow.

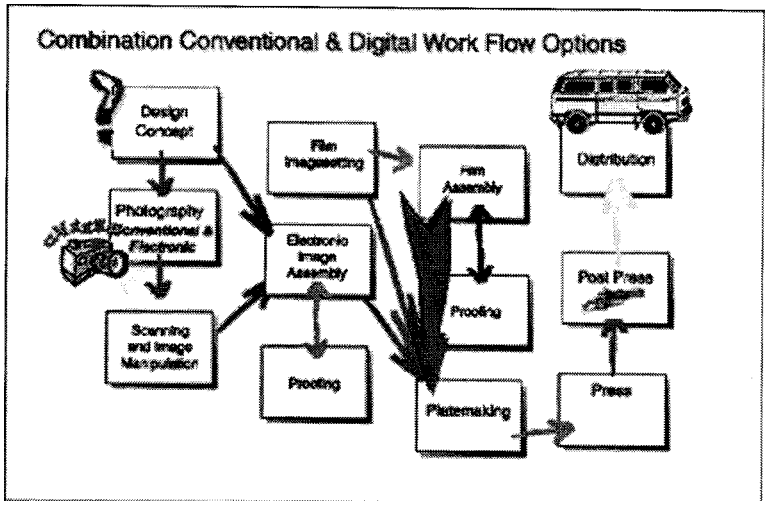

Figure 2.6. Combination Conventional & Digital Work Flow Options.

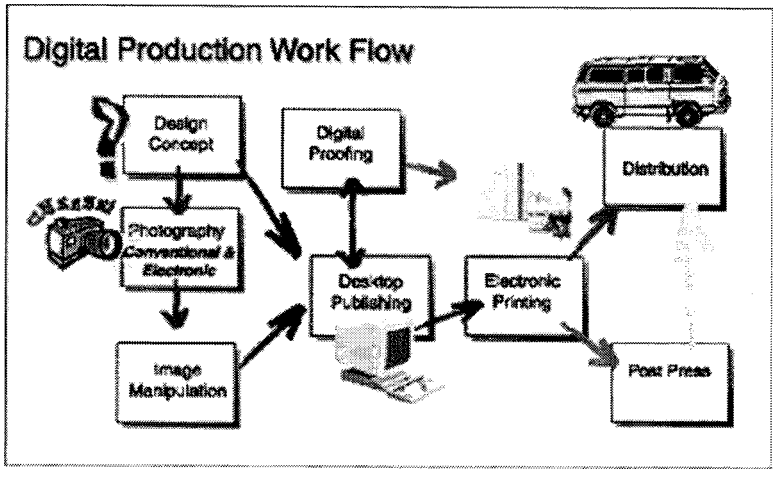

Figure 2.7. Digital Production Work Flow.

Digital printing has several advantages over conventional printing methods. When using digital presses, the content on an application can be changed for every document that is printed, if necessary. Changing the content for each document can be

useful for personalizing an application such as a direct mail piece. This method of printing is known as Variable Information Publishing.

For short runs, **digital printing cost** are usually lower than conventional printing because the digital workflow eliminates many of the manual operations of conventional processes. Time savings can be gained in prepress and the make-ready time on digital output equipment is less than conventional equipment. The time savings for short runs makes digital printing a good alternative to conventional printing.

The **color gamut** or range of color that digital equipment is able to reproduce is much larger than that of traditional offset equipment. This feature of digital printing equipment allows for the best possible color reproduction.

Using conventional printing methods, large print runs of a document are produced, stored, and pulled from stock as needed in order to gain the price advantages of a larger run. If changes to the document are required before all of the documents are used, the remainder would have to be destroyed eliminating the cost savings. With digital printing, there is no need to keep large quantities of an item in stock since it is so easy to make changes whenever they are required. Applications can be printed "on-demand" or " **just in time"** allowing you to print only what is required, when it is required, reducing the risk of having to destroy obsolete documents.

Digital print applications can be produced in almost any size. Equipment is available that can print images as wide as 16 feet and larger images can be produced in sections, or tiled. After printing, the individual pieces can be assembled to create the entire image.

It can be expensive to purchase conventional or digital printing equipment and to keep the technology current. This is especially true with digital equipment because

the technology and changes so rapidly that it can be expensive to continually update the equipment and remain competitive. The savings in make-ready time and the convenience in using digital equipment help to offset the initial cost and the cost of updates.

2.7 Digital Printing Image

Digital printing is generally defined as any type of print reproduction method that utilizes electronic files to produce a printed piece from spots and dots of ink, toner, or dye. Applying it to the print workflow has eliminated most of the manual steps involved with conventional print processes. Digital printing technology can be divided into two main classifications: **variable imaging** and **direct imaging.**

(1) **Variable imaging,** also known as **Computer-to-Print (CTPt),** is a totally digital workflow, from design and prepress through print output. Some Computer-to-Print systems use digital copying, laser, or ink-jet technologies, while other systems use a larger printer called a digital press in which the image carrier can be completely re-imaged for each impression. Common to all Computer-to-Print systems is the ability to produce print applications in which every page that is printed is different from the next one.

(2) **Direct imaging** uses electronic files to create films or plates for printing. Direct imaging technology includes the following:

Computer-to-Imagesetter (CTI): the electronic preparation of a print application through the stage in which film is output from an image setting device. The film is then used to create an image on printing plates which are mounted on a press to produce printed documents.

Computer-to-Plate (CTPe): Also known as **Digital Plate making,** Computer-to-Plate is the electronic preparation of a print application through the stage in which the printing plates (image carrier) are created. After imaging, the plates are mounted on conventional presses for print output.

Computer-to-Plate-on-Press (CTPs): the image is transferred directly from the digital files to the image carrier on a press known as a direct imaging press. This eliminates the need to mount plates onto the press. Many of the control settings such as image registration and ink flow are adjusted automatically as well.

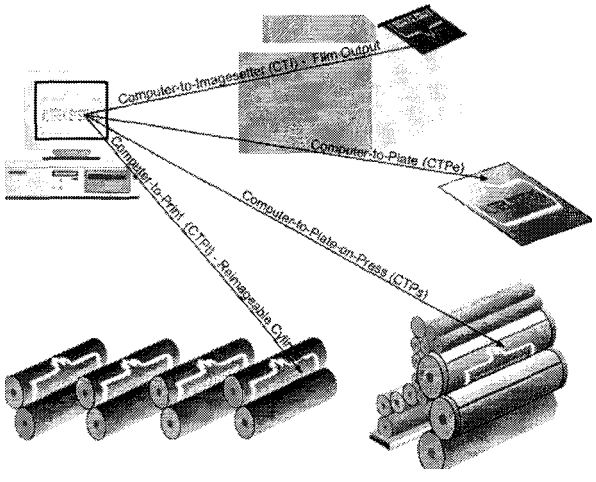

Figure 2.8. Direct Imaging.

2.8 Variable Information Publishing

Variable information applications, also known as variable data applications, are easily produced with digital equipment and can help businesses become more competitive. The variable information portion of a print application is the text and graphics that are altered for each printed piece produced during the same print run.

Sometimes only the name and address changes on every sheet and for other applications entire blocks of text, logos, and photos may change according to customer requirements. The nature of digital printing equipment makes it possible.

With traditional printing methods, applications that require variable imaging such as direct marketing pieces, are more limited and more time consuming than the same application manufactured with a completely digital workflow. A design consisting of background colors, company logos, text and photos may be produced with traditional presses so that they are of good quality and are produced quickly. The sheets are then run through some type of digital equipment such as a desktop laser or ink jet printer to insert personalized text for each consumer. This is basically like printing personalized information onto glorified stationery. The entire sheet could be produced on the desktop printer, but it would require much more time to print and the quality of the photos and graphics may not be as good as with traditional printing methods such as offset lithography. However, with the use of a larger digital press, many more sheets per minute can be printed and the print quality is better.

2.9 Breakeven Analysis

Breakeven Analysis refers to the calculation to determine how much product a company must sell in order to breakeven on that product. It is an effective analysis to measure the impact of different marketing decisions. It can focus on the product, or incremental changes to the product to determine the potential outcomes of marketing tactics (Hartman, 1999).

The output of the standard breakeven analysis. The unit sales volumes or actual sales amounts that a company needs to equal its running expense rate and not lose or make money in a given month. The formula for breakeven point in units is: The formula

for breakeven point in sales amount is: =Regular running costs/(1-(Unit Variable Cost/Unit Price)) This should not be confused with the recovering initial investment through the regular operation of a business. That concept, often confused with breakeven, is called the payback period.

The Breakeven Analysis helps the business owner determine the success of a business before it begins. It describes the number of units of a product or how many hours of a service must be sold to breakeven or to make a profit, or the effect that changing a product's price or reducing expenses has on profitability. This simple formula determines the breakeven point or the point where the business will begin to show a profit:

Breakeven Point = Fixed Expenses ÷ Gross Profit per Unit

Breakeven Analysis would help the management clears out the point where the investment has paid back. It would show the amount produce and period of payment. With BEP, it guides the organization in planning the sales strategy, volume targeting in order to achieve the cost and make profit. The above example of BEP was simple calculation in guiding to find BEP, however, in practical there would be some intangible cost add up. Printing industry has also intangible cost such as overhead cost which included electricity, salary and overtime, and maintenance on machine.

A calculation of the approximate sales volume required to just cover costs, below which production would be unprofitable and above which it would be profitable. Breakeven analysis is focuses on the relationship between fixed cost, variable cost and profit. In marketing sense, breakeven analysis refers to the calculation to determine how much product a company must sell in order to breakeven on that product. It is an

effective analysis to measure the impact of different marketing decisions. It can focus on the product, or incremental changes to the product to determine the potential outcomes of marketing tactics.

The formula for a breakeven analysis is:

Breakeven point ($) = (Total Fixed Costs + Total Variable Costs)

Total Variable Costs = Variable cost per unit x units sold

Unit contribution (contribution margin) = Price per unit - Variable cost per unit

Revenue per unit of volume is constant for every unit and varies directly with volume (revenue increases the more units we sell). Cost can be fixed or variable. Fixed cost remains constant regardless of the number of units. Some examples of fixed cost could be rent, property tax, and staff wages.

Variable costs are constant per volume. The amount is the same for each unit regardless of the number of units that are produced. Some examples of variable costs are material costs and sales commission.

2.9.1 Steps in Drawing Breakeven Point

The x-axis is the number of units and the y-axis is the sales revenue in dollars. Total revenue line always starts at the origin because when there are no units there is no money. Use two points to draw this line. Use your equation for total revenue and pick two x values. The easiest x values to use are when x is zero and when x is equal to the capacity (capacity is the maximum number of units that can be produced and this number is usually given). Substitute each x value into the revenue equation (one at a time) and solve the equation. The numbers you get represent sales re venue for that particular number of units.

Fixed cost line is drawn parallel to the x-axis. The y value for this line is the value of the fixed cost and remains constant regardless of the x value.

Total cost line is drawn in a similar manner to the total revenue. This line will start at the intersection of the fixed cost line and the y-axis. You can use the same two x values as you did for the total revenue line, or any other two x values o f your choice (x = 0 and x = capacity are the easiest). The breakeven point is the point where the total revenue line and the total cost line intersect. If you draw a vertical line from this point down to the x-axis you can find the breakeven point in units.

If you draw a horizontal line from this point across to the y-axis you can find the breakeven point in dollars. Fixed cost is the area between the fixed cost line and the x-axis.

The area between the fixed cost line and the total cost line represents the total variable cost in dollars for all levels of output. The area between the total revenue line and the total cost line to the left of the breakeven point represents the loss. If you sell fewer units than the breakeven point you lose money. The area between these two lines to the right of the breakeven point represents a profit. If you sell more units than the breakeven point you make a profit.

In summary of breakeven point, it is the point where you are not losing money and not making money either. It is good to know where this point is and how much of every dollar above that amount is profit.

Three terms must be defined first and then you need to calculate them. The first term is Fixed Costs. These are the costs that do not change whether sales go up or not. Some examples are rent, basic utilities, salaries/labor, memberships, car payments, equipment and lease payments, etc.

The second term is Variable Costs which are the costs that rise and fall depending on your sales. Some examples are the cost of the product sold, transportation, packaging, manufacturing costs, marketing, labor, etc.

The third term is Variable Cost Percent per Unit of Sales. Add up all the Variable Costs involved for each sale. Divide the variable cost per sale by the average sales price. The result is the Variable Cost Percent per Unit.

Example: If it costs $3 per unit and you sell the unit for $10, your Variable Cost Percent Per Unit is 30%. Fixed Cost divided by (1-Variable Cost Percent Per Unit). The result is the number of units you must sell to breakeven. To determine the dollar amount, multiply by the average amount of each sale.

This analysis is very valuable when making decisions about your business or a new venture. When looking at making a change to the marketing program, one can calculate the incremental breakeven volume, to determine the merits of the change. This determines the required volume needed such that there is no effect to the company due to the change.

When looking at making a change to the marketing program, one can calculate the incremental breakeven volume, to determine the merits of the change. This determines the required volume needed such that there is no effect to the company due to the change.

Perform a breakeven analysis. Provide: an algebraic statement of the total revenue, the total cost; a detailed breakeven chart; computation of the breakeven point in units, as a percent of capacity in dollars.

Algebraic solutions:

1) TOTAL REVENUE = (# Of Units) X (Revenue Per Unit)

We let x represent the number of units (because we have no idea what the number of units is). We know that the revenue per unit is the price at which the product can be sold.

2) TOTAL COST = Fixed Cost + Total Variable Cost

We were told that our fixed cost per period is *$valueB.* The total variable cost is the variable cost per unit (which they told us is *$valueA)* multiplied by the number of units (which we said was x). Now we can write our algebraic statement:

TC (Total Cost) = FC (Fixed Cost) + TVC (Total Variable Cost)

TC = *(valueB)* + *(valueA)x*

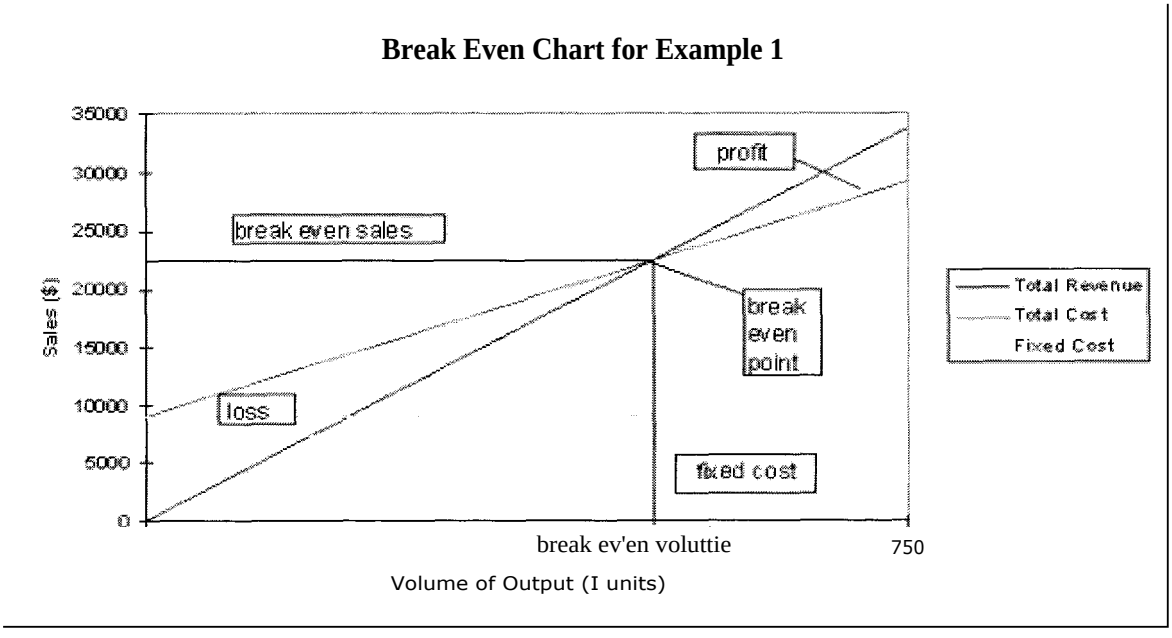

Figure 2.9. Breakeven Chart.

Determine breakeven point algebraically

We have the equation;

$$TR = FC + TVC + NI$$

We know that the NI is zero if we want the breakeven point, so the equation becomes

$$TR = FC + TVC$$

This is the breakeven point in units. This tells us that we must sell TR units to breakeven.

2.10 Replacement Analysis

The result of an alternative evaluation process is the selection and implementation of a project, asset, or service which has some estimated and planed functional or economic life. In time, companies often find it necessary to determine how the in-place asset may be replaced, upgraded or augmented. This analysis may be necessary before, at or after the estimated life. The results of the analysis, which is commonly referred to as "Replacement Study", provide answer to question such as

(1) Since the asset has become technologically obsolete, what is the most economic choice- upgrade or complete replacement?

(2) Which of the identified alternative should be accepted as a replacement?

(3) What is the most economic life estimate for an asset?

(4) Should I keep the asset for one more year before replacement?

The logic and computation of the replacement analysis will be discussed. There may be significant income-tax consequences to replacement especially a premature one.(Blank, 1998)

In order to perform a replacement study of an in-use asset and one or more alternatives. The analysis will be following the below steps;

Reason. Understand the basic reasons why a replacement study is performed.

Basic concept. Define the basic concepts and data for a replacement study.

Study period. Select the better of defender or challenger alternatives using specified study period.

Two approaches. Illustrate the difference between the conventional and cash-flow approaches to replacement analysis.

Economic service life. Determine the economic service life of an asset which minimizes the AW measure of worth.

The basic replacement study is designed to determine if currently used asset should be replaced. The term replacement study is also used to identify a variety of economic analyses which compare a currently owned asset with the augmentation by new, more advanced features; with custom upgrading of in-place equipment; or with retrofitting of existing, undersized, or oversized equipment.

Whether unplanned or anticipated, replacement is considered for one or more of several reasons;

(1) **Reduced performance.** Because of the physical deterioration of parts, the ability to perform at an expected level of reliability (being available and performing correctly when needed) or productivity (performing at a given level of quality and quantity) is not present. This usually results in increased costs of operation, higher scrap and rework costs, lost sales and larger maintenance expenses.

(2) **Altered requirement.** New requirements of accuracy, speed or other specifications have been established. These requirement cannot be met by the existing equipment or system. Often the choice is between complete replacement or enhancement through retrofitting or augmentation.

(3) **Obsolescence.** International competition and the rapidly changing technology of automation, computers and communications make currently used systems and assets perform acceptably but less productively than equipment coming onto the market. Replacement due to obsolescence is always a challenge, but management may want to undertake a formal analysis to determine if newly offered equipment may force the company out of current markets or may open new market areas. The ever-decreasing development cycle time to bring new products to market is often the reason for premature replacement studies, that is, studied performed before the estimated functional or economic life is reached.

2.10.1 Basic Concept of Replacement Analysis

In most engineering economy studies two or more alternatives are compared. In a replacement study, one of the assets, referred to as the "Defender", is currently owned (or in-place), and the alternatives are one or more "Challengers".

For the analysis we take the "perspective (viewpoint) of the consultant or outsider; that is we are assume that we are currently own or use neither asset and we must select between the challenger alternative(s) and the in-place defender alternative. In order to acquire the defender, therefore, we must "invest" the going market value in this used asset. This estimated market or trade-in value become the first cost of the defender alternative.

There will be new estimates for the remaining economic life, annual operating cost (AOC), and salvage value for the defender. All these values will likely differ from the original estimates. Because of the consultant's perspective, however, all estimates made and used previously should be neglected in the replacement analysis.

2.10.2 Replacing Decision Making

The decision-making on whether replacing the existing system with the new advance technology system will be highly met the economy aspect. As the high amount of investment on the proposing system with regarding relatively high production capacity required. The decision on investing on the new system need to be carefully analyzed.

The following works will emphasis on the factors, which illustrate the economic details of each system. These details will be discussed in term of production and financial. Further, there will be a comparison of both systems to provide the criteria of making decision.

2.11 About Digital Printing Features, Capacity, Types of Output

The business application of digital printing primarily is printed on demand characteristic. The digital printing has ability to print personalized data such as address, statement or bar-coding application.

2.12 Printing Classifications

2.12.1 Push/Pull Models

The "push" and "pull" models are the two classifications into which all variable information applications are grouped. A company that sends personalized documents to an individual or group based on the information that the company know about the target audience, is using a push model. The company may keep track of the interests and

buying patterns of individuals and groups and issue new information and product offers when they believe individuals in their target audience are ready to buy.

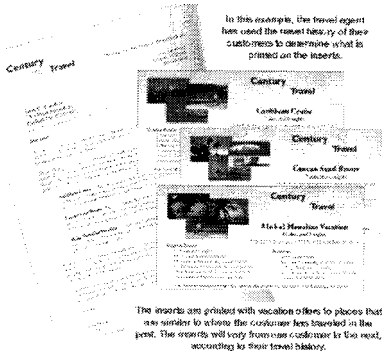

Figure 2.10. Push Model.

When a company responds directly to the inquiry of an individual, they are using a pull model. Variable information documents related to the inquiry can then be created on demand so that the customer has a quick response to their request. Digital equipment allows documents to be produced quickly. It makes no difference if 1 or 1000 are printed because the price is the same for each document.

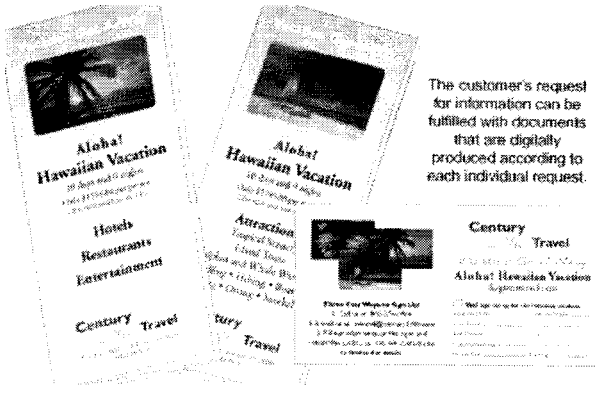

Figure 2.11. Pull Model.

2.12.2 Personalized

Personalized applications are variable information documents that are produced for one person. Some personalized applications simply combine the name and address of the individual with the same document going out to everyone else on a mailing list

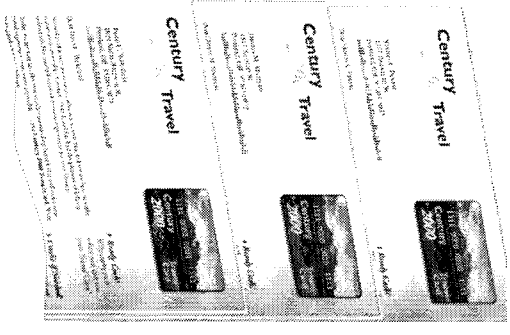

Figure 2.12. Personalized Brochures.

There are also many personalized applications in which the name and address not only change, but some of the text and graphics as well, so that the piece is much more personalized for each individual. For direct marketing, personalized pieces often follow a "pull" model in that a company responding to the requests of an individual with a quick correspondence.

2.12.3 Customized

Customized applications are variable information documents that are changed according to the requirements of a specific group. For direct marketing, they often follow a "push" model in that a different type of document is sent to each specific group based on the requirements or interests of the group. Each group may receive the same document format, but with some changes in text and graphics so that the document relates specifically to the group.

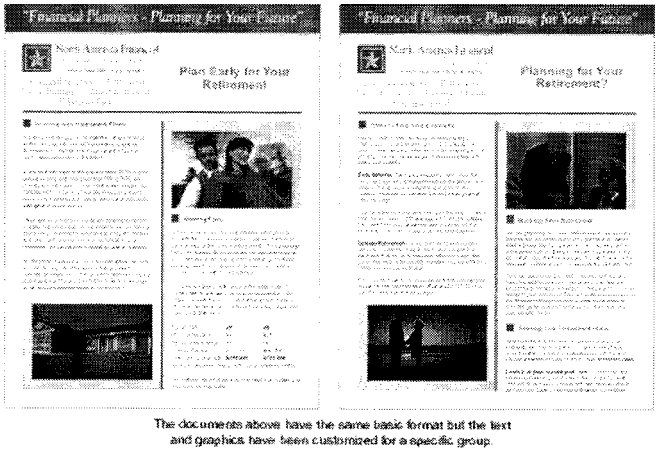

Figure 2.13. Customized Brochures.

2.12.4 Database Publishing

Some applications require so many variations in the information presented that complete changes in the layout, text, and graphics are required. A database of information is required to store all of the information required for an application. For example, do-it-yourself manuals offered by a building supply company may have many different versions for the same type of project such as building a deck. Changes in the instructions, supply lists, and illustrations have to be made for each style of deck while the basic format for each manual may be similar.

A database contains data that relates to a particular subject or product. It is used to store and manage the information. The data contained in the database could be names, address, product numbers, company or product descriptions, or any other details pertaining to the subject or product. The data can be in the form of text or images.

The data is stored in tables where each record has a number of fields containing information relating to that record. The information in the fields can be accessed for use in many areas, such as direct mail, variable imaging and detailed reports.

2.12.5 Organizing Data

The table that contains the data that you enter into your database should be broken into small units which make up the fields for each record in the table. Breaking the information into small units will allow for greater flexibility when you are want to extract information from your database for printing and report analyzing. The data should be broken into units such as customer's first name, customer's last name, address, state, zip, phone and e-mail address. The data can then be queried by one or any number of the individual units.

Your database will probably contain more than one table of information. A table organizes the information into rows and columns. The rows represent individual records and the columns are the individual fields for each record.

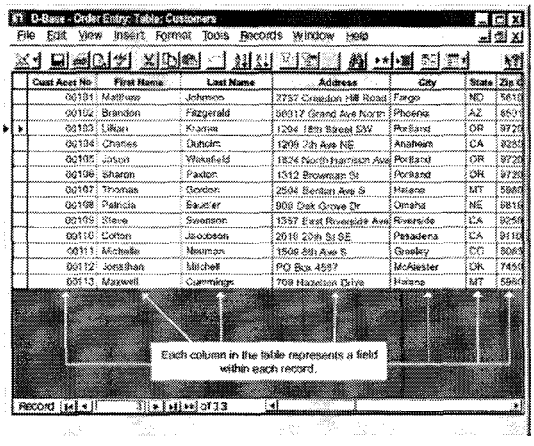

Figure 2.14. Organizing Data.

2.12.6 Mail Merge

With the use of mail merge, a different name and its corresponding address is merged with a generic document. It's basically the merging of the mailing list from a database with the same document for everyone on the mailing list. The mail merge is the simplest form of database publishing.

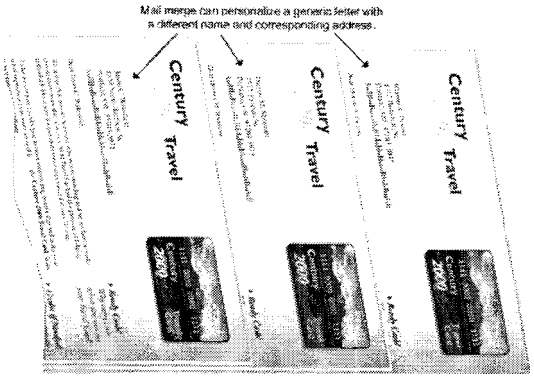

Figure 2.15. Mail Merge.

2.12.7 Versioning

Versioning involves more than just changing the name and address for each document. Documents may have photographs and graphics that change for different customers, but the basic format of the document remains the same. Different customers are basically receiving a different version of the same document. For example, a company issuing a monthly newsletter may have many articles and graphics to include in the newsletter, but only the articles and graphics important to each customer are used. Customer A would get a newsletter with their name and address and articles that are pertinent to their interests, while customer B would get a newsletter with completely different articles and graphics based on their interests. Both customers may get some of the same articles as well. The different articles are kept to the same length and different photographs and graphics are the same size so that they can all be plugged into the same areas of the layout. It is possible that every customer would receive a different newsletter, depending on the number of elements that are changed, but the basic layout of the elements would remain the same. Variable imaging printing equipment allows versioning to work easily because each different newsletter can be printed during one

press run. Besides newsletters, other products that are printed using versioning are manuals, booklets, brochures, and training pieces.

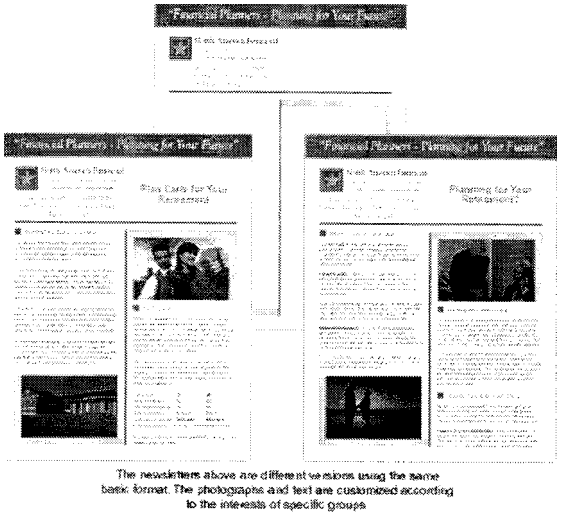

Figure 2.16. Versioning.

2.12.8 Variable Layout

A step beyond mail merging and versioning of the same format, are variable layout applications. With variable layout applications, not only are the personal information, photographs, and graphics variable, but the basic layout of the document is variable as well. Text blocks, photographs, and graphic elements can be added, deleted, and rearranged in order to give each document a completely different look.

2.12.9 Transaction Oriented

Applications such as bills and statements are being personalized by banks and other financial institutions to provide additional information that is important to an individual customer or group of consumers.

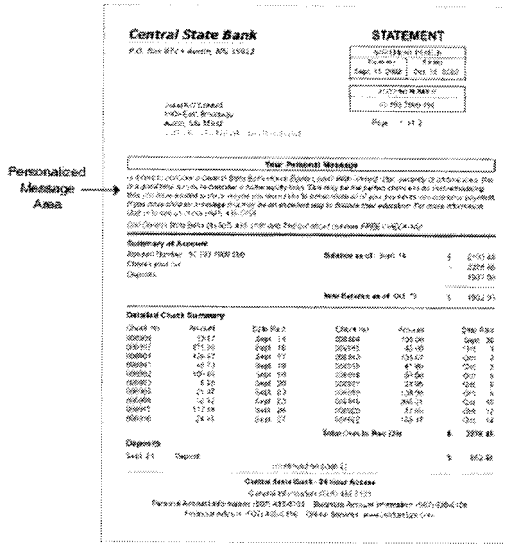

Figure 2.17. Transaction Oriented.

2.12.10 Direct Mail

One of the most common types of applications produced with variable information equipment is direct mail documents. Variable information direct mail marketing is replacing generic forms of mass marketing and is one of the most cost effective ways for an organization to reach individual customers and groups and increase sales.

Direct marketing must meet the specific requirements of a person or group. With variable information technology, a company can customize a document, such as a monthly statement to include the information requested by the customer and eliminate information which has no importance for that particular customer. Consumers respond more favorably to documents created specifically for them. Direct marketing improves customer service and provides a positive affect for the company through increased responded rates. However, a negative impact can be made if after gathering infoimation,

the company doesn't follow through and customize a document according to the requests of the customer.

Another negative affect can be created if the consumer receives a marketing package in which the personalized information is inaccurate, or key elements such as the customer's name are misspelled. Also, too much personal information can make the consumer uneasy and leave them wondering how all of the personal information was gathered.

All direct mail applications use some degree of database publishing such as mail merge or versioning. Nearly 90% of all direct mail non-catalog applications can be classified as a self-mailer with a reply card, an envelope (with contents), or a postcard. The other 10% consists of posters, booklets, brochures, publications, and samples.

2.12.11 Self-Mailers

Most self-mailers consist of three or more panels with one of the panels being a reply card that the recipient can fill out and return. It is very important to have to use the proper perforation with the self-mailer. It should be strong enough to keep the entire piece intact and yet it must detach easily when the mailer is ready for use. A perforation that is difficult to detach will decrease the response rate.

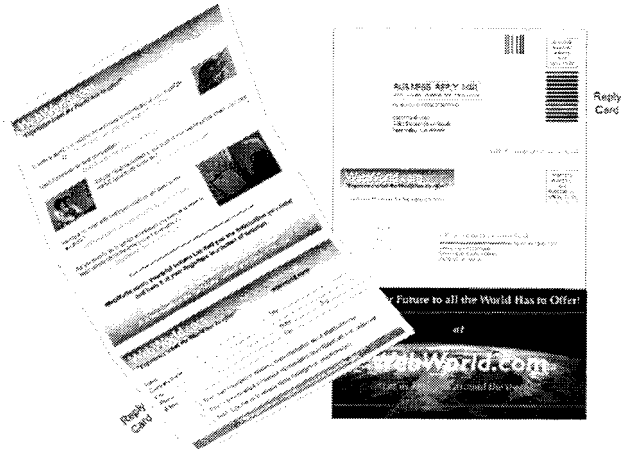

Figure 2.18. Self-Mailers.

2.12.12 Postcard

A postcard is used to deliver a specific key message to the recipient and may contain all text, mostly an image and very little text, or any other combination of text and images. Do not try to put too much information on the card because it can have a negative affect. Most people will not take the time to read a card that is crammed with information. A simple message and graphic are all that are necessary in order for a key point to be noticed.

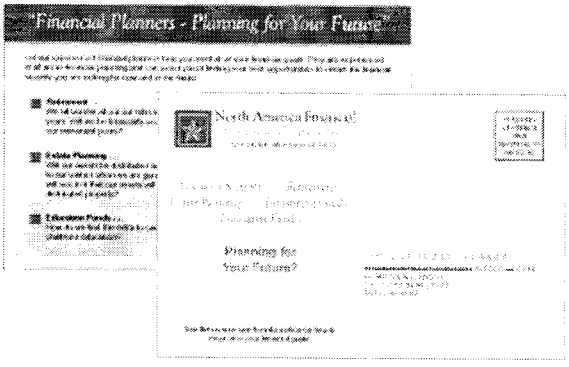

Figure 2.19. Postcard.

2.12.13 Just-in-Time Printing

When using conventional printing methods, the main reason for having a large quantity of printed materials on hand is cost. The cost per printed piece decreases as the volume increases when using conventional equipment. Printing a large quantity can be very economical as long as the entire quantity of printed documents are used, but what if the content of the document must be revised while there is still a large quantity of the original print application left in stock? The remaining documents would be of no use and would have to be destroyed, creating waste and making a potentially economical print application much more costly.

Just-in-Time (JIT) digital printing changes the conventional workflow by eliminating the need to have large quantities on hand. JIT systems are more aptly called print-on-demand systems because the product does not have to be produced until their is a demand for it. This is due to the ease of producing printed items with a fully digital workflow. The expense of producing large inventories and warehousing them is eliminated. The price per printed piece is the same for any quantity when using digital

equipment. If the content of a print application must be changed suddenly, there is less chance of having a large quantity in stock that must be destroyed. Just-in-time digital printing reduces waste, reduces inventory, and is very cost effective for short run applications.

III. BREAKEVEN ANALYSIS

In this chapter we are determining the cost and the possibility of acquiring the proposing system against the competitor system. In this case we emphasized on the cost and profit generate by each system. As well as comparing the period of time to breakeven if any of these system are employed.

However, these two systems have their own different technical specifications. This differentials will not engage in this analysis at the moment. As we are mainly preoccupied with the economic point of view.

In this case, the pricing information based on the middle range of service is charged by the printing service provider. The real cost of production and the profit making of the service provider is a confidential information. Therefore, the printing charge of 0.78 Baht is determined by the subtracting the other cost out of the whole sum of charge. The sum of charge including the postage is 4 Baht per envelop. We are deducting the postage charge of 0.7 Baht and the envelop costs around 0.36 Baht. The average number of page for each account is 3 sheets which cost the statements charge of 2.34 Baht. It leaves the margin and overhead of the document inserting at 0.66 Baht. Therefore, this estimated printing charge is quite realistic and accountable enough to be used for this analysis.

Determining the throughput, there is a standard unit, which is "impression per minute (IPM). The definition of the IPM is when printing image on the paper one image page will be counted as one impression. Therefore, when printing out one sheet of document that contains image on front and back. So we will count the throughput of that one page as two impressions.

3.1 The proposing system

The proposing system is the Advance Technology Digital color printer from Kodak Versamark. This printer is a commercial high-speed printer with ability to print duplex (front-back printing with full color on the front page and black on the bottom page.

The following is the information with the details of variable running cost for the proposing system.

Table 3.1. Estimated pricing from machine manufacturer.

Kodak Versamark VT 3000 $^{4}/_{1}$ 350 feet/min		
Machine cost	51600000	recommended retail price
Maintenance cost	3,612,000	per year (7% of the system cost)
Ink cost/litre	300	recommended retail price
Ink consumption	25000	page/litre (ink coverage 25%)

The average price charged by the printing service provider is *0.78* Baht. Per page A4.

Table 3.2. Printing service charge and cost details.

Printing Service Charge (A4 size		
Service Charge	0.78	Baht per page
Material cost	0.3	Baht per page
Printing cost	0.2	Baht per page
Overhead cost	0.1	Baht per page

As the detail above, each page of printing, the printing service provider will make revenue of *0.18* Baht per page A4.

Hence, the amount production should be produce in order to gain the breakeven. The new implementation of the new system should be;

$$Breakeven = \frac{Fix\ Cost}{Revenue - Variable\ Cost}$$

In this case, fix cost will be the machine cost and the cost incurred with the printing activity will be classified as the variable cost.

$$\textbf{Breakeven} = \frac{51600000}{0.78-0.6}$$

Therefore; Breakeven = *286,666,667* sheets

However, in implementing printing industry there are intangible cost that cannot be avoided; overhead and maintenance cost.

Based on the working hour of 12 hours per day with 22 working days per month. With the quarterly analysis period, the average production capacity of this system will be determined under the following condition.

Table 3.3. Estimated quarterly machine capacity.

maximum capacity (sheet per min)	Productivity (%)	Working hour per quarter	Production Capacity per quarter (Sheets)
350	85	792	14,137,200.00

From table above, we define as a quarterly analysis. These values will be used for calculating the breakeven where this new acquired machine will pay off and start to produce profit. These values are derived from the normal practice of working condition which the productivity does not set at the 100%. The conventional machine productivity will be ranged from 80% to 90%. In this case we choose the nominal of the range which is 85% productivity to be fair condition.

The quarterly interval which uses to format this analysis giving a reasonable length of period to determine the economic condition. Most companies monitor their economic condition quarterly, therefore this period format would make the committee board to conveniently review the possibility of acquiring new system according to their perspective.

Once the working condition and all the costing detail obtained, now we are looking at the overview characteristic how this new system generates the cost and profit when this machine is on the production with the controlled condition. Refer to the attached Table 4.4, it contains the information on costing and revenue obtained by running the machine at the constant environment.

After the cost and revenue analysis on the new system has been constructed. This chart is ploted from the data determined on the Table 4.4. The graphical breakeven analysis as illustrate in Figure 4.1;

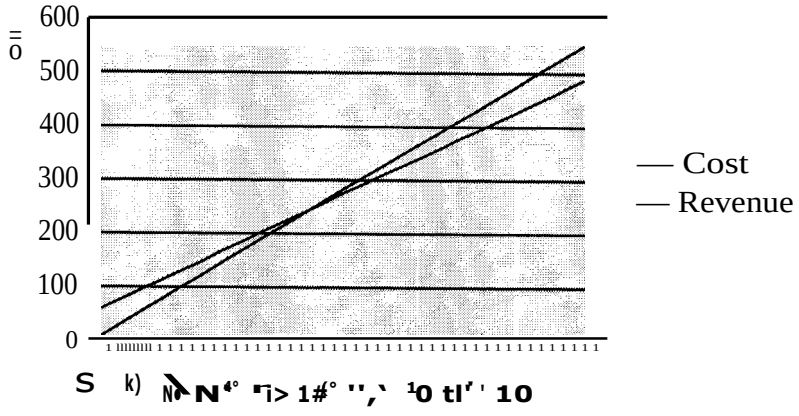

Figure 3.1. Graphically Illustrate the Period of Breakeven.

At Figure 3.1, we can see the chart of cost and revenue. Both lines are raising up almost to linear which results from most of the costs are variable cost except the machine price. For revenue, the chart characteristic is perfectly linear as result from the revenue of this activity is count by sheet and the printing service provider's income or expenses are determined in the unit of sheet produced.

The crossing point of revenue and cost chart, as we can see, it crosses at the time interval of quarter 21st to quarter 26th . This crossing point indicates where the breakeven point starts.

Production Cost from the proposing system.

Quarter	terial	Overhead		maintena nce	Machine Cost	Total Cost	Total Cost Accumulate		Production Accumulat	Revenue	Revenue Accumulate
	$4,241,160	$1,413,720	$2,827,440		$51,600,000	$60,985,320				$11,027,016	11,027,0161
CV	$4,241,166	$1,413,720	$2,827,440					14137200	28274400	1$11,027,016	
	84,241,160	$1,413,720	$2,827,440			$8,482,320		14137200	424116001		$33,081,0481
	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$86,432,280	14137200	56548800		
	,241,160		$2,827,440				$95,817,600	14137200	70686000	1$11,027,016	$55,135,0801
	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$104,299,920	14137200	84823200	1$11,027,016	
	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$112,782,240	14137200	98960400	$11,027,016	
	4,1		$2,827,4461			$8,482,320		14137200	113097600		
	$4,241,160		$2,827,440			$9,385,320	$129,746,880	14137200	127234800	$11,027,016	$99,243,1441
P	$4,241,160	$1,413,720	82,827,440			$8,482,320	$138,229,200	14137200	141372000		
		$1,413,720	$2,827,440			$8,482,320	$146,711,520	14137200	1155509200		$121,297,1761
			$2,827,440			$8,482,320	8156,096,840	11413720	1169646400		$132,324,1921
		$1,413,720	$2,827,440					14137200	183783600	$11,027,016	$143,351,2081
	$4,241,160		$2,827,440			$8,482,320	$173,964,480	14137200	197920800	1$11,027,016	$154,378,2241
N	$4,241,1W		4132,827,440			$8,482,320	$182,446,800	14137200	212058001		E13110
	$4,241,160	$1,413,720	$2,827,440			$8,482,320		14137200	226195200		
		$1,413,720	$2,827,440	000.£06113				14137200	240332400	$11,027,016	
	$4,241,160		$2,827,440					14137200	254469600	$11,027,016	$198,486,2881
	$4,241,160	$1,413,72A	$2,827,440			$8,482,320	$217,279,080	114137200	268606800	$11,027,016	$209,513,3041
	$4,241,160	$1,413,72A	$2,827,440			$8,482,320	$225,761,400	14137200	282744000		$220,540,320
	,241,160		$2,827,440			$9,385,320			296881200	$11,027,016	$231,567,3361
		$1,413,72(T)	$2,827,440				6242,726,040	14137200	311018400		
	$4,241,160	$1,413,720	$2,827,44			$8,482,320	$251,208,3641	14137200	325155600		$253,621,3681
	,241,160		$2,827,440			B8,482,320		14137200	339292800		$264,648,3841
			$2,827,440					14137200	353430000		$275,675,400
		$1,413,720	$2,827,440				$278,461,320	14137200	367567200	$11,027,016	$286,702,4161
	$4,241,160	$1,413,7241	$2,827,440				$286,943,640	14137200	381704400		$297,729,432
	$4,241,160	$1,413,720	$2,827,440			$8,482,320		14137200	395841600	$11,027,016	$308,756,448

Production Cost from the proposing system (continue).

a	Material	Overhead	Printing Cost	maintenance		Total Cost	Total Cost Accumulate	Production	Production Accumulate	Revenue	Revenue Accumulate
32	$4,241,160	$1,413,720	$2,827,440	$903,000		$9,385,320	$304,811,280	14137200	409978800	$11,027,016	$319,783,464
33	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$313,293,600	14137200	424116000	$11,027,016	$330,810,480
34	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$321,775,920	14137200	438253200	$11,027,016	$341,837,496
35	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$330,258,240	14137200	452390400	$11,027,016	$352,864,512
36	$4,241,160	$1,413,720	$2,827,440	$903,000		$9,385,320	$338,740,560	14137200	466527600	$11,027,016	$363,891,528
37	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$347,222,880	14137200	480664800	$11,027,016	$374,918,544
38	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$355,705,200	14137200	494802000	$11,027,016	$385,945,560
39	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$364,187,520	14137200	508939200	$11,027,016	$396,972,576
40	$4,241,160	$1,413,720	$2,827,440	$903,000		$9,385,320	$374,475,840	14137200	523076400	$11,027,016	$407,999,592
41	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$382,958,160	14137200	537213600	$11,027,016	$419,026,608
42	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$391,440,480	14137200	551350800	$11,027,016	$430,053,624
43	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$399,922,800	14137200	565488000	$11,027,016	$441,080,640
44	$4,241,160	$1,413,720	$2,827,440	$903,000		$9,385,320	$409,308,120	14137200	579625200	$11,027,016	$452,107,656
45	$4,241,160	$1,413,720	$2,827,440			17,790,440	1 14137200	593762400	1$11,027,016	L$463,134,672	
46	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$426,272,760	14137200	607899600	$11,027,016	$474,161,688
47	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$434,755,080	14137200	622036800	$11,027,016	$485,188,704
48	$4,241,160	$1,413,720	$2,827,440	$903,000		$9,385,320	$443,237,400	114137200	636174000	$11,027,016	$496,215,720
49	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$451,719,720	14137200	650311200	$11,027,016	$507,242,736
50	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$460,202,040	14137200	664448400	$11,027,016	$518,269,752
51	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$468,684,360	14137200	678585600	$11,027,016	$529,296,768
52	$4,241,160	$1,413,720	$2,827,440	$903,000		$9,385,320	$478,972,680	14137200	692722800	$11,027,016	$540,323,784
53	$4,241,160	$1,413,720	$2,827,440			$8,482,320	$487,455,000	14137200	706860000	$11,027,016	$551,350,800

Table 3.5. Data Prepare for Linear egression (proposing system).

X	Y1	Y2	XY1	XY2	
1	60,985,320	11,027,016	60,985,320	11,027,016	1
2	69,467,640	22,054,032	138,935,280	44,108,064	4
3	77,949,960	33,081,048	233,849,880	99,243,144	9
4	86,432,280	44,108,064	345,729,120	176,432,256	16
5	95,817,600	55,135,080	479,088,000	275,675,400	25
6	104,299,920	66,162,096	625,799,520	396,972,576	36
7	112,782,240	77,189,112	789,475,680	540,323,784	49
8	121,264,560	88,216,128	970,116,480	705,729,024	64
9	129,746,880	99,243,144	1,167,721,920	893,188,296	81
10	138,229,200	110,270,160	1,382,292,000	1,102,701,600	100
11	146,711,520	121,297,176	1,613,826,720	1,334,268,936	121
12	156,096,840	132,324,192	1,873,162,080	1,587,890,304	144
13	165,482,160	143,351,208	2,151,268,080	1,863,565,704	169
14	173,964,480	154,378,224	2,435,502,720	2,161,295,136	196
15	182,446,800	165,405,240	2,736,702,000	2,481,078,600	225
16	190,929,120	176,432,256	3,054,865,920	2,822,916,096	256
17	200,314,440	187,459,272	3,405,345,480	3,186,807,624	289
18	208,796,760	198,486,288	3,758,341,680	3,572,753,184	324
19	217,279,080	209,513,304	4,128,302,520	3,980,752,776	361
20	225,761,400	220,540,320	4,515,228,000	4,410,806,400	400
21	234,243,720	231,567,336	4,919,118,120	4,862,914,056	441
22	242,726,040	242,594,352	5,339,972,880	5,337,075,744	484
23	251,208,360	253,621,368	5,777,792,280	5,833,291,464	529
24	260,593,680	264,648,384	6,254,248,320	6,351,561,216	576
25	269,979,000	275,675,400	6,749,475,000	6,891,885,000	625
26	278,461,320	286,702,416	7,239,994,320	7,454,262,816	676
27	286,943,640	297,729,432	7,747,478,280	8,038,694,664	729
28	295,425,960	308,756,448	8,271,926,880	8,645,180,544	784
29	304,811,280	319,783,464	8,839,527,120	9,273,720,456	841
30	313,293,600	330,810,480	9,398,808,000	9,924,314,400	900
31	321,775,920	341,837,496	9,975,053,520	10,596,962,376	961
32	330,258,240	352,864,512	10,568,263,680	11,291,664,384	1,024
33	338,740,560	363,891,528	11,178,438,480	12,008,420,424	1,089
34	347,222,880	374,918,544	11,805,577,920	12,747,230,496	1,156
35	355,705,200	385,945,560	12,449,682,000	13,508,094,600	1,225
36	365,090,520	396,972,576	13,143,258,720	14,291,012,736	1,296
37	374,475,840	407,999,592	13,855,606,080	15,095,984,904	1,369
38	382,958,160	419,026,608	14,552,410,080	15,923,011,104	1,444
39	391,440,480	430,053,624	15,266,178,720	16,772,091,336	1,521
40	399,922,800	441,080,640	15,996,912,000	17,643,225,600	1,600
41	409,308,120	452,107,656	16,781,632,920	18,536,413,896	1,681
42	417,790,440	463,134,672	17,547,198,480	19,451,656,224	1,764
43	426,272,760	474,161,688	18,329,728,680	20,388,952,584	1,849
44	434,755,080	485,188,704	19,129,223,520	21,348,302,976	1,936
45	443,237,400	496,215,720	19,945,683,000	22,329,707,400	2,025
46	451,719,720	507,242,736	20,779,107,120	23,333,165,856	2,116
47	460,202,040	518,269,752	21,629,495,880	24,358,678,344	2,209
48	469,587,360	529,296,768	22,540,193,280	25,406,244,864	2,304
49	478,972,680	540,323,784	23,469,661,320	26,475,865,416	2,401
50	487,455,000	551,350,800	24,372,750,000	27,567,540,000	2,500
1,275	*13,689,336,000*	*14 059,445,400*	*439,720,935,000*	*473,334,661,800*	*42,925*

Now take a closer look at the point of breakeven where exactly the point of breakeven lie on which quarter. This can be determined by the linear regression approach. With linear regression approach, we have to prepare some data to analyze the outcome.

The attached Table 3.5 contain the prepared data for calculating the exact point when the breakeven occurs. In Table 3.5, let x be the number of quarter of production, y_i represent the cumulative cost of production and *y2* represent the cumulative revenue produced by the new system.

By the formula of linear regression approach, we will apply this formula to the prepared data.

Y= $a+bx$

b= $\frac{Zxy\ nxy}{Zx\ (x) - nx}$

a= $y-bx$

Assuming y_i = Cost of production and y2 = Revenue

Cost fraction line would be:	Revenue fraction line would be
b=439,720,935,000-50(25.5)273,786,720 / 42,925-50(25.5)(25.5)	*b=473,334,661,800-50(25.5)(281,188,908) / 42,925-50(25.5)(25.5)*
b= *9,362,548.38*	b= *11,027,016.00*
b= *9,362,548*	
a= yi - bx	a= y2 - bx
a= *273,786,720425.5) 9,362,548*	*a= 281,188,908425.5)11,027,016*
a= *35,041,746*	a= 0

Then y_i = *35,041,746 + 9,362,548* (x) and y_2 = *0+11,027,016 (x)*

Next step is finding breakeven point,

$$11{,}027016(x)-9{,}362{,}548(x) = 35{,}041{,}746-0$$

$$1{,}664{,}468(x) = 35{,}041{,}746$$

$$x = \underline{21.06}$$

A period when cost and revenue are equal at the quarter of *21.06.* This is because of the machine itself pays and starts to gain profit at that period of time. This figure will play an importance part in decision making whether the new system will be acquired.

The breakeven period of 21.06 quarter is between year 5th and year 6th. Therefore, when the management decides to purchase the proposing system. The expected production period at the full system's capacity should be at least 5 years duration in order to reach the breakeven point.

3.2 The Competitor

The competitor of the proposing system is the monotone printer with laser technology. This technology has been widely used in the market for statement printing for about 10 years. At the time when this technology was launched, it was highly accepted by users in the industry. The reasons are its relatively high production speed, acceptable print quality and reliability of the system.

Table 3.6. Machine & Service cost of competitor system.

IBM Infoprint 4100 250 feet/min		
Machine cost	30,400,000	recommended retail price (US$ 800,000)
Maintenance cost	3,040,000	per year (10% of the system cost)

As we can see in Table 3.6, the machine cost of the competitor system is lower than the proposing system. But the maintenance charge in term of percentage is higher because the competitor system contains more wearable parts than the proposing system. Therefore, the maintenance cost factor is higher as they have to cover more items in the maintenance list.

Table 3.7. Cost detail of competitor system.

Mailing Service Charge (Standard size envelope)		
Service Charge	0.78	Baht per page
Material cost	0.38	Baht per page
Printing cost	0.25	Baht per page
Overhead cost	0.1	Baht per page

For the printing service charge of both proposing system and competitor system, the pricing charge to customer is similar, even the printing service charge is possibly at the higher price. But for this case we will set at the equal service charge, this will create a fair competitive condition for both system.

The material cost of the competitive system can be higher than the proposing system. This is caused by the require of the background pre-printed image. As this system only prints black image, therefore the background such as company logo or corporate image has to be pre-printed before printing the personalized data. However, this cost is normally responsible by the end customer. Therefore, the material cost for this discussion is set as the plain (non pre-print) paper.

Therefore, the profit makes from this machine will be *0.13* Baht per sheet. Now we are looking at number of sheet to be produced in order to reach the breakeven.

$$\text{Breakeven} = \frac{\text{Fix Cost}}{\text{Revenue - Variable Cost}}$$

The fix Cost in this case will be 30,400,000 Baht which is the machine cost. The variable cost will be the 0.73 Baht and the revenue will be the same as previous case, 0,78 Baht. Now we are substitute the value in to the equation.

$$\text{Breakeven} = \frac{30400000}{0.78\text{-}0.65}$$

Therefore, the breakeven of this case will be *233,846,153.85* sheets. In this case, the breakeven point seem to be a little lower than the proposing system.

With the same working condition as the proposing system , now we are looking for the productivity at each quarter.

Table 3.8. Production Capacity of Competitive System.

maximum capacity (sheet per min)	Productivity (%)	Working hour per quarter	Production Capacity per quarter (Sheets)
200	85	792	8,078,400.00

The result of cost and revenue analysis from the competitive system will be shown in the attached Table 4.8

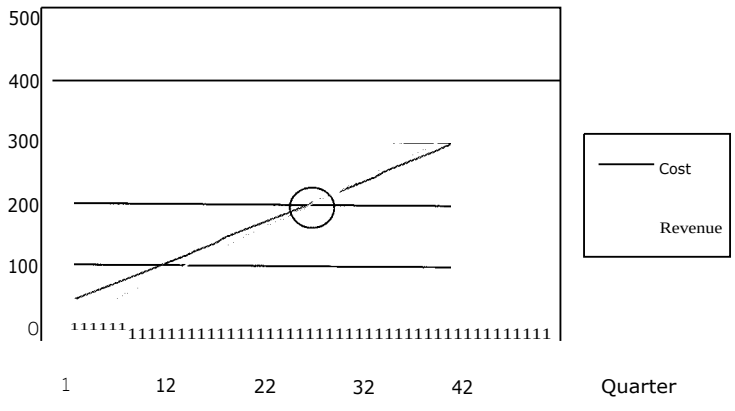

Figure 3.2. Graphical Breakeven of Competitive System.

[illegible] Production Cost from the competitive system.

[illegible]	Material	Overhead	Printing Cost	[illegible]	Machine Cost	Total Cost	Total Cost Accumulate	Production	Production Accumulate	Revenue	Revenue Accumulate
	$3,029,400	$1,009,800	[illegible]	[illegible]	$30,400,000	$37,723,700	$37,723,700	10098000	[illegible]	$7,876,440	$7,876,440
N	$3,029,400	[illegible]	$2,524,500			[illegible]	[illegible]	[illegible]	20196000	$7,876,440	[illegible]
M	[illegible]	[illegible]	[illegible]			$6,563,700	[illegible]	10098000	30294000	$7,876,440	[illegible]
	[illegible]	$1,009,800	$2,524,500			[illegible]	$57,414,800	10098000	40392000	$7,876,440	$31,505,760
[illegible]	$3,029,400	[illegible]	$2,524,500	[illegible]		[illegible]	$64,738,500	10098000	50490000	[illegible]	$39,382,200
[illegible]	[illegible]	$1,009,800	$2,524,500			[illegible]	$71,302,200	10098000	60588000	[illegible]	$47,258,640
[illegible]	$3,029,400	[illegible]	$2,524,500			[illegible]	[illegible]	10098000	70686000	$7,876,440	855,135,080
[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	10098000	80784000	$7,876,440	[illegible]
[illegible]	$3,029,400	[illegible]	$2,524,500	[illegible]		$7,323,700	[illegible]	10098000	90882000	[illegible]	[illegible]
[illegible]	$3,029,400	$1,009,800	$2,524,500			[illegible]	19 7,557,000	[illegible]	100980000	$7,876,440	$78,764,400
[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	10098000	111078000	$7,876,440	[illegible]
[illegible]	[illegible]	$1,009,800	$2,524,500			[illegible]	$111,444,400	10098000	121176000	$7,876,440	[illegible]
[illegible]	$3,029,400	[illegible]	$2,524,500	[illegible]		$7,323,700	$118,768,100	10098000	131274000	$7,876,44A	$102,393,720
[illegible]	$3,029,400	$1,009,800	$2,524,500			[illegible]	$125,331,800	[illegible]	141372000	[illegible]	[illegible]
[illegible]	[illegible]	$1,009,800	[illegible]			[illegible]	$131,895,500	10098000	151470000	$7,876,440	[illegible]
[illegible]	$3,029,400	[illegible]	[illegible]			[illegible]	$138,459,200	10098000	161568000	$7,876,440	$126,023,040
[illegible]	[illegible]	[illegible]	$2,524,500	[illegible]		$7,323,700	$145,782,900	10098000	[illegible]	$7,876,440	$133,899,480
[illegible]	$3,029,400	[illegible]	$2,524,500			$6,563,700	$152,346,600	[illegible]	181764000	$7,876,440	$141,775,920
[illegible]	$3,029,400	[illegible]	$2,524,5014			[illegible]	$158,910,300	10098000	191862000	$7,876,440	[illegible]
[illegible]	1 $3,029,400	$1,009,800	$2,524,500			$6,563,700	[illegible]	10098000	201960000	$7,876,440	$157,528,800
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		$7,323,700	$172,037,700	10098000	212058000	[illegible]	$165,405,240
[illegible]	$3,029,400	[illegible]	$2,524,500			[illegible]	$178,601,40(1)	10098000	222156000	[illegible]	$173,281,6801
[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	10098000	232254000	$7,876,440	[illegible]
[illegible]	[illegible]	[illegible]	$2,524,500			[illegible]	$192,488,800	10098000	[illegible]	[illegible]	8189,034,5601
[illegible]	$3,029,400	$1,009,800	[illegible]	[illegible]		$7,323,700	$199,812,500	10098000	252450000	$7,876,440	[illegible]
[illegible]	1$3,029,400	[illegible]	$2,524,500			[illegible]	$206,376,200	10098000	262548000	$7,876,440	[illegible]
[illegible]	$3,029,400	$1,009,800	$2,524,500			$6,563,700	[illegible]	10098000	272646000	[illegible]	8212,663,8801
[illegible]	[illegible]	[illegible]	$2,524,500			[illegible]	$219,503,600	10098000	282744000	[illegible]	[illegible]

Production Cost from the competitive system (continue).

	Material	Overhead	l Printing Cost	maintenance	Machine Cost	Total Cost	Total Cost Accumulate	Production	Production Accumulate	Revenue	Revenue Accumulate
28	[illegible]	[illegible]	$2,524,500	$160、000		[illegible]	[illegible]	10098000	10098000	[illegible]	[illegible]
63	[illegible]	$1,009,800	$2,524,50			[illegible]	[illegible]	10098000	20196000	$7,876,440	r$324,509,3281
5[illegible]	$3,029,400	[illegible]	$2,524,500			[illegible]	$319.857,300	10098000	30294000	[illegible]	B332,385,768
Z	$3,029,4001	$1,009,800	[illegible]			[illegible]	$326,421,000	10098000	40392000	$7,876,440	$340,262,208
33	1333,029,4001	[illegible]	$2,524,500	[illegible]		$7,323,700	$336,821,940	10098000	50490000	E$7,876,440	$348,138,648
[illegible]	$3,029,4001	[illegible]	B2,524,500			[illegible]	[illegible]	10098000	60588000	[illegible]	$356.015,088
[illegible]	[illegible]	[illegible]	$2,524,500			[illegible]	[illegible]	110098000	70686000	B7,876,440	$363,891,528
68	1 $3,029,400	[illegible]	$2,524,500J			[illegible]	$357,273,040	10098000	80784000	$7,876,440	[illegible]
67	$3,029,4001	$1,009,800]	$2,524,500	[illegible]		$7,323,700	$364,596,740	10098000	90882000	[illegible]	$379,644,4081
69	$3,029,4001	[illegible]	[illegible]	[illegible]		[illegible]	$371,160,440	10098000	100980000	$7,876,440	$387,520,848
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	$377,724,140	10098000	111078000	[illegible]	$395,397,288
[illegible]	1 $3,029,4001	$1,009,800	[illegible]	[illegible]		[illegible]	$384,287,84T)1	10098000	121176000	$7,876,440	$403,273,728
[illegible]	$3,029,400	[illegible]	[illegible]	[illegible]		[illegible]	$391,611,540	10098000	131274000	[illegible]	[illegible]
[illegible]	$3,029,400	[illegible]	$2,524,500			[illegible]	$398,175,240	10098000	141372000	r	r$419,026,6081
43	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	$404,738,940	10098000	151470000	$7,876,440	$426,903,048
[illegible]	$3,029,4001	[illegible]	1 $2,524,500]			$6,563,700	$411,302,640	10098000	[illegible]	$7,876,440	$434,779,488
451	$3,029,400	[illegible]	LID2,524,510	[illegible]		$7,323,700	[illegible]	10098000	[illegible]	$7,876,440	[illegible]
[illegible]	[illegible]	$1,009,8001	[illegible]			[illegible]	$424,430.040	10098000	181764000	$7,876,440	$450,532,368
47	[illegible]	$1,009,800	[illegible]			[illegible]	$430,993,740	10098000	191862000	[illegible]	$458,408,808
[illegible]	$3,029,400	$1,009,800	L$2,524,5001			[illegible]	$438,317,440	10098000	201960000	[illegible]	$466,285,248
[illegible]	[illegible]	$1,009,800	[illegible]	[illegible]		[illegible]	$445.641,140	10098000	212058000	$7,876,440	$474,161,688
[illegible]	$3,029,400	[illegible]	$2,524,500			[illegible]	$452,204,840	10098000	222156000	$7,876,440	$482,038,128

Table 3.10. Data Prepare for Linear egression (competitor system).

x	Yi	Y2	XY1	xy	
1	37,723,700	7,876,440	37,723,700	7,876,440	1
2	44,287,400	15,752,880	88,574,800	31,505,760	4
3	50,851,100	23,629,320	152,553,300	70,887,960	9
4	57,414,800	31,505,760	229,659,200	126,023,040	16
5	64,738,500	39,382,200	323,692,500	196,911,000	25
6	71,302,200	47,258,640	427,813,200	283,551,840	36
7	77,865,900	55,135,080	545,061,300	385,945,560	49
8	84,429,600	63,011,520	675,436,800	504,092,160	64
9	90,993,300	70,887,960	818,939,700	637,991,640	81
10	97,557,000	78,764,400	975,570,000	787,644,000	100
11	104,120,700	86,640,840	1,145,327,700	953,049,240	121
12	111,444,400	94,517,280	1,337,332,800	1,134,207,360	144
13	118,768,100	102,393,720	1,543,985,300	1,331,118,360	169
14	125,331,800	110,270,160	1,754,645,200	1,543,782,240	196
15	131,895,500	118,146,600	1,978,432,500	1,772,199,000	225
16	138,459,200	126,023,040	2,215,347,200	2,016,368,640	256
17	145,782,900	133,899,480	2,478,309,300	2,276,291,160	289
18	152,346,600	141,775,920	2,742,238,800	2,551,966,560	324
19	158,910,300	149,652,360	3,019,295,700	2,843,394,840	361
20	165,474,000	157,528,800	3,309,480,000	3,150,576,000	400
21	172,037,700	165,405,240	3,612,791,700	3,473,510,040	441
22	178,601,400	173,281,680	3,929,230,800	3,812,196,960	484
23	185,165,100	181,158,120	4,258,797,300	4,166,636,760	529
24	192,488,800	189,034,560	4,619,731,200	4,536,829,440	576
25	199,812,500	196,911,000	4,995,312,500	4,922,775,000	625
26	206,376,200	204,787,440	5,365,781,200	5,324,473,440	676
27	212,939,900	212,663,880	5,749,377,300	5,741,924,760	729
28	219,503,600	220,540,320	6,146,100,800	6,175,128,960	784
29	226,827,300	228,416,760	6,577,991,700	6,624,086,040	841
30	233,391,000	236,293,200	7,001,730,000	7,088,796,000	900
31	239,954,700	244,169,640	7,438,595,700	7,569,258,840	961
32	246,518,400	252,046,080	7,888,588,800	8,065,474,560	1,024
33	253,842,100	259,922,520	8,376,789,300	8,577,443,160	1,089
34	260,405,800	267,798,960	8,853,797,200	9,105,164,640	1,156
35	266,969,500	275,675,400	9,343,932,500	9,648,639,000	1,225
36	273,533,200	283,551,840	9,847,195,200	10,207,866,240	1,296
37	280,856,900	291,428,280	10,391,705,300	10,782,846,360	1,369
38	287,420,600	299,304,720	10,921,982,800	11,373,579,360	1,444
39	293,984,300	307,181,160	11,465,387,700	11,980,065,240	1,521
40	300,548,000	315,057,600	12,021,920,000	12,602,304,000	1,600
41	307,871,700	322,934,040	12,622,739,700	13,240,295,640	1,681
42	314,435,400	330,810,480	13,206,286,800	13,894,040,160	1,764
43	320,999,100	338,686,920	13,802,961,300	14,563,537,560	1,849
44	327,562,800	346,563,360	14,412,763,200	15,248,787,840	1,936
45	334,886,500	354,439,800	15,069,892,500	15,949,791,000	2,025
46	341,450,200	362,316,240	15,706,709,200	16,666,547,040	2,116
47	348,013,900	370,192,680	16,356,653,300	17,399,055,960	2,209
48	354,577,600	378,069,120	17,019,724,800	18,147,317,760	2,304
49	361,901,300	385,945,560	17,733,163,700	18,911,332,440	2,401
50	368,465,000	393,822,000	18,423,250,000	19,691,100,000	2,500
1,275	*10,141,037,500*	*10,042,461,000*	*328,960,302,500*	*338,096,187,000*	*42 925*

Form the graphically breakeven chart Figure 4.2, it indicates that the breakeven period of the competitive system lies between quarter 22nd and quarter 32nd.

Now we are taking a closer look at the exact breakeven period by employing the linear regression approach for the competitive system.

Assuming yi = Cost of production and y2 = Revenue

Cost fraction line would be:

$$b = \frac{328,960,302,500 - 50(25.5)202,820,750}{42,925 - 50(25.5)(25.5)}$$

$b = 6,757,632.30$

$b = 6,757,632$

$a = yi - bx$

$a. = 202,820,750425.5)6,757,632$

$a = 30,501,134$

Revenue fraction line would be

$$b = \frac{338,096,187,000 - 50(25.5)(200,849,220)}{42,925 - 50(25.5)(25.5)}$$

$b = 7,876,440.00$

$a = y2 - bx$

$a = 200,849,220425.5)7,876,440$

$a = 0$

Then yi = $30,501,134 + 6,757,632$ (x) and y2 = $0+7,876,440$ (x)

Next step is finding breakeven point,

$$6,757,632(x) - 7,876,440(x) = 30,501,134 - 0$$

$$-1,118,808(x) = -30,501,134$$

$$x = 27.27$$

The result from linear regression analysis indicates the exact breakeven period of the competitive system. This analysis show that the period of quarter 27th is the point where the machine pays off its cost and starts to generate profit.

The breakeven at 27th quarter of the competitor system is equivalent to the last quarter of year 6th. Comparing the breakeven point of these two systems, the competitor system has the breakeven occurred six quarters later than the proposing system. Even

the cost of the proposing system is higher than the competitor, but the result of analysis shows that the new system performs better in breakeven. This is caused by the higher production's capacity of the proposing system. In addition with the lower operating cost, this will enhance the proposing system to be in the better position for decision making of acquiring the new digital printing system.

IV. REPLACEMENT ANALYSIS

The decision making whether replacing the existing system with the new system is depended on a several reasons. The most important reason should be the characteristic of job requirements. Along with the job requirements, the profit making is always another factor to be considered whether the transition to meets the requirement is worthwhile for investment.

The limitation of the printing equipment is one of the factor of replacement consideration. The more flexible and higher capacity equipments can fulfill the broader requirements in term of larger production quantity at the shorter production time, as well as the variety kind or design the printer viable to produce.

The limitation on the production capacity which leads the management initiate the idea on the system replacement is incurring some cost. If the decision making on acquiring the new machine, whether it makes enough return of investment at the reasonable period. Or else, they would keep the existing equipment and share the market to competitors in the industry.

From the investment point of view, since the new Kodak system has shown its earlier breakeven over the competitor system; IBM. The factors involve in last section breakeven analysis based on each system its performance in productivity. However, each of print service organization is facing different circumstances.

Hence, in the replacement analysis study, the different cases will be demonstrated to complied to each conditions.

(1) Replace due to the requirement of color application.

(2) Replace due to the increment of quantity.

(3) Replace due to both reasons.

However, these analyze will be constructed for period of 30 years on the yearly basis for the convenience spreading out the period into the form of time interval. This will provide the management a clear view point.

4.1 Replace Due to the Requirement of Color Application

This replacement consideration happens when the customer would like to change the format of their print jobs. This requirement may give opportunity to the print service provider to increase the service charge as the totally new printing system needs to be acquired.

In this case of analysis, even the new proposing system is capable to produce higher production, but the quantity of production for this study will be referenced to the existing system capacity.

Table 4.1. Cost summary for existing production demand.

	Machine cost	Operating cost per Unit	Operating cost per Year	Production quantity per year	Revenue per year @0.78 per unit
Proposing system	51,600,000	0.60	19,388,160	32,313,600	25,204,608
Competitor system	30,400,000	0.65	21,003,840		

The above Table 4.1 summarizes the existing demand which compares operating cost of two systems. The revenue making, which has been mentioned before that the print charge of new system can be increased as it prints with color. In this case, the competitive conditions, are remaining the same charge at 0.78 per unit.

Table 4.2. Summary of profit on each operating year (Case 1).

Year	Annual Worth of Proposing machine	Profit summary on Proposing system	Annual Worth of Competitor machine	Profit summary on Competitor system
	(54,696,000.00)	($48,879,552.00)	($32,224,000.00)	($28,023,232.00)
2	(28,144,704.00)	($22,328,256.00)	($16,581,376.00)	($12,380,608.00)
3	(19,304,076.00)	($13,487,628.00)	($11,372,944.00)	($7,172,176.00)
4	(14,891,244.00)	($9,074,796.00)	($8,773,136.00)	($4,572,368.00)
5	(12,249,840.00)	($6,433,392.00)	($7,216,960.00)	($3,016,192.00)
6	(10,493,376.00)	($4,676,928.00)	($6,182,144.00)	($1,981,376.00)
7	(9,243,624.00)	($3,427,176.00)	($5,445,856.00)	($1,245,088.00)
8	(8,309,664.00)	($2,493,216.00)	($4,895,616.00)	($694,848.00)
9	(7,586,232.00)	($1,769,784.00)	($4,469,408.00)	($268,640.00)
10	(7,010,892.00)	($1,194,444.00)	($4,130,448.00)	$70,320.00
11	(6,542,364.00)	($725,916.00)	($3,854,416.00)	$346,352.00
12	(6,154,848.00)	($338,400.00)	($3,626,112.00)	$574,656.00
13	(5,828,736.00)	($12,288.00)	($3,433,984.00)	$766,784.00
14	(5,551,128.00)	$265,320.00	($3,270,432.00)	$930,336.00
15	(5,312,736.00)	$503,712.00	($3,129,984.00)	$1,070,784.00
16	(5,105,820.00)	$710,628.00	($3,008,080.00)	$1,192,688.00
17	(4,924,704.00)	$891,744.00	($2,901,376.00)	$1,299,392.00
18	(4,765,776.00)	$1,050,672.00	($2,807,744.00)	$1,393,024.00
19	(4,624,392.00)	$1,192,056.00	($2,724,448.00)	$1,476,320.00
20	(4,498,488.00)	$1,317,960.00	($2,650,272.00)	$1,550,496.00
21	(4,386,000.00)	$1,430,448.00	($2,584,000.00)	$1,616,768.00
22	(4,285,380.00)	$1,531,068.00	($2,524,720.00)	$1,676,048.00
23	(4,194,048.00)	$1,622,400.00	($2,470,912.00)	$1,729,856.00
24	(4,111,488.00)	$1,704,960.00	($2,422,272.00)	$1,778,496.00
25	(4,036,668.00)	$1,779,780.00	($2,378,192.00)	$1,822,576.00
26	(3,968,040.00)	$1,848,408.00	($2,337,760.00)	$1,863,008.00
27	(3,906,120.00)	$1,910,328.00	($2,301,280.00)	$1,899,488.00
28	(3,848,844.00)	$1,967,604.00	($2,267,536.00)	$1,933,232.00
29	(3,796,728.00)	$2,019,720.00	($2,236,832.00)	$1,963,936.00
30	(3,748,740.00)	$2,067,708.00	($2,208,560.00)	$1,992,208.00

Table 4.3. Summary of Profit (Case 1.).

Year	Annual Worth of Proposing machine	Profit summary on Proposing system	Annual Worth of Competitor machine	Profit summary on Competitor system
5	(12249840.00)	(6433392.00)	(7216960.00)	(3016192.00)
10	(7010892.00)	(1194444.00)	(4130448.00)	70320.00
15	(5312736.00)	503712.00	(3129984.00)	1070784.00
20	(4498488.00)	1317960.00	(2650272.00)	1550496.00
25	(4036668.00)	1779780.00	(2378192.00)	1822576.00
30	(3748740.00)	2067708.00	(2208560,00)	1992208.00

From the Table 4.3, the figure of profit summary from both systems are different even they are running at the same production quantity and same amount of revenue. This results from the different machine cost and operating cost. The table is showing some important information which can be interpreted as;

(1) If production period is planned for 10 years, the competitor system is the better choice.

(2) At year 30^{th}, the proposing system generate higher profit.

(3) If acquiring the proposing system over the competitor, the production should be planed for the period at least 30 years or more.

4.2 Replace Due to the Increment of Quantity

When the capacity of the existing system can not handle the incoming order, this replacement consideration will take place. There is two option for this replacement analysis. The first option is to retain the existing equipment and to add another system to be able to handle the production requirement. Another option is to acquire the higher capacity equipment and to completely discard the old system.

The analysis for this requirement based on the production speed of the proposing system, Kodak Versamark VT3000, which has the rate of production at 350 sheets per

minute. To run at this production rate, it requires more than one of competitor system to be able to handle this condition. In this calculation, assuming that the cost of the installed system is paid-off and not included in this calculation.

Table 4.4. Cost summary for extended demand.

	Machine cost	Operating cost per Unit	Operating cost per Year	Production quantity per year	Revenue per year @0.78 per unit
Proposing system	51,600,000	0.60	33,929,280	56,548,800	44,108,064
Competitor system	30,400,000	0.65	36,756,720		

The Table 4.4 contains information of cost summary when the production rate increases to the extended demand.

The attached Table 4.5 shows all the details of replacement analysis on the extended demand.

Table 4.5. Summary of profit (Case 2.).

Year	Annual Worth of Proposing machine	Profit summary on Proposing system	Annual Worth of Competitor machine	Profit summary on Competitor system
5	(12,249,840)	($2,071,051.00)	($7,216,960.00)	$134,389.00
10	(7,010,892)	$3,167,897.00	($4,130,448.00)	$3,220,901.00
15	(5,312,736)	$4,866,053.00	($3,129,984.00)	$4,221,365.00
20	(4,498,488)	$5,680,301.00	($2,650,272.00)	$4,701,077.00
25	(4,036,668)	$6,142,121.00	($2,378,192.00)	$4,973,157.00
30	(3,748,740)	$6,430,049.00	($2,208,560.00)	$5,142,789.00

Table 4.6, summarizes profit in the case of required the extended demand of production. The result has the similar pattern compared to the previous case. The similarity is if the transition has been made, it will recover the investment at the long run period. The information from Table 4.6 can be interpreted as:

(1) If production period is planed for 5 years, the competitor system is preferable.

(2) If production period is planed for 10 years, both system deliver equivalent result.

(3) From year 15^{th} to 30^{th}, the proposing system generates a better profit.

Table 4.6. Summary of profit on each operating year (Case 2).

Year	Annual Worth of Proposing machine	Profit summary on Proposing system	Annual Worth of Competitor machine	Profit summary on Competitor system
1	(54,696,000)	($44,517,211.00)	($32,224,000.00)	($24,872,651.00)
2	(28,144,704)	($17,965,915.00)	($16,581,376.00)	($9,230,027.00)
3	(19,304,076)	($9,125,287.00)	($11,372,944.00)	($4,021,595.00)
4	(14,891,244)	($4,712,455.00)	($8,773,136.00)	($1,421,787.00)
5	(12,249,840)	($2,071,051.00)	($7,216,960.00)	$134,389.00
6	(10,493,376)	($314,587.00)	($6,182,144.00)	$1,169,205.00
7	(9,243,624)	$935,165.00	($5,445,856.00)	$1,905,493.00
8	(8,309,664)	$1,869,125.00	($4,895,616.00)	$2,455,733.00
9	(7,586,232)	$2,592,557.00	($4,469,408.00)	$2,881,941.00
10	(7,010,892)	$3,167,897.00	($4,130,448.00)	$3,220,901.00
11	(6,542,364)	$3,636,425.00	($3,854,416.00)	$3,496,933.00
12	(6,154,848)	$4,023,941.00	($3,626,112.00)	$3,725,237.00
13	(5,828,736)	$4,350,053.00	($3,433,984.00)	$3,917,365.00
14	(5,551,128)	$4,627,661.00	($3,270,432.00)	$4,080,917.00
15	(5,312,736)	$4,866,053.00	($3,129,984.00)	$4,221,365.00
16	(5,105,820)	$5,072,969.00	($3,008,080.00)	$4,343,269.00
17	(4,924,704)	$5,254,085.00	($2,901,376.00)	$4,449,973.00
18	(4,765,776)	$5,413,013.00	($2,807,744.00)	$4,543,605.00
19	(4,624,392)	$5,554,397.00	($2,724,448.00)	$4,626,901.00
20	(4,498,488)	$5,680,301.00	($2,650,272.00)	$4,701,077.00
21	(4,386,000)	$5,792,789.00	($2,584,000.00)	$4,767,349.00
22	(4,285,380)	$5,893,409.00	($2,524,720.00)	$4,826,629.00
23	(4,194,048)	$5,984,741.00	($2,470,912.00)	$4,880,437.00
24	(4,111,488)	$6,067,301.00	($2,422,272.00)	$4,929,077.00
25	(4,036,668)	$6,142,121.00	($2,378 ,192 .00)	$4,973,157.00
26	(3,968,040)	$6,210,749.00	($2,337,760.00)	$5,013,589.00
27	(3,906,120)	$6,272,669.00	($2,301,280.00)	$5,050,069.00
28	(3,848,844)	$6,329,945.00	($2,267,536.00)	$5,083,813.00
29	(3,796,728)	$6,382,061.00	($2,236,832.00)	$5,114,517.00
30	(3,748,740)	$6,430,049.00	($2,208,560.00)	$5,142,789.00

4.3 Replace Due to Both Reasons.

The replacement consideration happens when customers need to change their design to be colors format with a increment of the order volume. This requirement falls in to this case of analysis. In order to comply with the requirement, the print service provider most likely has to discard their existing system and purchases a new equipment which is capable to print color with the higher production capacity.

To reduce the investment for the new equipment, the existing one can be sold and invested that sum of capital to the new machine. This could save some investment cost and gain back the investment at the shorter period of time. In this analysis, the assumption is the existing equipment will be sold at the 30% of its original cost which is 9,120,000 reduction by the new equipment purchased and the production capacity will based on the new equipment performance.

Table 4.7. Cost summary for trade-in option.

	Machine cost	Operating cost per Unit	Operating cost per Year	Production quantity per year	Revenue per year @0.78 per unit
Proposing system	42,480,000	0.60	33,929,280	56,548,800	44,108,064

From Table 4.7, in this case, the fix cost which is machine cost is reduced due to the selling out of the existing system. The operating cost and revenue still remain as the previous analysis as the production quantity and revenue are still unchanged.

The attached Table 4.8 is showing the detail of the replacement analysis of purchasing new system with the fix cost reduced by the trade-in of old equipment.

Table 4.8. Summary of profit on each operating year (Case 3).

Year	Annual Worth of Proposing machine	Profit summary on Proposing system
1	(45,028,800)	($34,850,011.00)
2	(23,170,291)	($12,991,502.20)
3	(15,892,193)	($5,713,403.80)
4	(12,259,303)	($2,080,514.20)
5	(10,084,752)	$94,037.00
6	(8,638,733)	$1,540,056.20
7	(7,609,867)	$2,568,921.80
8	(6,840,979)	$3,337,809.80
9	(6,245,410)	$3,933,379.40
10	(5,771,758)	$4,407,031.40
11	(5,386,039)	$4,792,749.80
12	(5,067,014)	$5,111,774.60
13	(4,798,541)	$5,380,248.20
14	(4,569,998)	$5,608,790.60
15	(4,373,741)	$5,805,048.20
16	(4,203,396)	$5,975,393.00
17	(4,054,291)	$6,124,497.80
18	(3,923,453)	$6,255,336.20
19	(3,807,058)	$6,371,731.40
20	(3,703,406)	$6,475,382.60
21	(3,610,800)	$6,567,989.00
22	(3,527,964)	$6,650,825.00
23	(3,452,774)	$6,726,014.60
24	(3,384,806)	$6,793,982.60
25	(3,323,210)	$6,855,578.60
26	(3,266,712)	$6,912,077.00
27	(3,215,736)	$6,963,053.00
28	(3,168,583)	$7,010,205.80
29	(3,125,678)	$7,053,110.60
30	(3,086,172)	$7,092,617.00

Table 4.9. Summary of profit (Case 3.).

Year	Annual Worth of Proposing machine	Profit summary on Proposing system
5	(10,084,752)	$94,037.00
10	(5,771,758)	$4,407,031.40
15	(4,373,741)	$5,805,048.20
20	(3,703,406)	$6,475,382.60
25	(3,323,210)	$6,855,578.60
30	(3,086,172)	$7,092,617.00

From Table 4.9, the figure shows that the profit is made when acquiring the new equipment started earlier compared with the previous case analysis. The result in this case at the year 30^{th} is remarkably better profit. As well as the production plan can be as short as five years plan.

The replacement analysis for new printing system requires the production planning and the expecting quantity of orders to be able to determine whether to make a transition of printing facilities. Once the decision made to acquire a new printer, it comes to the question of which system should be selected.

If the requirement of color printing is a must, definitely the proposing system should be purchased with the condition of the new acquired machine should be used for at least for 15 years with minimum requirement of production quantity.

With the case of extended production rate requirement from the existing capacity, there will be two alternatives; whether to buy another similar machine to increase the capacity or to decide on the new technology system to have the better capacity with advance feature of color printing. In this case, if the new technology system can handle the require production capacity with the production planned for

more than 10 years. The proposing system with color technology is more viable to invest. The reasons are most capacity of new machine will be used and the explore of color printing limitation of existing system, on account of the new proposing system can produce the existing mono-tone format jobs or increase the limitation boundary by offer the color printing option to be more flexible in job requirements.

V. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

Organizations across all industries are seeking new and efficient ways to staying competitive and profitable. At the same time, they are seeking to reduce their cost of production as the challenge in rapid market changes, cost pressure and the need of customer requirement on respond time..

The decision making on acquiring new machine needs to consider on the specific criteria and weights the criteria on its level of importance. This project has pointed out the features of new machine that benefits over the competitor.

For comparison between these two system we are looking at;

(1) Machine cost

(2) Printing Cost

(3) Production Speed

(4) Advance Features

Table 5.1. Comparison between two system.

Primary Concerns	Proposing System	Competitor System
Machine Cost	Higher	Lower
Cost per Sheet	0.6	0.65
Production Speed	350 PPM	25OPPM
Advance Feature	Full Color	Mono Tone

From the comparison table above, the machine cost of the KODAK system is higher than the IBM at about 30%. On the other hand, KODAK is running at 8.34%

cheaper than IBM. The further advantage of 40% higher production speed is gained from KODAK system.

However, a new proposing machine, KODAK system, would cost more and that breakeven analysis would need to be applied in finding the equilibrium. The new equipment has come with advantages of speed, price per unit, quality and other application. In this project, the breakeven studies are constructed to find the appropriate system for the organization.

In management perspective, the faster the machine paid itself off should be the first criteria for making the decision.

From the breakeven analysis, even the KODAK has relatively higher cost at the start-up period, with the higher production speed and lower in cost of production. The new proposing system will reach to the breakeven 6 quarters earlier than the competitor.

Another analysis is constructed in this report is the replacement analysis. The replacement analysis has constructed according to 3 cases with the 30 years study period, first, when production volume retains, second, when higher production volume required and third, when replace the old machine with a new one.

The result from the analysis of the first case; production speed at 250 sheets per minute, the production plan should be longer than 14 years in order to gain the profit from the new system. Otherwise, it is better to leave the existing equipment running with out any new machine acquire.

The second case, replacement due to the higher production volume, in this case if the new system is purchased, the production plan should be at least 7 years and longer in order to gain profit from the machine.

However, for the first two cases, the production plan period of the new system has to be longer than the competitor system. On the other hand, with the long run, the proposing system makes more profit than the competitor. As analysis figure showing that both case at the year 30th, new proposing system, Kodak Versamark, produces more profit over the competitor system. The summary Table 5.2 below, shows the type of requirement which is suitable for which system.

Table 5.2. Summary of system selection.

	Production volume		Production period		Color application
	Low	High	Short	Long	
Kodak		X		X	X
IBM	X		X		

For the last case, when the old equipment is sold and replaced with the proposing system. The old equipment sold is estimated at 30% of their new purchased price. The proposing system can be acquired if the production is planned for as short as 5 years. If customers require high volume of color printing service and have contract for more than five years. This new system will be an ideal machine to be purchased.

For the decision making criteria of economic and production perspective, the new proposing KODAK system has greater performance over the competitor on that specific points. The potential system acquired should be the KODAK system.

Finally, with the High-volume digital printing based on continuous inkjet technology offered by KODAK overcomes the shortcomings of conventional toner-based technology. It is emerging as the new engine of high-volume commercial

printing. The KODAK system represents a low-risk investment with tremendous upside potential for the printing opportunities over the competitor in the industry.

5.2 Recommendations.

As the market in printing industry now has been driven fast with the many factors. In the successful organizations over the world, they are improving customer retention through the printing material as the communication channel to their customers. Hence, the leading companies become more aware of "customer relation management". The aim is to optimizes the communication with the customer with the personalized information, keeping them informed about the new products and improving the organization image.

The digital printing technology combined with the proper data mining tools can fulfill this requirement. The personally relevant information will reach the customer without wasting cost in putting as much as possible information to the recipient but there is nothing that is relevant to their need or life style. It means that all the efforts in delivery the information are wasted.

The digital printing technology can be an important tool in applying customer relation management concept to the real practice. This is also an opportunity if the KODAK system is acquired. The marketing people can make use of these feature for improving their customers relationship. Also, the organization image, this printing system has ability in printing full colors image. With the effective use of image and colors, the impression from customer to the organization will be improved with the customer satisfaction in intelligent personalized offering. This should be another way to retain the valuable customer.

Another area where a billing can generate profit is through personalized, targeted marketing. The bill summary is often becoming the most frequent form of contact with a customer and this contact should be utilized to create potential profit opportunities. The monthly bill will draw traffic to the website and this is the ideal place to introduce new products or services targeted to a particular customer's usage patterns.

Armed with this data, they are better equipped to up-sell a customer to a different tariff or service that is perhaps more suited to their requirements, in order to increase potential profit per customer.

As CRM databases becomes increasingly pervasive and more robust, new business opportunities rely on the printing service that can customize mass-scale mailing by geographic, demographics or purchase pattern. With the personalized content capability, this improves the response rate from the mail recipient . These result in more effective marketing promotion, improving customer retention and producing more income to organization.

By gaining the indirect profit through the marketing strategies, even sometimes may not be able to visualize by the figure, but this can be accountable for the cost sharing in purchasing the printing system. In future, with the proper usage of the resource, the printing facility can be a profit generator to their own organization.

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