CHAPTER 2
THEORITICAL BACKGROUND

The dynamic of business environment and the market created the effort of management to seek the continuous improvement in the core business processes. The organization's strategy have the major impact on what the organization does and how it does it, Strategies can be long term, intermediate term, or short term. (Stevenson, 2009).

The strategies of manufacturing industry have major impact on operation and supply chain process flows, the trend of company situation such as utilize process in low-cost, high-volume strategy capacity limit the amount of variety products that offered to customer. One of the focuses of manufacturing company is to achieve productive use of an organization's resources.

2.1 Productivity

Productivity is an index that measure output (goods and services) relative to the input (labor, material, energy, and other resources) used to produce it. It is usually expressed as the ratio of output to input:

$$productivity = \frac{Output}{Input} \qquad (2.1)$$

Productivity has importance implications for business organizations and for entire country. In business organizations, company with higher productivity means lower costs, and productivity determining the competitiveness of product that produced by a manufacturing company.

The productivity growth is very importance to support with the manufacturing company's strategy, the productivity growth is the increasing in productivity from one period to the next relative to the preceding period. (Stevenson, 2009).

$$productivity\ growth = \frac{Current\ prod. - \Pr evious\ \ prod.}{previous\ productivity} X \quad 100 \qquad (2.2)$$

For example, if productivity of hydraulic excavator increased from 660 units to 720 units per year, the productivity growth rate would be :

$$productivity\ growth = \frac{720 - 660}{660} X \quad 100 = 9.09\%$$

Improving productivity at the manufacturing company can take a number of key steps toward improving demonstrated productivity as follows:

a. Develop productivity measures for all operations.
b. Look at the process flow or system as a whole to deciding the critical path of the operation. The effective increasing the productivity should review with the bottleneck of operation, if not the increasing productivity isn't effective. For example the manufacturing company consists of two operations there are fabrication as first process and then assembly processes as second process, with the maximum capacity was 660 machines. If the assembly line improved and could produced 720 machines, but the fabrication line still remain not improved, the output of manufacturing company at the level 660 machines.
c. Develop methods for achieving productivity improvements, Rapid improvement by creating the continues improvement ideas from team members, replication and benchmarking process from successful company, and validate the current process to set up the future improvement.
d. Establish reasonable goals for improvement. (SMART)
e. Make it clear that management supports and encourages productivity improvement.
f. Measure improvements and share the results of the performance metric.

2.2 Lean Operations

As business organizations strive to compete and maintain the competitiveness in an ever-changing global economy (Stevenson, 2009).

The company aggressively to improve and transform their current process to seeks better process and improved way of process. A lean operation is a flexible system of operation that uses considerably fewer resources such as production steps or routing, man power, inventory, work center space, time than current processes.

Lean is both philosophy and a methodology that focuses on eliminating all waste (non-added value activity) and streamlining operations by closely coordinating all activities. Lean system have three basic elements : they are demand driven, are focused on waste reduction and have a culture that is dedicated to excellence and continuous improvements.

Many of the methods that are common to lean operation were developed as parts of Toyota's approach to manufacturing such as:

a. *Muda*: Waste and inefficiency. Perhaps the driving philosophy. Waste and inefficiency can be minimized by using the following tactics.
b. *Kanban*: A manual system used for controlling the movement of parts or materials that responds to signals of the need (i.e., demand) for delivery of parts or materials. This applies both to delivery to the factory and delivery to each work workstation. The result is the delivery of a steady stream of container of parts throughout the workday. Each container holds a small supply of parts or materials. New containers are delivered to replace empty containers.
c. Pull system: Replacing material or parts based on demand; produce only what is needed.
d. *Heijunka*: Variation in production volume lead to waste. The workload must be leveled; volume and variety must be averaged to achieve a steady flow of work.
e. *Kaizen*: Continuous improvement of the system. There is always room for improvement so this effort must be on going.
f. *Jidoka*: Ouality at the source. Each worker is expected to perform ongoing quality assurance. The objective is to avoid passing defective products to following work stations, and to make workers aware of quality.

g. *Poka-yoke*: Safeguards builts in to a process to reduce the possibility of committing an error.
h. Team concept: Use small teams of worker for process improvement.
(Stevenson, 2009).

The importance of lean concept is a balance system, on of that achieved a smooth production process, rapid flow of material in the system. According to Stevenson (2009), “the idea is to make the process time as short as possible by using resources in the best possible way, with the goals: eliminate disruptions; make the system flexible and eliminate waste”.

There are three major impediments to production efficiency. One is plain waste, activity that consumes resources without creating value for the customer. It caused increasing cost, delivery lead time and quality problems. Waste adds zero value. It can be created by difference sources, from the beginning process on the suppliers to the unreliable equipment in the production processes.

The common type of waste in the lean concepts as follows (PT ABC Production System, 2008):

a. Unused Creativity / Capability - Lost opportunities due to poor safety and an underutilized workforce.
b. Defects - Production or rework of out-of-specification parts.
c. Inventory - Excess raw material, work-in-process or finished good.
d. Over Production - Excess supply beyond the requirements of the next process.
e. Waiting – Lost time due to poor product flow – shortages, bottlenecks, down machines.
f. Excess Motion – Wasted movement made while working.
g. Transportation – Excess movement of work-in-process.
h. Over Processing - Work that adds no value for the customer or business.

Second impediment is unevenness of fluctuation in work mostly due to the internal factor such as lack of production scheduling. Lean improvement seeks to address production fluctuations by leveling by mix and volume.

The third major impediment to efficiency is the unnecessary burden or difficulty placed on workers or equipment. This can generate in safety hazards and risks, improver design that impacted with ergonomic, unclear standard, inadequate tooling.

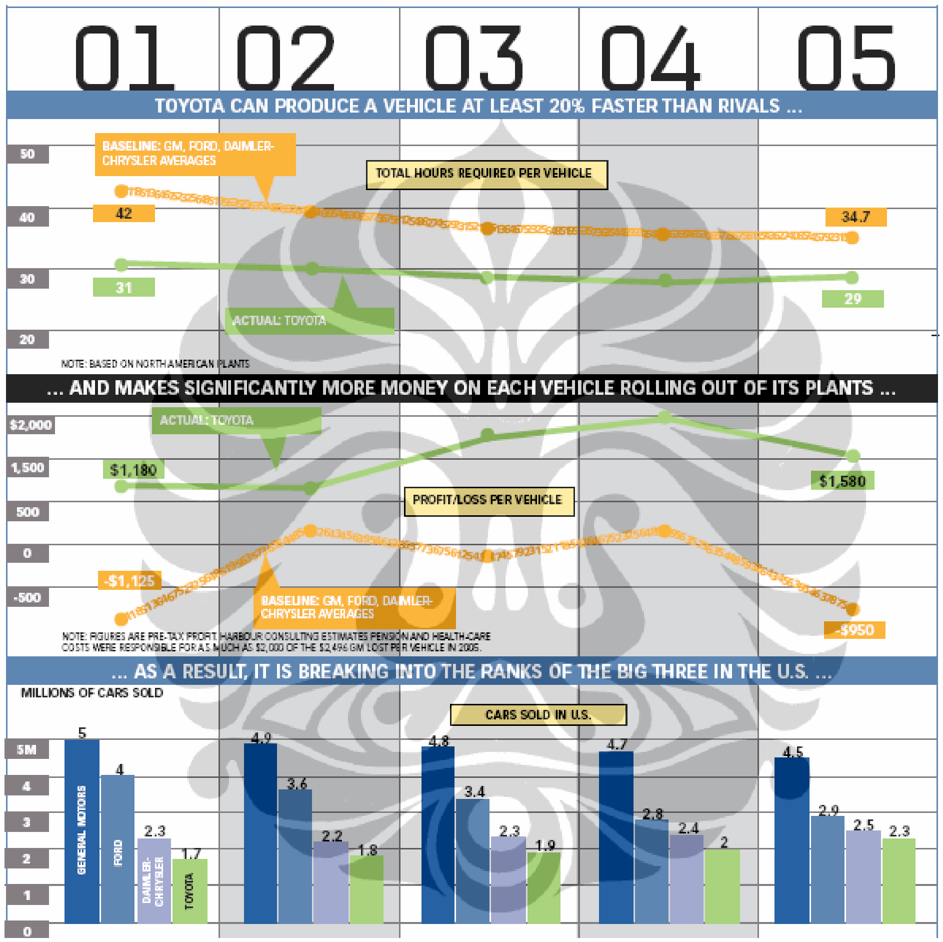

Figure 2.1 Toyota's Power Drive

Source : Mel Duval, What's Driving Toyota, 2006

The Figure 2.1, shown the successful implementation of lean system at Toyota under the TPS (Toyota Production System). Despite its success, Toyota is not immune to some of the problem such as recall products, Toyota may be going through a rough patch, but industry experts say the recall issue has to be viewed in context.

2.3 Value Stream Transformation Process

Value Stream in the book Lean Thinking: Banish Waste and Create Wealth in Your Corporation, James P. Womack and Daniel T. Jones defined a value stream as “Specified activities required to design, order, and provide a specific product, from concept to launch, order to delivery and raw material into the hands of customer.” Value Stream Transformation is an enabling process that drives the execution of production system processes on production floor – including all processes involved in the production from receiving raw material at the facility to delivering the finished product to the customer. At PT ABC value streams used for overall future state planning and prioritizing of transformation activities and manufacturing value streams where transformation effort must be aligned with future state goals of the product or high-level value stream. Therefore a manufacturing value stream is defined as the span of control of a primary shift section manager. All of activities and energy of the Value Stream Transformation process encompasses four defined processes including:

a. Value Stream Mapping (VSM) – A technique to capture and map the current state of value stream, as well as to develop and map its future state.
b. Defined methodology used to guide the development of transformation plan to achieve the future state.
c. Defined methodology to improve a narrowly scoped area within a value stream quickly.
d. Defined process that connects employee’s improvement ideas.

The high-level elements or steps used to apply the value stream transformation process and accomplish its strategy include:

a. Identifying and recording each value streams.
b. Understanding and mapping current state performance at the company process.
c. Developing future state (or vision) maps.
d. Developing and implementing prioritized plans to improve the value stream through special projects.
e. Activating the continuous improvement process within the value streams and engaging all levels of the organization in value stream improvement.

Refer to PT ABC production system manual (2008) Value stream lifecycle stages are not exclusive or independent from one another. For example, there will always be elements of stability that need to be addressed, and some elements of pull may be introduced while the primary focus of value stream transformation project is establishing flow.

Value Stream lifecycle Initial efforts focus on establishing stability in terms of manpower, machine, material and method (process). After the processes are stabilized, the focus should move on to flow, which involves connecting independently capable and stable processes in a value stream. The next stage in the value stream transformation lifecycle is production based on goods consumed by customer demand, which is referred to as Pull Production. Once the value stream reaches the Level stage, production is carefully balanced for mix and volume and is operating in an ideal state.

2.4 Value Stream Mapping Process

At the present time, manufacturing companies need to redesign and improve their system in order to be ready on the competitiveness arena by challenges of current market (European Commission, 2004). As a result, it is necessary to have practical tools that will support the redesign process for manufacturing systems (Marchwinsky, 2004).

> Business processes often become bloated with inefficiencies and waste, and over time, these inefficiency become ingrained in the processes. Rooting out the inefficiency and waste using techniques such as value stream mapping offers tremendous opportunities to greatly improve these processes (Stevenson, 2009).

Creating a value stream map is not the goal of the mapping process. The goals resides in the process of documenting the current state so that we become familiar with the dynamic forces at play within the value stream.

Value Stream Map is a visual tool that represents the process steps, material and information flow and production facts, including opportunities to eliminate waste from the value stream. In other words, the value stream is a simple diagram of every steps involved in the material and information flows needed to bring a product from order to delivery. There are two steps of value stream maps:

a. Current State Value Stream Map – reflects the existing conditions of the value stream at a specific point in time. Mapping the current state centers on the process of discovering and developing a common understanding of the existing conditions.
b. Future State Value Stream Map – reflects optimal flows based on anticipated (customer) demand.

Value Stream Mapping (VSM) is the process that captured value stream conditions on paper. VSM captures both visible and obvious characteristics of the value stream, such as process steps and inventory. It also identifies hidden, difficult to observe characteristics of value stream such as information flow, interrupted in flow, excess motion and transportation snags.

As regards the application process, VSM is based on five phases put into practice by a special team created for such a purpose (Rother and Shook, 1998). The phases are:

a. Selecting of product family;
b. Current State mapping;
c. Future State mapping;
d. Defining a working plan; and
e. Achieving the working plan.

The process of creating the current state map highlights the sources of obvious waste in a value stream. Finding the root cause and eliminating the obvious wastes should be the first wave of the transformation activities in the value stream.

Unlike geographical, political or topographical maps, value stream maps are not drawn to scale, nor do they shown a facility’s layout. A value stream map is simply a visual representation of the dynamic nature of a production process.

A typical value stream map depicts interrelationships between customers, suppliers, information and material flow. The typical placement of the following is illustrated on Figure 2.2.

a. Customer information is located in the upper right of the value stream map.
b. The upper left of the typical map contains supplier information
c. Information flow (i.e., customer demand, production triggers, schedules, supplier communication) is shown from the customer through the internal production control to supplier.
d. Material flow starts at the supplier and move through the production (process) steps and ends as the finished product delivered the customer.

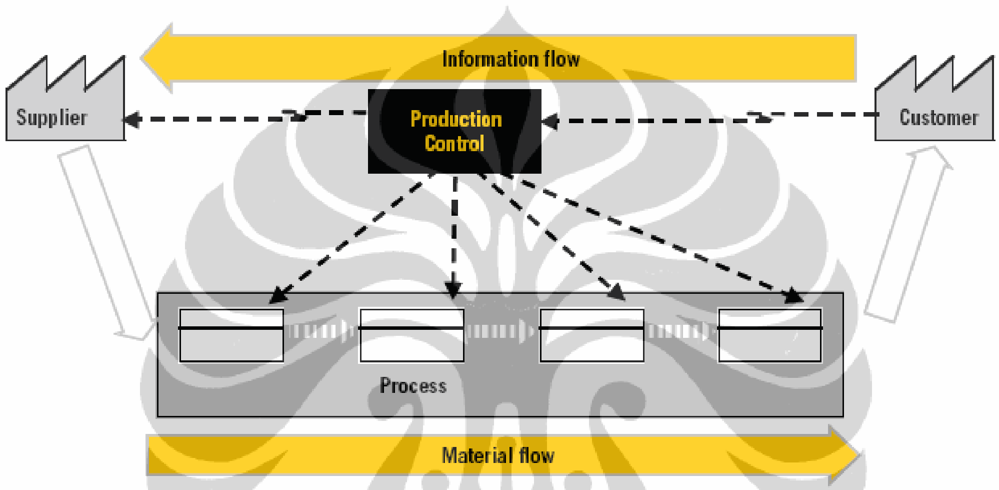

Figure 2.2 Contents of Value Stream Map

Source : PT ABC Production System Manual, 2008

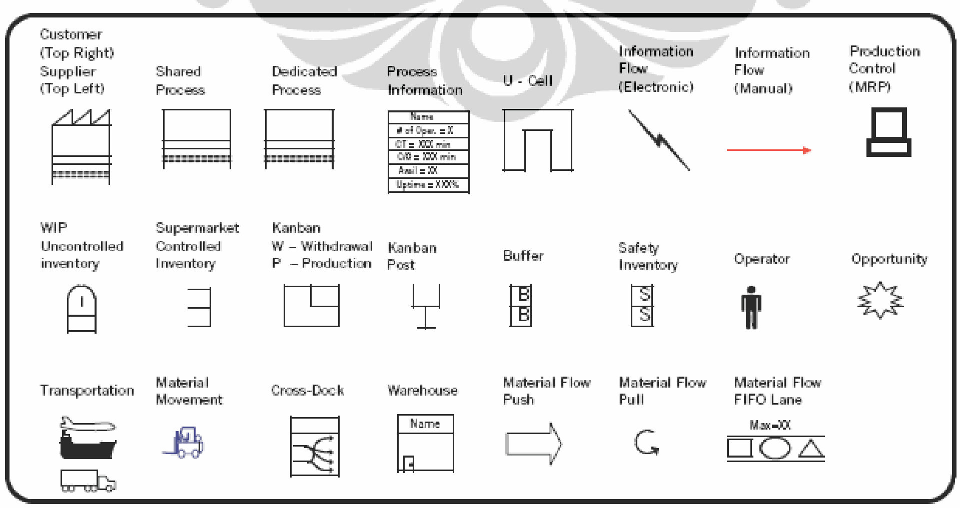

Figure 2.3 Common Symbol of a Value Stream Map

Source : PT ABC Production System Manual, 2008

It is important to define a few basic concepts to ensure understanding before moving forward in the discussion about Value Stream Mapping. The key concepts defined here include takt time, value-added and non-value-added activity, cycle time and push versus pull production.

According to Mike Rother and John Shook (1998), takt time is the time within which you should produce one part or product, based on the rate of sales, to meet customer requirements. Tack time is calculated by dividing the customer demand rate per shift (in units), into your available working time per shift (in seconds).

Takt time is used to synchronize the pace of production with the pace of sales. It is a reference number that gives a sense for the pace at which each process needs to be producing. It helps you are doing and what you need to improve.

Producing to takt sound simple, but it required concentrated effort to: provide fast respond (within takt) to problems, eliminate causes of unplanned downtime, and eliminate changeover time in downstream, assembly-type processes.

For example on the assembly process of manufacturing company PT ABC, shown on the table 2.1 with the data of production as below:

Table 2.1 Manufacturing Data of PT ABC

Product Model	**3 – month Demand**	**Workdays January**	**Workdays February**	**Workdays March**	**Daily Demand**
A	420	20	19	21	7 units
B	300	20	19	21	5 units
C	120	20	19	21	2 units
D	60	20	19	21	1 units

Source : Sample of Production Data at PT ABC

The aggregate demand is determined by taking demand for all the parts or models going through the same value stream over a period of time and dividing by total work days in the time period.

$$Takt\,time = \frac{Available\ time\ per\ shift}{Customer\ Demand\ rate\ per\ shift} \tag{2.3}$$

- Aggregate demand from all models is 15 units per day.
- One shift operation = 480 minutes
- Available time = 430 minutes *
  (*480 minutes – 20 minutes (lunch) – 20 minutes (two x 10 minutes breaks) – 10 minutes meeting morning))
- Takt time = 430 minutes / 15 units = 28.7 minutes per unit.

It means that every process stage at assembly process must achieve the takt time of 28.7 minutes, or must compensate for it by adding resources or increasing the available time.

The guideline of content and concepts of a VSM as follows:

a. Value-Added and Non-Value-Added Activities.
   Value added refers to any activity that transforms or shapes material or information or improves quality to meet customer requirements. Conversely, a non-value-added activity is one that takes time, resources or space but does not add value to the product itself.
b. Cycle Time.
   Cycle time is defined as a timed observation of how often a part or product is completed by process.
c. Process Time.
   Process time is the time it takes for all the work elements to be completed. For example process painting takes 200 minutes. And every 5 minutes a batch of 10 parts exits from paint booth.
   Batch size = 10 parts
   Cycle Time = 5 minutes

Cycle Time piece = 5 minutes / 10 parts = 0.5 minute

Process Time = 200 minutes

d. Push versus Pull

Push replenishment is a material replenishment method based on materials resource planning (MRP) scheduling. It is often plagued by inefficiencies resulting in parts being “pushed” from one to next steps, without regard for real needs or demands. Push production contributes to several wastes in value stream such as inventory, transportation and waiting. For pull consumption the triggers moving material needed based on consumption.

2. 5 Current State VSM Process Steps

The most outstanding features of the current state are as follows:

a. Define customer requirements

First and foremost in Value Stream Mapping (VSM), the customer(s) must be identified and understood, along with the customer’s specific requirements regarding product demand, including mix, shipment, packaging, order size and so on. Calculate the pace of customer demand — takt time. Takt time, along with other pertinent customer information, is recorded directly on the value stream map.

b. Identify process steps.

A process step is defined as when a material or product changes form, fit or function. A value stream map should depict all significant process steps for the level (product, facility or process) of the map being developed. A standard process box symbol is used to represent a process step on the map. The process boxes are positioned left to right on the lower half of the map to represent the transformation steps of material into final product, with the most upstream process on the left and most downstream process on the right. Shared process steps (e.g., several product families sharing the paint booth or heat treat) are denoted by hatched lines above a process box.

A process step should be depicted on a value stream map where significant disruption or interruption to the flow of product occurs or significant time or material / product movement occurs. For example, the inspection step should be represented on a value stream map to indicate significant activity, interruption in the general flow and possibly uncontrolled inventory before and after the inspection step.

c. Gather process data such as name of process, number of operators, available time, cycle time, batch size, Overall Equipment Effectiveness (OEE), and change over time.
d. Gather inventory data.
e. Determine external material flow such as transportation, receiving warehouse and location.
f. Determine information that's driving flow and internal material flow.
g. Calculate and Map Total Cycle Time.

Steps number one until six develop a visual physical flow of product as it undergoes a transformation from raw materials to final product, including the flow of information related with production cycle.

To represent the time component of the value stream, compute the total product cycle time or TCT_P, which is an estimated of the time required for the product to move through a value stream at current demand levels. Work in process (WIP) represent all product inventories used in a process, such as raw materials, standard work in process and finish products.

$$TCT_P = \frac{WIP}{Current\ Customer\ \ Demand} \quad (2.4)$$

Total demonstrated cycle time or TCT_D is a measure of the current ability of the value stream to product.

$$TCT_D = \frac{WIP}{Demonstrated\ Exit\ \ Rate} \quad (2.5)$$

Comparison TCTP to TCTD determines the gap in the current ability to meet a customer demand.

To shown delay process, the value stream map consists a two timeline that representing the time equivalent value of inventory at current demand and each valley representing the process time. For example assume at the manufacturing company keep the inventory before and within production process is 50 units. Assume daily demand is 10 units. The time-equivalent of this inventory is 5 days (50 / 10 = 5).

Process time and TCT_P impacted to the cycle efficiency, that shown on the formula below:

$$Cycle\ Efficiency = \frac{the\ sum\ of\ process\ time}{TCT_P} \quad (2.6)$$

h. Create a Takt Time / Cycle Time Bar Chart.

Is a chart that shows cycle times plotted against takt time (or customer demand rate). The chart shows per piece cycle time for each process and takt time. The takt time / cycle time bar chart is added to the value stream map to provide a quick visual of which process steps do not meet takt time.

i. Creating a required response timeline.

A required response timeline shows the critical processes in a manner that is plotted back from the "ready to ship" day or day zero.

Attribution Note:

The industry standard for value stream mapping was originally detailed in the book Learning to See: Value-Stream Mapping to Create Value and Eliminate Muda, by Mike Rother and John Shook.

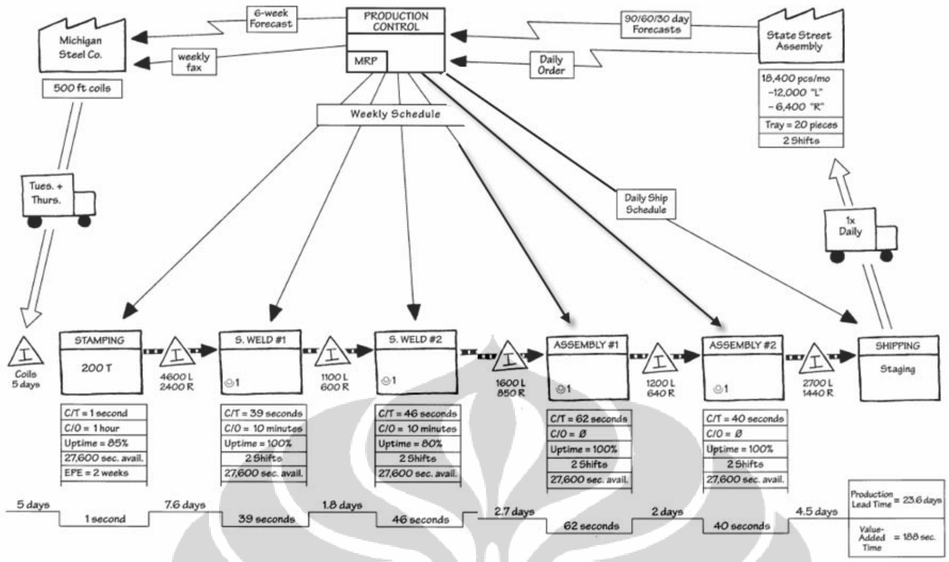

Figure 2.4 Current State Mapping

Source: Mike Rother and John Shook, Learning to See, The Lean Enterprise Institute, 1998.

Advices on Creating a Value Stream Map refer to PT ABC production system manual (2008) as follows:

a. Follow the safety guidelines for the area
b. "Walk" the actual material and information flow of the value stream
c. Start "walking" the value stream as close to the customer as possible, e.g., the shipping dock
d. Sketch the value stream by using standard symbols.
e. Gather data and observations from the "floor" as you walk the value stream.
f. Be considerate of the production team members and others working in the area:
   - Introduce yourself
   - Explain your purpose for observing the operations
   - Respond to questions in a courteous and professional manner, and most importantly
   - Engage employees and other Subject Matter Experts; ask them questions to dig deeper and learn more about the processes and working environment they encounter on a daily basis — not just

the environment present on the day of a visit, but the typical environment they work within.

g. Hand-draw the initial value stream map
   - Once the initial value stream map has been developed, transfer the information into an electronic file.

2. 6 Future State VSM Process Steps

The purpose of value stream mapping is to highlight source of waste and eliminate them by implementation of a future-stream value stream that can become a reality within a short period of time. (Mike Rother and John Shook, 1998). According the production system manual at PT ABC, all high performing, ideal value stream exhibit certain characteristics as below:

a. The production capability as required takt time, e.g., meets customer demand.
b. Continuous flow of production.

   The future state of the value stream should be designed to achieve continuous flow wherever possible. Continuous flow is producing and moving one item at a time (or a small and consistent batch of items) through a series of processing steps as continuously as possible, with each step making only what is requested by the next step. Continuous flow consists of three components: Materials, Information and People. These three components must function together to achieve and sustain flow. When they do, continuous flow production:

   - Reduces delays
   - Minimizes in-process inventory
   - Minimizes the wastes of Over Production, Waiting and Transportation

   In continuous flow production, each work piece moves from one value-adding step to the next without being delayed in a heap of inventory or a re-work pile. Materials must be delivered in the right quantity, at the correct location and at the right time to facilitate continuous flow. To achieve continuous flow production, operators must be able to perform their tasks in a repeatable and consistent manner. A two-way information flow must be established to provide targets to the production floor, as well as to signal information about issues and abnormalities between production steps and up to production control.

c. Interruptions in flow are connected via small, controlled supermarket of parts.

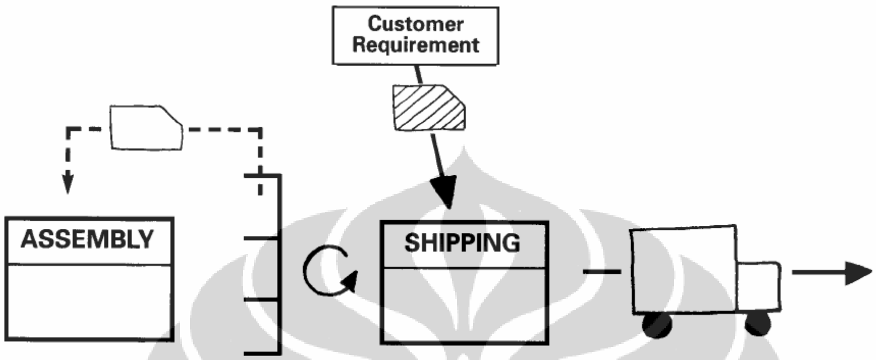

Figure 2.5 Building to a Supermarket

Source: Mike Rother and John Shook, Learning to See, The Lean Enterprise Institute, 1998.

d. Information flow is controlled. A production signal is communicated to one process, which triggers a production signal upstream. This process is typically recognized as the "pacemaker."

   Once the sizing and placement of the supermarket are determined, a means for withdrawing from and replenishing the supermarket is designed. This cycle of production and withdrawal is typically orchestrated by a set of signals, or Kanban for both production and withdrawal. Kanban is a signaling device that gives authorization and instructions for production or withdrawal (conveyance) of items in a pull system.

e. Production mix is leveled at the pacemaker.

   A pacemaker is the balance point of continuous flow processing. It ties together the three components: Materials, Information and People. The pacemaker serves as a proxy customer to the upstream processes, providing a production target signal. The pacemaker is the point in the value stream that receives instructions from the production control and then initiates production at the upstream processes. Processes downstream of the pacemaker must be capable of flow.

f. Production volume is also leveled at the pacemarker.

Leveling production means evenly distributing the work required to meet customer demand over a specified work period. Leveling can be accomplished either by volume and / or product mix. The success of leveling depends upon how capable processes are and on the elimination of long changeovers. When successful, leveling reduces lead times and excess inventory.

g. The ability to make every part in processes upstream of the pacemaker process during every time period.

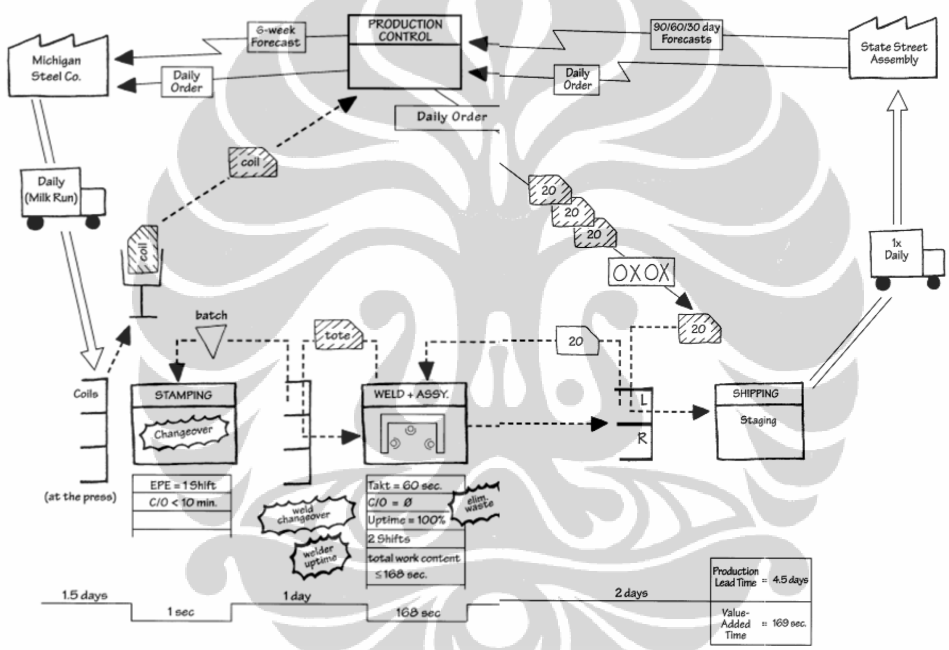

Figure 2.6 Future State Mapping

Source: Mike Rother and John Shook, Learning to See, The Lean Enterprise Institute, 1998.

2. 6.1 Future State VSM Characteristics

a. Continuous Flow

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To achieve continuous flow production, operators must be able to perform their tasks in a repeatable and consistent manner. A two-way information flow must be established to provide targets to the production floor, as well as to signal information about issues and abnormalities between production steps and up to production control.

b. Supermarket

A supermarket is an interim measure enabling continuous flow at a downstream process. The supermarket connects value stream segments where continuous flow is impossible or impractical to maintain for various reasons, such as:

- Geographical issues.
- Inherent batch production
- Multiple value streams and product lines sharing the same process step.

c. Pull System

In general, a supermarket pull system is developed as part of the future state value stream design. Once the sizing and placement of the supermarket are determined, a means for withdrawing from and replenishing the supermarket is designed.

This cycle of production and withdrawal is typically orchestrated by a set of signals, or *Kanban* for both production and withdrawal.

Kanban is a signaling device that gives authorization and instructions for production or withdrawal (conveyance) of items in a pull system. The term is Japanese for “sign” or “signboard.” Kanban cards are the best-known and most common example of these signals.

d. Pacemaker

A pacemaker is the balance point of continuous flow processing. It ties together the three components: Materials, Information and People. The pacemaker serves as a proxy customer to the upstream processes, providing a production target signal. The pacemaker is the point in the value stream that receives instructions from the production control and then initiates production at the upstream processes.

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e. Leveling

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2. 7 Net Present Value (NPV) and Other Investment Rules

The objective of the investment analysis process is to provide quantitative decision support for individual investment proposals. Management must be able to rely on the business information provided in an investment analysis proposal and clearly understand how each proposed investment will support the company's long-term financial objectives. The investment analysis methodology provides a logical and comprehensive approach for evaluating the attractiveness of the company’s investment decision. An investment analysis is a quantified plan which estimates the profitability of a proposal requiring the commitment of company management. This is accomplished by estimating year by year sales, savings, costs, investments, and other cash flows caused or generated by the proposal being considered. The analysis is an "objective" exercise. Consequently, estimates must be provided by the appropriate departments and must be the product of a logical process. Since estimates are made on a year-by-year basis, the analysis process provides profitability measurements for each year, as well as totals for the study period. This enables the project originator to identify the benefits of the proposal.

In the large companies uses the discounted cash flow (DCF) technique which recognizes the time value of money in completing an investment analysis to determine the internal rate of return and the present value of a proposal's cash flows. If the rate of return is considered acceptable, when compared to the company's hurdle rate, and the non-quantifiable factors (e.g., competitive strategy, etc.) are judged acceptable, then approving the proposal should facilitate achievement of the company's long-term financial objectives.

In the basic capital budgeting methods pointed out that a dollar received in future is worth less than a dollar received today. (Ross, Westerfield, Jaffe, & Jordan, 2008). The basic investment rule can be generalized thus: Accept a project if the NPV is greater than zero and reject the project if NPV is less than zero, the basic point on accepting positive NPV benefit for stockholders. NPV rule lead to good decisions for the management of company, for example there are two strategies available, number one use $1000 of company cash to invest in expansion project, and the $1070 will be distributed as a dividend in one year. The number two no investment consideration and pay $1000 cash a dividend today.

If strategy number two accepted, the stockholder save the dividend allocation to the bank for on year with 5 percent interest rate, this strategy would produce $1050 ($1000 X 1.05). With this condition the stockholder would prefer first strategy because give higher return at the end of the year.

The NPV of the project can calculated as:

$$NPV = -CF_0 + CF_1/(1+k)^1 + CF_2/(1+k)^2 + ...CF_n/(1+k)^n \qquad (2.7)$$

$$\sum_{t=0}^{n} \frac{CF_t}{(1+r)^t}$$

Where:

CF_0 = Cash flow of the initial investment

CF_t = Cash inflow would receive at t period

r = the interest rate

t = the number of periods over which the cash is invested

From the example above the NPV calculated as:

$19 = - $1,000 + ($ 1,070 / 1.05), because its NPV is positive that the project on strategy number one should be accepted. When the project is risky, the expected return perhaps increase by 10 percent the NPV would be:

($ 27.27) = - $1,000 + $1,070 / 1.10), because its NPV become negative the project should rejected. The discount rate on a risky project is the return that one can expect to earn on a financial asset of comparable risk. This discount rate is often referred to as an opportunity cost because corporate investment in the project takes away the stockholder's opportunity to invest the dividend in financial asset. For independent project, the net present value rule is to accept the project if NPV greater than zero and for mutually exclusive projects, select the project with the highest NPV subject to the condition that NPV is greater than zero.

According to Ross, Westerfield, Jaffe, and Jordan (2008) Net Present Value is a sensitivity approach method, there are three key to NPV is its attributes:

a. NPV uses cash flows. Cash flow from a project can be used for other corporate purpose (such as dividend payments, other capital budgeting projects, or payments of corporate interest).
b. NPV uses all the cast flows of the project.
c. NPV discount the cash flows properly.

There are several ways to calculate the investment decision for accepting or rejecting the projects as follows:

a. The Payback Period (PP) Method is one of the most popular alternatives to NPV is payback, this method is simple for making the investment decisions. All investment projects that have payback less than cutoff date are accepted if more than cutoff dates are rejected.

$$CF_0 = \sum_{t=1}^{n=PP} CF_t \quad (2.8)$$

Where:

CF_0 = Cash flow of the initial investment

CF_t = Cash inflow would receive at t period

PP = Payback Period

For example consider a project with an initial investment of -$180,000; cash flows are $100,000; $80,000; and $90,000 in the first three years. A summary way of writing down investments like proceeding is with the notation (-$180,000, $100,000, $80,000, $90,000) the company receives cash flows of $100,000 and $80,000 in the first two years, which add up the $180,000 initial investment. In this example case two years is the payback period of the project investment. Consider three projects on the table 2.2, shown the example of projects with similar payback period. With payback period method there are at least three problems.

Table 2.2 Expected Cash Flows on Project A - C

Year	A	B	C
0	-$100	-$100	-$100
1	20	50	50
2	30	30	30
3	50	20	20
4	60	60	60,000
Payback Period (Yr)	3	3	3

Source: Table 6.1 from Ross, Westerfield, Jaffe, and Jordan, "Modern Financial Management".

- Problem A: Timing of Cash Flows within the payback period.
  Compare on project A and B. In year 1 until 3, the cash flows of project A rise from $20 to $50, while project B the cash flows fall from $50 to $20. Because the large cash flow of $50 come earlier

on project B, its NPV must be higher. On this example shown that this method is inferior.

- Problem B: Payment after the payback period.

  Compare project B and C, Project C is clearly preferred because it has cast flow of $60,000 in the fourth year. Using payback period method ignores all cash flows after the payback period, because of the short term focus.

- Problem C: Arbitrary Standard for Payback Period.

  There is no comparable guide for choosing the payback cutoff date, the choice somewhat arbitrary.

b. The Discounted Payback Period (DPP) Method, under this method first should discounted the cash flows, then check for how long discounted cash flows equal with initial investment.

$$CF_0 = \sum_{t=1}^{n=PP} \frac{CF_t}{(1+r)^t} \qquad (2.9)$$

CF_0	= Cash flow of the initial investment
CF_t	= Cash inflow would receive at t period
PP	= Payback Period
r	= the interest rate

c. The Average Accounting Return (AAR) Method is the average project earning after taxes and depreciation, divided by the average book value of the investment during its life. To compute the AAR on the project, divide the average net income by the average amount invested. The most importance flaw on AAR method is does not work properly with the raw materials, then no account of timing and just as payback requires an arbitrary choice of the cutoff date, the AAR method offers no guidance on what the right targeted rate of return should be.

d. The Internal Rate of Return (IRR) is the most importance alternative to the NPV method, is the discount rate that causing the NPV of the project to be zero. The basic reason on the IRR method is that it provides a single number summarizing the merit of a project. The number does not depend on the interest rate prevailing in the capital market. (Rose, Westerfield, Jaffe and Jordan, 2008, p.169).

$$0 = -CF_0 + \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} \quad (2.10)$$

$$CF_0 = \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} \quad (2.11)$$

CF_0 = Cash flow of the initial investment

CF_t = Cash inflow would receive at t period

IRR = Internal Rate Return

e. Profitability Index (PI) is the ratio of the present value of the future expected cash flows after initial investment dividend by the amount of the initial investment. Profitable Index = NPV / Initial Investment

The rule use on the profitable index considers the situation as below:

- For the independence projects, accept the project if PI > 1, and reject the project it if PI < 1.
- For mutual exclusive project select the highest PI.

According to Graham and Harvey (2001) approximately three-quarters of U.S. and Canadian companies use the IRR and NPV methods. This is not surprising, given the theoretical advantages of these approaches.

According to information released by the Census Bureau in 2006, capital investment for the economy as a whole was actually \$1.05 trillion in 2004, \$975 billion 2003, and \$953 billion in 2002, this investment need careful analysis of capital expenditures is some thinks at which successful corporations seek to become adept. The capital budgeting methods on the large firms more sophisticated than the methods of small firms. Table 2.3 provide the date for the large and small firm indicate frequency of use of the various capital budget method on a scale 0 (never) to 4 (always), from the information both the IRR and NPV methods are used more frequently.

Table 2.3 Percentage of CFOs Who Always or Almost Always Use a Given Technique

	% Always or Almost Always
Internal rate of return (IRR)	75.6%
Net present value (NPV)	74.9
Payback Method	56.7
Discounted payback	29.5
Accounting rate return	30.3
Profitability index	11.9

Source: Table 6.4 from Ross, Westerfield, Jaffe, and Jordan, "Modern Financial Management".

Table 2.4 Percentage of CFOs Who Always or Almost Always Use a Given Technique

	Large Firm	Small Firm
Internal rate of return (IRR)	3.41	2.87
Net present value (NPV)	3.42	2.83
Payback Method	2.25	2.72
Discounted payback	1.55	1.58
Accounting rate return	1.25	1.41
Profitability index	0.75	0.78

Source: Table 6.5 from Ross, Westerfield, Jaffe, and Jordan, "Modern Financial Management".

2.8 Discounted Cash Flow Analysis

According to the guide on PT ABC, Discounted cash flow (DCF) analysis is typically the tool used for evaluating investment proposals. DCF analysis is used to evaluate an investment proposal by combining an initial investment (necessary to receive future cash flows) with future cash flows and a residual value. All these calculations are performed to identify the net cash flows that will occur during the study period. By discounting the cash flows, an internal rate of return (IRR) can be calculated, and by using a specific discount factor a net present value (NPV) can also be determined. The IRR and NPV indicate the viability of an investment proposal, but assumptions and estimates used in the study are keys to understanding the results and properly reporting those results.

The credibility of DCF analysis results is largely dependent on the credibility of the assumptions and estimates used in the analysis. DCF analyses are generally based on the "most likely" assumptions and estimates provided by appropriate personnel and must be the product of a logical process. A DCF analysis based on the most likely assumptions and estimates is often referred to as the "base case". After the base case results are determined, the sensitivity of the base case results to changes in critical assumptions and estimates should be measured. The determination of critical assumptions and estimates should be based on the judgment and concerns of the project sponsor, as well as the Business Analyst. Two characteristics of sensitivity tests deserve special emphasis. First, it is essential to understand that sensitivity tests can only be used to identify those assumptions and estimates which affect or influence the DCF analysis results the most. Sensitivity tests do not represent alternative investment analysis results for the base case results. The results of sensitivity tests should not be treated as "another study" because of the manner in which the sensitivity tests are completed. For example, generally all assumptions and estimates are held constant as in the base case except for the assumption or estimate being tested. In reality, a change in one assumption or estimate would most likely affect other assumptions or estimates. If the credibility of many assumptions and estimates is suspect, a separate DCF analysis with a completely different scenario is preferable to a sensitivity test. Again, the base case represents the most likely answer given the most likely assumptions and estimates developed under a given scenario.

Second, it is not appropriate or mathematically correct to combine separate sensitivity test results. The arithmetic accumulation of sensitivity test differences from the base case results cannot be used to estimate the IRR which would result if all of the factors were combined into one sensitivity test. Estimated sales volume is generally the most critical assumption or estimate used in preparing a DCF analysis. Volume determines a large portion of the revenue and provides the basis for establishing the amount of investment required. As a general guideline, volume sensitivity tests should measure the effect of failing to achieve the projected sales volume. The alternative approach would be a separate DCF analysis to measure the financial viability of a smaller business (i.e., lower sales, volume, thus lower investment, etc.).

2.9 Cash Flow Analysis

The most importance step in capital budgeting is estimating project's cash flows operation. Ross, Westherfield, Jaffe, and Jordan (2008) point out that the cash flow of a single project is the cash flow discounted from the projects the firm receives.

2.9.1 The Relevant Cash Flow

Relevant cash flows are the specific cash flows that should be considered in capital budgeting decision. Identify the relevant cash flow very importance before run to the budgeting analysis.

$$\begin{aligned} \textit{Cash Flow} &= \textit{After Tax Income} + \textit{Depreciation} - \\ &\quad \textit{Change in Net Operation Working Capital.} \\ &= EBIT\,(1-t) + \textit{Depreciation} - [\textit{Current Assets} - \textit{Current Liabilities}] \end{aligned} \tag{2.12}$$

The rules considered to avoid mistake when identifying the relevant cost as follows:

a. Capital budgeting decisions must be based on cash flows, not accounting income. When performing a capital budgeting calculation. Earning do not represent real money. Earning can not spend out, eat out, and pay dividend out. the sources of incremental cash flow as follows:
    - Cost of fixed assets. Investment project required assets and represent the negative cash flows. Although the acquisition of assets results in a cash outflows, on the accounting report not shown the purchased of fixed asset is a deductive from accounting income. Instead, they deduct depreciation expense on the depreciation each year depend the life of an asset.

- Change in net operation working capital. The difference between the required increase in current assets would increase in current liabilities is the change in net operation working capital.

b. Only incremental cash flows to the project should be used. These cash flow the changes in the firm's cash flows that occur as a direct consequence of accepting the project. Several pitfalls of determining incremental cash flows are as follows:

  - Sunk Cost. Sunk cost is cost that has already occurred. Because sunk cost are in the past. Sunk cost can not be changed by the decision to accept or reject the project.
  - Opportunity Cost. Opportunity cost is the highest return that will not be earned if funds are invested in particular project. For example a company has an asset that is considering selling, leasing, or employing elsewhere in the business. If asset use in a project, potential benefit or revenue from other alternatives are lost. The lost revenues as opportunity cost.
  - Side Effect. Side effect the proposed project on other parts of a company, two classified of side effect are erosion or synergy. Erosion occurs when a new product reduces the sales and, hence, the cash flows of existing products. Synergy occurs when a new project positive supports the cash flows of existing projects.
  - Allocated Costs. Allocation should be viewed as a cash outflow of the project if it is an incremental cost of the project.

2.10 Project Study Period

According with finance manual at PT ABC, A critical assumption in an investment analysis is the study period (or study life). The study period is defined in basic economic analysis theory as the economic life of an asset. It is sometimes also defined as the period of time over which an asset yields cash flow benefits. In other discounted cash flow (DCF) writings, the study period is defined as the shortest of the physical, technological, or product life.

The definitions above may be theoretically sound but are difficult to translate into study periods for the broad range of investment analyses performed by company. A Business Analyst would normally not be able to determine an appropriate study period based on these definitions. The investment decision at company makes include a variety of assets, having different, perhaps un-measurable, economic lives.

The following general criteria should be considered when determining the study period:

- The study period should be long enough to provide a reasonable matching of the expected cash outflows (i.e., the costs) with the expected cash inflows (i.e., the benefits).
- The study period should be long enough to include the major cash outflows required to support the investment decision.
- The study period should encompass the number of years over which the investment decision can be reasonably expected to remain in effect.
- The study period for a comparison of investment alternatives should be equal to the life of the investment alternative having the shortest economic life.

Extraordinarily long study periods should be avoided, primarily due to the decreasing credibility of study assumptions as the study period is extended. There is also a risk of adding years of mature sales volume levels without fully considering the costs necessary to maintain those sales volumes (e.g., replacement of worn out machinery and equipment, development costs for product redesign, etc.).

2.11 Depreciation Analysis

According to Wild (2008), depreciation is the process of allocating the cost of a plant asset to expense in the accounting period benefiting from its use. Depreciation does not measure the decline in the asset’s market value each period, nor does it measure the assets physical deterioration. Actually depreciation is an allocation of past cash flow. There are several acceptable methods of computing depreciation, and the method selection depend of firm own choice.

a. Straight-Line Method. Straight-line depreciation charges the same amount of expense to each period of the asset's useful life. There are two steps on this method, first compute the depreciable cost of the asset from computed by subtracting the asset's salvage value from the total cost. Second step, divided the first step by the number of accounting periods of asset's useful life.

$$Depreciation\ Expense = \frac{Cost - Salvage\ Value}{Useful\ life\ in\ periods} \quad (2.13)$$

b. Units-of-Production Method, The straight line method charges an equal share of an asset's cost to each period, on this method charges a varying amount to expenses for each period of an asset's useful life depending on its usage. There are two steps on this method, first compute depreciation per unit by subtracting the asset's salvage value from its total cost and then divide by the total number of production plan within its useful life. Second step is to compute depreciation expense by multiplying the units produced in the period by the depreciation per unit.

First step:

$$Depreciation\ Per\ Unit = \frac{Cost - Salvage\ Value}{Total\ Units\ of\ production} \quad (2.14)$$

Second step:

$$Depreciation\ Expense = Depreciation\ Per\ Units - Units\ produced\ in\ period$$

c. Declining-Balance Method, An accelerated depreciation method yields larger depreciation expenses in the early years of an asset's life and less depreciated in later year. A common depreciation rate on this method is double-decline-balance (DDB) method. There are three steps on this method, first compute the asset's straight line depreciation rate, second double the straight-line rate, and third compute depreciation expense by multiplying rate by the asset's beginning-of-period book value.

First step:

$$Straight \quad Line \quad rate = 100\% \div Useful \quad life \qquad (2.15)$$

Second step:

$$DDB \quad rate = 2 \times Straight.line \quad rate$$

Third step:

Depreciation Expense = DDB rate X Beginning period book value