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REMOVING BOTTLENECK FROM A MANUFACTURING UNIT: A case studies to BET-KER OY, Ylivieska-84100, Finland

Thesis
CENTRAL OSTROBOTHNIA UNIVERSITY OF APPLIED SCIENCES, YLIVIESKA UNIT
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Abstract

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Name of thesis Removing bottleneck from a manufacturing unit: A case studies to BETKER OY, Ylivieska-84100, Finland		
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Bottlenecks are obstacles, which reduce the entire capacity of the system. Bottlenecks are always present in the system in different forms like constraints of management, people, material, equipment, process, policy, environment etc. Its forms can be different according to the type of business but the methods to identify it can be same. A number of approaches have been developed by several scholars; what ever may be the approach of identifying root cause for the prevailing problem is the only way to get rid of bottlenecks.

The aim of this thesis is to identify different types of bottleneck prevailing in Bet-ker Oy and recommending a solution. In the process of identifying bottleneck, I tried my best to utilize all the knowledge gained through learning and practical works done under different subjects in the class and several articles, reports and research work published in different books and internet were followed.

I have tried my best to cover all possible theories needed under each topic, so that the reader can get a clear picture of different types of bottlenecks, ways to identify and deduce possible solutions to it.

Key words

Bottleneck, Refractory, Pretreatment, Monolithic, Silo, forecasting, Improvement, Analysis

PREFACE

I would like to express my gratitude to all those who gave me the opportunity to complete this final thesis of my studies titled **REMOVING BOTTLENECK FROM MANUFACTURING UNIT** (A case studies to **BET-KER OY**, Ylivieska-84100, Finland). The purpose of the thesis is to analyze the manufacturing unit from different perspective of business activities such as manufacturing management, supply chain management and project management, and to give a comprehensive view to eliminate the prevailing bottleneck from the manufacturing unit.

The entire thesis is based on the knowledge gained during study, article, report, research work published in different books and internet along with the information provided by Bet-ker Oy. I have tried my best to provide as much details as possible on the topic. I am grateful to all the researchers, writers, publishers and different organization whose work has contributed a lot to complete my thesis.

My deepest thanks to thesis supervisor Ossi Päiväläinen for giving the guide line to write the thesis from beginning to end. At the same time I would like to give special thanks to Mikko Miettinen, working life supervisor for providing me the task. Also I am heartily thankful to Kyösti Ruotanen and Päivi Hautamäki for guideline, correction of my work and providing necessary information from the company's side.

During the thesis work I came across the various facts of refractory manufacturing and over all management of a manufacturing unit. I hope this thesis report will be useful in various forms, especially in removing bottleneck from manufacturing unit in some extent.

Thank you!

PREFACE
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1 INTRODUCTION

In the present world of competitive business, cost minimization and efficient management of manufacturing unit is not an easy task. Always in practice when one problem is solved there comes other new or may be old problems will reoccur with the passage of time. All these problems that are constraints of business utilizing various resources in different forms without adding any value in the system, can be commonly called bottleneck of manufacturing unit.

Identifying and removing the bottleneck is critical to a business. It is an ongoing process which needs to be carried throughout the year in order to utilize resources of production and maximize profit of the firm.

The aim and objective of my thesis is to give a general picture of different types of bottlenecks that can prevail in a manufacturing, ways to finding bottleneck and give possible solution to each of them. In general the aim and objectives can be listed as follows:

- Measuring and controlling the flow of materials
- Identify the bottlenecks in the process
- Recommending the necessary changes
- Speeding up the production (turnaround time) i.e. Increasing the production

I divided the whole thesis work in different chapters with specific goals to be achieved which are highlighted as below:

1. Bottleneck in manufacturing
   - Different types of bottleneck in manufacturing unit
   - Approach to find bottlenecks
2. Manufacturing management
   - Analyzing current manufacturing process, machinery and equipment
   - Applying of “Pull materials” through the system
3. Supply chain management

- Create flow of products to eliminate surplus

4. Project management
    - Identify and eliminate the activities which are not adding value in the project
5. Conclusion
    - Recommending a road map for the improvement

The methods of the thesis is entirely based on research work, theoretical part is covered from the different books followed during the class hours in different subject, article, reports, research work published in different books and internet. First the theoretical framework is given during the first chapter entitled “Bottleneck in manufacturing unit” which is followed by successive chapters as mentioned above. There were specific goals behind each chapter to be achieved; it was not easy to penetrate each and every task in the manufacturing unit of Bet-Ker Oy.

To the best of my knowledge, I have tried my best to respond the entire possible bottleneck prevailing in the system. I hope this will add some value in the manufacturing unit of Bet-Ker Oy.

2 BET-KER OY IN BRIEF

Bet-ker Oy is a private owned company involved in manufacturing of refractory materials since 1977. Its customers include the steel industry, metal smelting industry, foundries, metal reheat furnaces and incinerators. The main products of the company are refractory castables and pre-shapes made out of castables (for ladle, tundish, wear and safety linings), dry installed inorganic bond coating materials (especially for tundish), spray & gunning mixes for ladles and furnaces and troughs, repair & finishing materials having plastic rheology. The different products are manufactured in accordance with customer needs.

The Bet-ker Oy is located in Ylivieska with good connection to road and railway transportation. It is only 50 km away from the nearest harbor, the port of Rahja at Kalajoki. The company has several international patents related to refractories technology as well as licenses abroad.

The monolithic refractory and precast shapes are manufactured in a fully computer controlled plant. The plant's annual output capacity is 40,000 metric tons. The mixed materials manufactured are packed in paper bags, big bags or they are delivered in bulk by silo trucks to the customer destination.

Various types of sophisticated precast shapes are manufactured according to customers' needs. Company has a facility to dry and fire the precast shapes as required. The precast components sizes and shapes can vary extensively, with weights ranging from 1 to 5,000 kilos.

The main market of the company is Russia, Belorussia, Denmark, Germany, Indonesia and the biggest customers are Finnish steel manufacturer. The factory produces about 20,000 tons of monolithic refractory materials and precast shapes a year. The main raw materials are natural and synthetic silicates, alumina, magnesia, calcined bauxite and reclaimed refractories.

The company is spread in the area of 23 159 m^2. Presently there are total of 24 employee, among which 15 workers and 9 officials. The company had a turnover of 10 343 321.60 € in the year 2010 with share capital of 504 563.78 €.

The different works in the factory includes manufacturing (grinding, mixing, drying etc.) maintenance/repair, import, export of materials etc. Bet-ker Oy has different departments like sales, production, research and development working under one managing director.

In general, there are 3 employees working in office, 2 people in maintenance/repair, 2 in laboratory, 1 in dispatch department/warehouse, 4-5 in element production, 3-4 in mixing/ castable/material production, 2 in crushing, grinding and material transfer and so on.

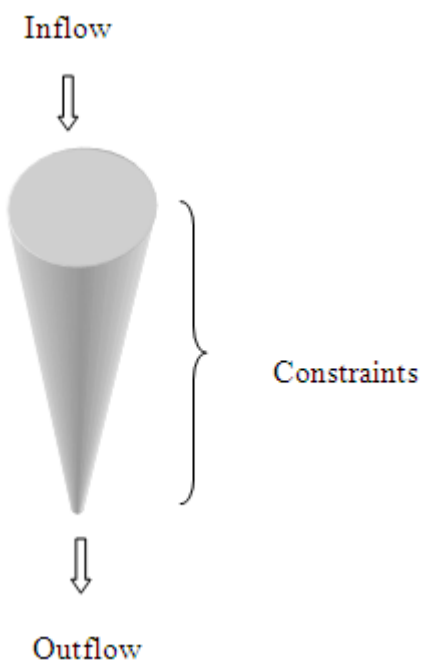
In most cases customer has the possibilities to quality inspection at the plant, so that proper attention can be given to customer needs and requirements. The Bet-ker Oy has been awarded several times by the AAA+ certificate (the best possible) related to company's economy. In the year 2010 Bet-ker Oy has also been nominated among seven most advanced companies in Finland by major Finnish bank and economic magazine (Bet-ker Oy, 2012).

GRAPH 1.Bet-ker Oy

3 BOTTLENECK IN MANUFACTURING

3.1 Introduction

An activity which delays the performance of a system and reduces overall efficiency of the process is known as bottleneck. As for example a manufacturing company has different line of production; each of them are connected to each other i.e. the work produced from one unit is the input for other unit and so on. In this case if one line is broken or halted due to some reason than the other lines of production is directly affected causing lower level of output as a result of bottleneck.



GRAPH 2. Example of Bottleneck

Here in the above diagram it is seen that the inflow rate is higher than the outflow rate, it may be due to several reasons from design of the equipment to assemble and operation of the process, which helps to reduce the overall efficiency of the systems. All these constraints of the system are known as bottleneck.

Thus a bottleneck is an obstacle in the process of manufacturing which restricts the production. It can vary according to time and changes in production process (Cecil C. Bozarth & Robert B. Handfield, 2008).

3.2 Types of bottleneck in manufacturing

There can be many different types of bottleneck in manufacturing industry as for example labor, time, material or machine etc. In general different forms of bottleneck can be described as below:

3.2.1 People constraints

People are one of the most important factors of the production and difficult to manage in an effective way. In any manufacturing unit there are different people working together with different experience, background and educational qualification. Each people have their own way of motive towards work. So in an manufacturing unit differents constraints of bottleneck can be due to union problem, illness, unexpected vacancy, hiring and training problems etc.

3.2.2 Material constraints

Production capacity is highly affected by the poor management of inventory, inadquate forecast, inefficient supplier, poor production planning, inediquate finance, changing product mix etc. one or all of these factors may cause improper flow of materials resulting reduction in overall production capacity and increasing lead time(SMC Focus, 2012).

3.2.3 Equipment constraints

Equpiment for manufacturing should meet the current demand. The machines and equipment should be flexible to expand in order to meetfuture demand, but some times due to inappropriate planning, brakedown of machine, unavailability of spareparts, improper maintenance, low level of infrastructure machines and equipments becomes a constraint of manufacturing.

3.2.3 Process constraints

Process constraints in manufacturing unit can be due to quality problems, insufficient resources, poor plant layout and inflexible process (not able to change according to time and market demand). The constraints can occure anywhere in the process, supply chain, customer, supplier etc. Hence anykinds of problems affecting entire output of the system is known as process constraints (Small business took kit, 2012).

3.2.4 Management constraints

Efficient management means better performance resulting in higher output and profit. Overall management of a manufacturing unit should comply with aim and objective of the company. Sometimes the management is not be able to meet the needs of the system and becomes a constraint causing different problems like demotivation of employee, ineffective flow of material and information etc.

3.2.5 Policy constraints

Policy of a manufacturing unit should meet the goal of company, it should be clearly defined what actions are to be taken at what conditions. Generally (not always) the management is not

able to define all the issue in specific way, this may leads to a constraint in manufacturing.It is the most common form of constraint (Lean production, 2012).

3.2.6 Environmental constraint

Operating environment of any business includes competitors activities, rules and regulations formulated by government, labour law, union law, customer demands & expectation, economical situation, technological improvement, development in infrastructure etc. at the same time the firm should bear the social responsibilities. These all factors affecting the activities of business is called environmental constraints (The times 100 business case studies, 2012).

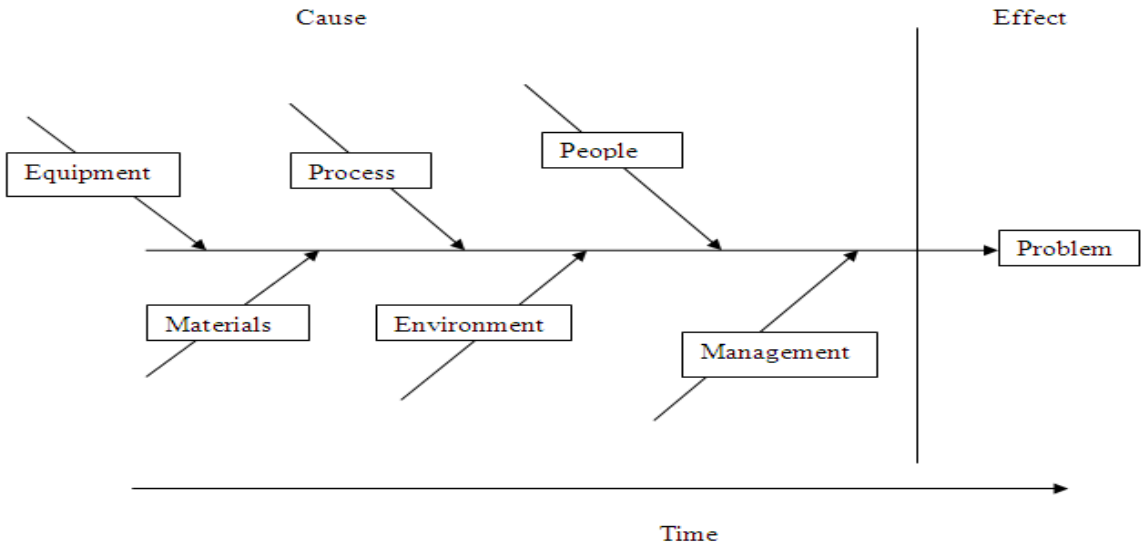
3.3 Approach to find bottleneck

Bottleneck is the main reason for slowdown of the production in a manufacturing unit. It has to be identified, analyzed and needs to be resolved on the basis of facts. Once the bottleneck is identified correctly and efficiently; It helps to reduce production cost increasing overall efficiency of the system. There can be long term or short term constraints in the system. Bottleneck can be identified in a process/system by following the simple approach as follows:

3.3.1 Fishbone diagram

“Fishbone diagram is a tool that provides a systematic and graphic way of identifying possible causes for a problem, using categories to focus and structure the thinking, in order to work toward determining root causes. Also known as the Ishikadiagram (After Dr. Kaoru Ishikawa, the Japanese quality control statistician credited with investing it) and cause effect diagram” (John Kamauf, 2010, 47).According to this approach there should be a cause to see the effect.

So under this approach, different data related to the problem are collected. These data are analyzed precisely in order to find the root cause for that particular problem (Peter D.Mauch, 2010).



GRAPH3. Fishbone diagram (Peter D. Mauch,2012)

3.3.2 Failure mode and effect analysis(FMEA)

"FMEA is a methodology for analyzing potential problems early in the development or improvement process, by identifying relationship between process and product requirement and anticipating the potential for unacceptable outputs and their effects, enabling teams to take action to reduce risk and increase reliability"(John Kamauf, 2010, 82).

FMEA helps to know all different ways for occurrence of failure and estimate its effect and seriousness, in the same time it also helps to find the possible ways of correction. Generally FMEA identifies following issues for every process/steps examined:

- Potential failure mode
- Potential effects of failure

- Potential cause of failure
- Severity
- Times of occurrence
- Present control methods
- Recommend actions

Failure mode and effect analysis focuses on improvement of product functionality, safety and reduction of external failure cost like warranty cost, service delivery obstacles. It can be used in several dimensions to eliminate failure modes in a process or system (James R. Evans & William M. Lindsay, 2008).

3.3.3 Theory of constraints (TOC)

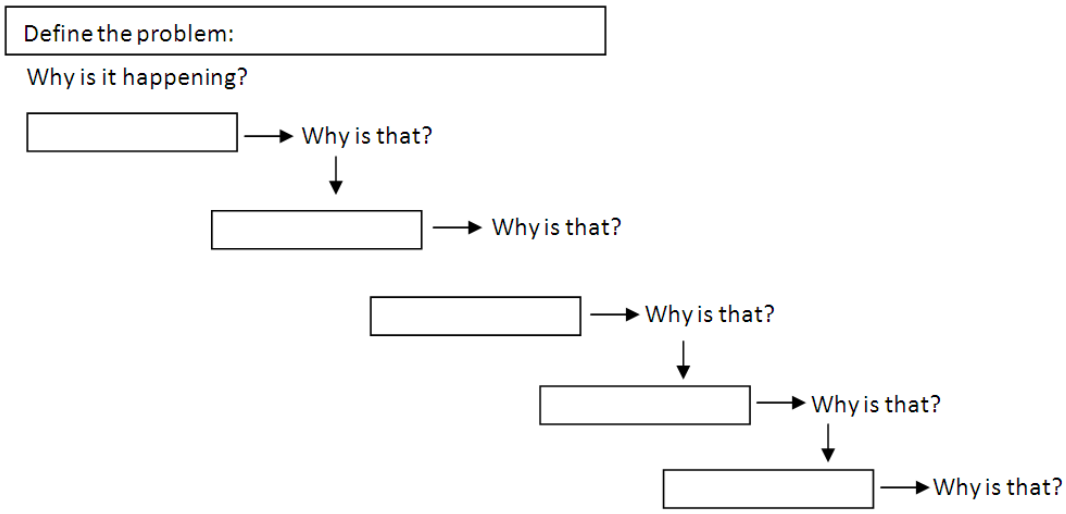
Theory of constraints guides for regular improvements on the system. Any system is consists of a series of independent sub system working together in a defined way in order to meet fixed target. In the same way there can be a number of weak places working as constraints in the system. And TOC focuses on those weak places where improvement is necessary. Theory of constraints follows following five steps:

- Identify the constraints
- Exploit the constraints
- Elevate the constraints and
- Repeat the cycle

Thus the TOC works on speed and volume of production with time and can be an effective method to find the bottleneck in the system (Eliyahu M. Goldratt& Jeff Cox, 2004).

3.3.4 Five why Principle

This is one of the best approaches developed by Japanese industrialist Sakichi Tyoda.It helps to explore the root cause of a problem. This methods guides us to ask “why?” questions until we find the root cause for the problem (Dmaic tools, 2012).



GRAPH 4. Five whys Worksheet (Asian Development Bank, 2012)

3.3.5 Benchmarking

A process of correlating different activities (process, product, service etc) of a firm with similar others in order to find best possible options in order to improve or solving a problem of specified task or operation is known as Benchmarking. It helps to know where the improvement is necessary and how other industries are doing. Thus helping to improve own performance (James W. Dean, Jr. James R. Evans, 1994).

3.4 Some important terms of manufacturing management

Manufacturing management includes all activities that lead to an increase in the efficiency of manufacturing process. Some important terms of manufacturing management are given below:

3.4.1 Capacity planning

Process capacity is maximum capacity output rate measured in units produced per unit of time. In a manufacturing unit capacity planning means designing plant layout, installing machine equipments and arranging different factors of production for a specific period of time. The aim of the capacity planning should be able to meet the present and future demand of the goods or service produced. The capacity should be flexible in the time frame. Thus the capacity planning is the process of identifying necessary resources to meet the production plan. It should be able to calculate the start and end time of the production. Factors like number of workers, number of machine, waste and scrap, defects and errors, productivity, suppliers, buyers, government rules and regulations, repair and maintenance etc affects the capacity planning of any manufacturing unit. The capacity planning can be long as well as short term and helps a firm to make more profit (Wise GEEK, 2012; Search Enterprise WAN, 2012).

3.4.2 Process analysis

A process is combination of different resources in a specific way to get the desired output through given input. It is also an approach to identify connections between different resources within a system. While analyzing a process each and every steps of manufacturing needs to be described and connected to the next preceding step. It should follow chronological order of manufacturing from start to end step of manufacturing. Thus the process analysis gives a clear

picture of what is to be done and what we are doing (University of Florida, 2012; Changing Minds, 2012; Process analysis, 2012).

3.4.3 Data collection and simulation

Different data e.g. output rate, production capacity, working hour etc. from manufacturing unit are collected. The collection of data can be made by survey, inspection, experiments and so on. Each data collected needs to be simulated and analyzed with the specified standards of manufacturing. It helps analyst to indentify the problems of manufacturing (Biology online,2012; Business dictionary, 2012; Business excellence, 2012).

3.4.4 What if

Every time we make certain changes or improvement in the system, there is possibility of failure i.e. the changes or improvement made may not work as planned. In that case it would be better if there is some other backup plan. So what if is the condition where alternative methods need to be determined or planned if something goes wrong or some changes in manufacturing are not working as planned (John Kamauff, 2010).

4 MANUFACTURING MANAGEMENT

4.1 Introduction

Manufacturing management in an organization deals with the design and management of products, processes, services and supply chain. Its main responsibility is to utilize all the resources so that a firm can meet the customer demands along with making profit, organizational growth and be competitive in the market.

In general well designed manufacturing management should be able to answer the following questions

- How total cost can be reduced?
- How to reduce working capital?
- How to increase profit?
- How Maximum utilization of resources can be made?

An answer to these questions helps a company to utilize different available resources effectively in order to obtain competitive advantage in the market. The competitive dimension can include cost, product quality, reliability, delivery speed, delivery reliability, demand changes, flexibility and support before and after sales.

As an operation manager one should be able to segment the market, identify the product or service requirement, demand pattern and profit margin of each segment. It is also necessary to determine what the customer wants, in the same time he/she should be able to convert customers according to the product or service produced.

In the same way an operation manager should be able to make decisions supporting the mission and the over all strategy of the organization.

In conclusion the fundamental work of operation manager can be described in three steps:

Plan → Implement the plan → Monitor the processes

In manufacturing management the use of technology such as Material requirement planning (MRP), Manufacturing resource planning (MRP II), Enterprise resource planning (ERP), Advanced planning and scheduling (ASP) and e-Procurement etc. is becoming mandatory. An operational manager should be aware of these technologies and must be able to identify which of them and what is suitable for his/her organization.

These technologies make operational manager work (Planning, buying, making, moving, selling etc.) easy. Ultimately it helps a firm to survive, compete and succeed in the market. Similarly it also helps an operational manager to make a better informed decision in real time with less risk.

However, the importance of technology in operation management is increasing. Its implementation is not so easy and at the same time it is costly too. So while implementing a technology "What-if?" question should be in mind.

Besides these technologies, the knowledge of collaborative planning (redesign and implementation of planning processes across multiple enterprises using electronic business to synchronize product flow, optimize resource allocation and reducing inventory) and Advanced planning and scheduling (integrating demand and supply process to reduce inventory levels, shorten supply chain cycle times and reduces supply chain cost) are also important in operation management of a firm.

Thus the implementation of the technology is for proper management of Manufacturing, Supply Chain management, Financial management, Project management, Human resource management, Customer relationship management, Data warehouse, Access control over every factors of manufacturing and customization of resources so that a firm can be more profitable and competitive in the market (John Kamauff, 2010).

4.2 Refractory materials

Refractories are the substances which can withstand high temperature without losing its physical and chemical properties. These are inorganic, nonmetallic, porous and heterogeneous materials composed of thermally stable mineral mixed together with a binder and additives. Refractory material are used in almost all processes involving high temperature, corrosive environment, insulation furnaces, kilns, incinerators, reactors, jet and rocket engines, parts of space vehicles such as space shuttle. They are also used to make crucibles (A. Bhatia, 2011).

According to American Society for testing and materials (ASTM), Refractories are "Non-metallic materials having those chemical and physical properties that make them applicable for structure or as components of systems, that are exposed to environment to above 1000° F (811 K; 538° C)".

Refractory materials are specially manufactured for insulation and protection of industrial furnaces and vessels due to their extra-ordinary properties such as heat resistant, chemical and mechanical damage. Materials like oxide of silicon, aluminum, magnesium, calcium, zirconium and non oxide like carbides, nitrides, borides, silicates and graphite are the main raw materials for manufacturing of refractories. Different factors like external environment, temperature and materials in contact determine the composition of refractory materials (The refractories Institute, 2011).

4.3 Types of refractory materials

There are a number of different types of refractory material commercially available in the market. They can be divided in four main groups as shown:

- Chemical composition
- Methods of manufacturing
- Physical form
- Special use

A. **Chemical composition:** Each refractory material has different composition and shows distinctive behavior when reacting with slags. On the basis of chemical reaction to slag it can be divided in to sub groups like acidic, basic and neutral.

- Acidic refractories: Refcatories which are attracted by basic slags to be neutralised but do not show any reaction with acidic slags are called Acidic refractories. These types of refractories are safe to use in acidic environment. Examples of acidic refractories are Silica (SiO_2), Zirconia (ZrO_2) etc.

- Basic refractories: Refractories which are attracted by acidic slag to be neutralized but do not show any reactions with basic slag are called Baisc refractories. These types of refractories are safe to use in basic environment (e.g. non-ferrous metallurgical operations). Examples of basic refractories are Magnesia, Doloma, Olivine, Chromite, Forsterite etc.

- Neutral refcartories: Refractories which are neither attracted towards basic nor acidic slags are known as Neutral refractories. These types of refractories are used in the environment of neither acidic nor basic. Examples of neutral refractories are carbon graphite, Chromites, Alumina etc.

B. **Methods of manufacturing:** On the basis of manufacturing method refractories materials can be divided into the following groups

- Dry pressed
- Fused cast
- Hand molded
- Formed (Normal, Fired or Chemical bonded)
- Unformed (Monolithic)

C. **Physical form:** on the basis of physical form refractories are classified into two groups i.e. Shaped (bricks) and Unshaped (monolithic).

- Shaped (bricks) refractories: Refractories which have specific shape when delivered to end users are known as shaped refractories. The users can not define the shape and size under this category.

- Unshaped (monolithic) refractories: Refractories which do not have any specific shape and size are known as unshaped refractories. These types of refractories can be designed according to use.

D. **Special use:** Under this category refractories are classified on the basis of special use like in rockets, jets and nuclear power plants. Many refractories like aluminium oxide, silicon carbide etc are very hard and used abrasives for example aircraft brake linings. More examples of this type of refractories are cerments, Sialon etc. (A. Bhatia, 2011; The refractories manufacturers association of Australia, 2011).

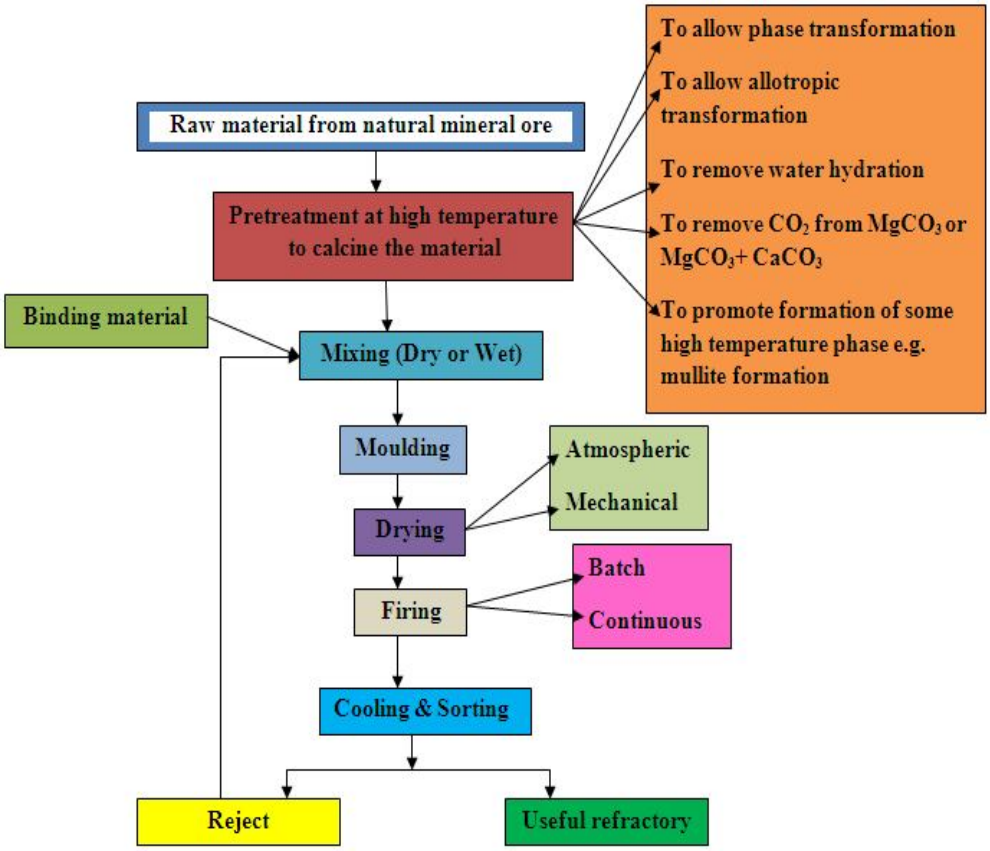
4.4 Refractory manufacturing

Commercially used refractories are not readily available in the nature. Refractory is manufactured by mixing different raw materials available in mineral ores. In general manufacturing process of manufacturing of refractories material can be described in following ten steps:

- Collection of raw materials
- Crushing and Grinding of raw materials
- Pretreatment of raw material(Calcinations, Stabilizer addition)
- Mixing
- Molding
- Drying

- Firing
- Cooling
- Milling/ Finishing
- Final product

The whole manufacturing process can be descried in the following flow chart



GRAPG 5.Manufacturing flow chart of Refractory materials (National programme on Technology enhanced learning, 2011).

4.5 Manufacturing process of Bet-Ker Oy

Raw materials come to Kalajoki Rahja harbor through ship from different countries in bulk (3000mt and even more), later transported to factory. Truck loads or smaller orders of the raw materials are directly transported to Ylivieska. Some of the raw materials are crushed, grinded while others are ready to use.

Once the raw materials arrives to manufacturing unit they are filled to flat silos(storage), some are crushed/grinded and goes with elevator to seizer and to silos. Powder silos are filled by puff car and additive containers from big bags. Materials are dosed in scales before filling to mixer. After mixing time (about60-80seconds) mix is dropped to bags, or goes to product silo.

There are different machines used like Crushing machine, 2 grinding machines (big and small ball mills), sieving machine, mixers, bridge cranes, different kind of conveyors (scale-, belt- and screw conveyors and elevators).

GRAPH 6. Packing of refractory in Betker Oy

The working of each machines are described as follows:

- **Big ball mill:** Its capacity is about 40 mt / 24 hours.
- **Small ball mill:** Its capacity is about 4-5 mt / 24 hours.
- **Crushing machine:** It can work from 30 mt to 70 mt / working day (working time about 7 hours), depending on the material.
- **Production, big factory:** It can work from 50 mt to 110 mt / working day (working time about 7 hours), depending on the product and batch size (110 mt / day can be produced straight to product silos). Also size of lot affects capacity: if making many small lots, amount per day is much smaller.
- **Production, small factory:** It can work From 25 mt to 50 mt / working day (working time about 7 hours), depending on the batch size.
- **Element production:** Big elements: about 7 mt / working day (working time about 7 hours), 2 other molding places: about 2.6 to 2.8 mt in each place / working day (working time about 7 hours). All elements combined together can produce about 12.4 mt /working day.

Employees don't change much here, so they know well how the work is supposed to be done. Employees know more than just one work task, and they can stand in for each others. Work here is not something that can be learned in school, so if new employees come, they learn from the other employees, who do the same work.

Production process is fully depending on the orders by customer; only a small amount is manufactured as ready goods by forecasting in advance. If the machines are working on full capacity, approximately 110 mt can be produced in one working day.

GRAPH 7. Crushing and Grinding

4.6 Raw materials used in Betker Oy

Different kinds of raw materials used in Betker Oy are as described below:

Aggregates: Olivine, magnesium oxide (magnesia), aluminium oxides (aluminas e.g. several types like white tabular, white fused, brown fused aluminas), calcined bauxite, Chalmette, fireclay, flint clay, mullite, kyanite, quartz etc.

Reclaimed aggregates (source is used refractory bricks): Magnesia-carboncrog, Fire claycrog, Magnesia crog, Chrome magnesia crog.

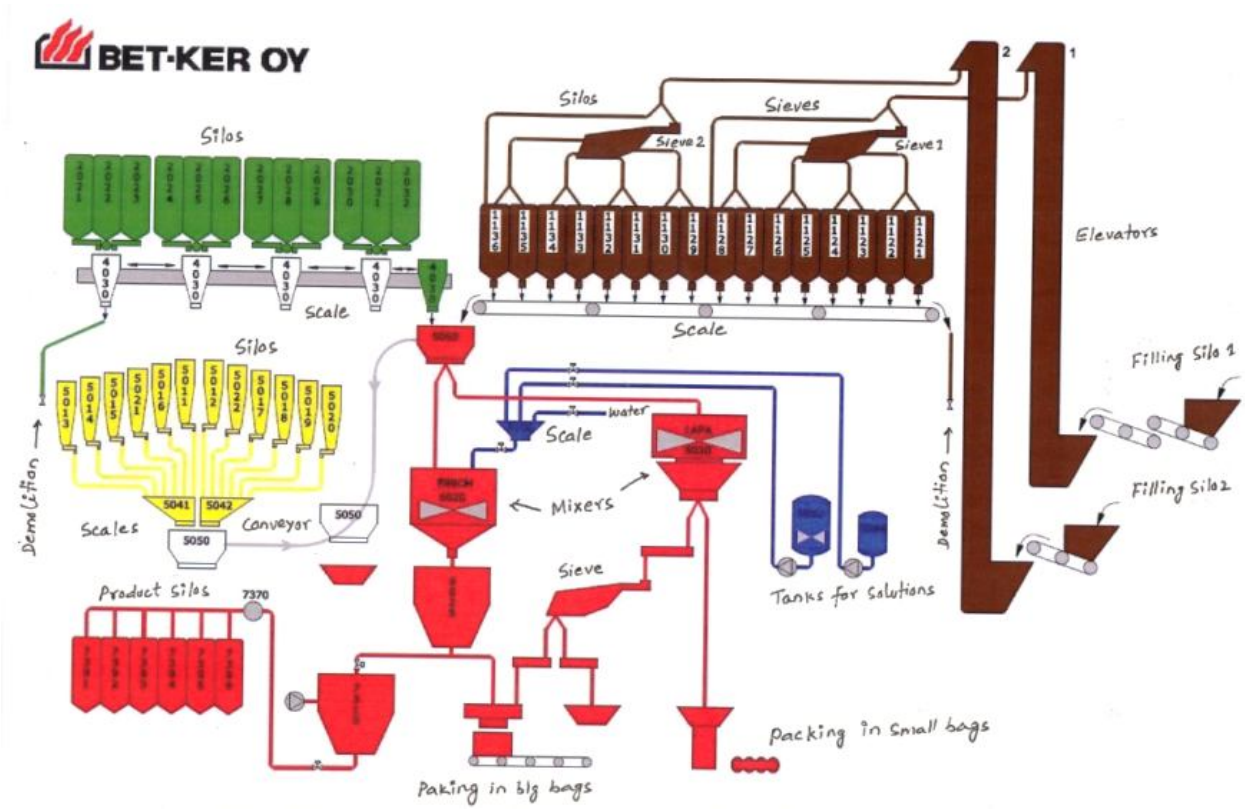
Reclaimed aggregates (source for panel forming alumina castable): alumina-spinel crog.

Other reclaimed aggregates: porcelain crog, ferro chromium slag.

Binders: Silica fumes, Calcium aluminates cements, Calcium silicate cements, Alkali phosphates, Sodium silicates, Earth-alkali salts, Bentonite, Calcined clays.

Additives: Deflocculates, Dispersing agents, Steel fibers, Polymer fibers, Rheology modifiers, Retarders, Accelerators.

Main products of Betker Oy are refractory castables and pre-shapes made out of castables (for ladle, tundish, wear and safety linings), dry installed inorganic bond coating materials (especially for tundish), spray & gunning mixes for ladles and furnaces and troughs, repair & finishing materials having plastic rheology.



GRAPH 8. Manufacturing of refractory (Betker Oy, 2012)

4.7 Analysis of manufacturing process of Bet-ker Oy

To analyze the manufacturing system was not an easy task because it needs detailed knowledge of the plant and experiences. I made some questionnaires (see appendix 1) and asked to answer my questions to different persons in the factory. Personal visit and discussion was also useful for analyzing the system.

4.8 Findings of analysis of manufacturing process

On the basis of discussion with personnel's and personal visit to factory, I came up with the following findings:

- **Inadequate dozing silo system:**

  More silos are necessary at the dry mix plant. The reason for this situation is especially the increasing amount of reclaimed raw materials possible to be applied due to relatively low price. The biggest need is for powder silos. However, adding these kind silos (e.g. 3 units) is a major investment (n* 100 000 €). So far no detailed engineering study has been carried out for expansion of powder silo system.

- **Inadequate volume of the additive silo tank conveyor:**

  The additive amount possible to be dozed from additive silos (at the ground floor) is limited. It is difficult to increase this conveyor size since it is a part of the aggregate and powder raw material feeding line into the mixers. To solve this problem is not simple because the height of the conveyor is limited and it must fit as a part of the raw material feeding line. On the other hand, broadening the walls wider would render the additive depletion difficult due to the fact that the binder additives are prone to stick into the walls of the conveyor and thus would not be depleted properly. Also, if the additive conveyor would fetch the additives twice, instead of once, the dozing time would be increased remarkably because the additives are dozed before the aggregates and powders from above silos; this would render the production slower and would limit the production capacity of some products.

  There has been also a suggestion that there would be two tank conveyors, applying the existing additive feeding route. This would however require extension of the route from its both ends, and that is technically challenging this is due to lack of space,

especially at the additive silo ends. Still another suggestion has been that there would be a new integral part in the raw material feeding line, replacing the additive conveyor from this task. Instead, the additive conveyor would be transported next to the current end station (perhaps into a bit higher position) and the conveyor would be depleted via a tubular conduit leading to the new part of the feeding line. No detailed engineering has been performed regarding the capacity increase of additive conveyor system.

Still another solution would be to build up a fourth silo battery for dry ingredients. The place of this might be the fourth floor, next to the powder silo conveyor box, on its eastern side, close to the shaft. The amount of silos may be from 4 to 6 units, the volume of each can be less than 1 m^3. The supply of raw materials would be via the shaft by shaft crane. The raw materials chosen for these silos should be additives dozed in small quantities because the service via the shaft is quite laborious. The raw materials would be packed in 15 – 25 kg paper bags and emptied into the silos manually. An additional crane or conveying system is necessary for the horizontal movement of raw material pallets after the pallet is lifted from the bottom floor by the shaft crane up to a required height. Also the weighing system and the conduits for feeding the weighed raw materials into the main raw material feeding line should be elaborated. No detailed engineering research has been carried out so far related to this fourth silo battery option.

The investment in improving additives and some powder dozing systems will cost probably a few thousand Euros, independent of the way how the investment would be accomplished.

The suitable raw materials to be dozed from this possible new silo battery would be e.g. bentonite, clay, sodium silicate, phosphates, and silica fume.

- **Inadequate milling capacity:**

There are two existing ball mills, the bigger one for magnesia and olivine, the smaller one for bauxite, shamotte and reclaimed alumina. The smaller one is prone for failures and its capacity is limited if there is more demand for certain products. There are some

basic ideas to invest on a third mill which would cost few hundred thousand Euros, with the supporting equipment and silos included. So far no design of the expanded milling system has been elaborated.

Some minor arrangements might be carried out with the storage of raw materials, ready mix products and pre-shapes. The newly erected, big capacity mixer system for producing big pre-shapes will limit the space in the casting house, especially limiting the storage capacity of castable mix bags and the dried pre-shapes in the casting house. Arrangements in the two bag storehouses (cold & hot) are necessary in order to get the better space benefited. If the demand is increased, some new storage room may be appropriate, too.

Capacities of the machines are not the same. When the process is running, different machines work one on the other, such as dosing materials for next portion is done while mixing and packaging previous. There are also different amounts that need to be handled with different machines, for example there is no need to crush or grind all materials, and in the factory the amounts of aggregate materials and additives or binders are not same.

The factory is not new, so there are machines that are not of the latest technology. The machines are replaced when there is a need for example after they broke.

As regards to employees they are satisfied with the work what they are doing, in general there are not such significant bottlenecks from the employee’s side.

In general overall manufacturing unit can be evaluated as follows:

TABLE 1. Overall rating of Bet-ker OY

Particulars	Ratings
Materials	3
Equipment	2
Process	4
Management	4
Policy	3
Environment	3
People	4

1= Poor management

2= Needs to change

3= It's ok

4= Good

5= Excellent

Basis for ratings.

Even though the manufacturing process of Bet-ker Oy is running well, during my factory visit and the information given by the factory personnel there were certain things to be changed or altered in order to utilize all the resources of manufacturing which are outlined as follows.

- Machines are not running in full capacity.
- Generally manufacturing is done in 30mt to 40mt batches.
- Some ready goods in stock for minor customers.
- Limited number of big customers.
- Grinding mill for bauxite, chamotte and etc. is too small and the capacity is very poor
- Too few silos for different materials in factory (on powder site) and for aggregates in the storage.
- Product sheets are poor there are not any good working tools for marketing
- www.betker.fi is not with sufficient information. In fact there exist only a telephone number and address (Bet-ker Oy, 2012).

4.9 Recommendation to remove bottlenecks

In general the bottlenecks in production can be evaluated as a comparison of the amount of workforce and potential investments in equipment and related software (the amount of production personnel and the amount of shifts applied, versus investments into production equipment and storehouse capacity). So far there is only the day shift with some overwork occasionally. There are evening and night shift at disposal, but of course with extra cost. During weekends and special holidays there has been no working at the production. So it has to be evaluated if it is more profitable to use more workforces, or if it is more profitable to invest on machinery and storehouse.

After analyzing the manufacturing process of Betker Oy the following recommendations are made for improvement in the manufacturing process.

In production there can be more silos, so there would not be a need to change the raw materials when changing the product.

Also there is one conveyor which could be bigger because of that some products need to be manufactured in smaller portions, though there are not so many of this kind of products. Also there is no adequate space, so that it could be an option to have bigger conveyor without making more changes. The conveyor can make two trips to the mixer, but a detail study is necessary to know if this kind of change could be rational or possible.

Machine sizes and capacities are not so much the problem, because when the process is running, different machines work one on the other, such as dosing materials for next portion while mixing and packaging last one.

Small ball mill and grinding machine needs to changed at some point, but so far the production capacity is enough with these machines.

Besides this there are certain important issues which need to be handled soon, some of them are highlighted below

- Big potential customer needs to be identified.
- Machine equipment needs to be improved.
- Overall manufacturing process, machine equipments needs to be examined and evaluated with the help of internal and external experts.
- In the casting department all the mixers should be washed after every casting operation. Mixers paddles and walls wear a lot if the washing hasn't been done. This leads to lower maintenance costs and the men in maintenance department needs to do less maintenance and repairing.
- Moulding technique and working methods has to be developed too. Cranes should be used always when moving moulds full or empty - not with workers physically. Casting chutes should be made slippery (for example: urethane coatings + nano coating finishing) or with vibrating so that the casting person have to do only opening and closing of mixer hatch.
- New order in storages materials should be as close as possible to the using place (new facilities) and storing same materials in several places should be avoided. When there is enough space in 40 m^3 silos, the powders should be blown into them and it should not be kept in big bags in storage halls.
- Website of the company needs to be changed; it should contain more information (Bet-ker Oy, 2012).

4.10 Application of pull materials through system

The pull production system is a part of lean manufacturing, under which the production is made on the basis of customer needs rather than demand forecasting. Under this system the information flows from prevailing market to production. As the pull system works on the basis of customer and helps a manufacturer to maintain cost effective production of service or goods required by the end users. Thus the end users are the key player in the pull system of manufacturing.

In the present world of business the customer needs are specific, they are always looking for quality product with lower price but from the manufacturer perspective it has always been challenging to meet the customer needs in terms of quality and cost. The proper implementation of pull system plays a bridge between end customer and manufacturer. Which means with pull system of manufacturing production inventories are reduced, work in progress is not exceeding the market demand, which helps manufactures to maintain low cost of production to a great extent.

Pull system can be implemented in different forms as mentioned below:

- **Kanban card:** A kanban card is a technique which helps to maintain quantity of goods manufactured or delivered in desired level before the scarcity arises. Kanban card can have different colors depending upon the priority and its use. Generally in kanban system move and production cards are used, where move card represents goods moving from one production unit to another; while production card guides to replace goods once they are sold or used.

- **Level scheduling:** It is a methodology which helps to maintain regular flow of materials during production. At the same time it helps to meet the changes in demand levels through proper scheduling or production planning.

- **Quick change over technique:** It is a strategy which helps us to reduce setup time for machine and equipments and also it guides us to adopt the changing environment (changes in demand, changes in production methods or specification etc) in short span of time.

- **Small lot production:** This approach helps us to produce small lot production on regular basis. So the flow of materials can be maintained easily.

The main benefits of the pull system is that, it provides flexibility in manufacturing to respond the customer needs along with the reduction in manufacturing waste, But to implement these technique a proper forecasting and good coordination between sales and manufacturing department is necessary (Jack B. Revelle, 2002).

4.11 Advantage & Disadvantage of Pull system of manufacturing

The advantages of pull system are as follows

- Helps to reduce production cost.
- Helps to reduce inventory cost.
- Proper utilization of resources.
- Acts as delegation to employee, supplier, management etc.
- Provides fast response to task.
- Helps to meet the customer demands.
- Provides better communication between customer, supplier and manufacturer.
- Helps to organize work place effectively.
- Helps to reduce lead time and work in progress inventory in some extent.
- Helps to maintain proper flow of information.

There are certain disadvantages of the pull system of manufacturing some of them are as follows:

- It creates problem in manufacturing if one unit is broken because the production needs to follow series of task through different shells.
- A proper co-ordination and long term relationship is needed between customer, supplier and manufacturer.
- It is not suitable for the products with high variability of demand.

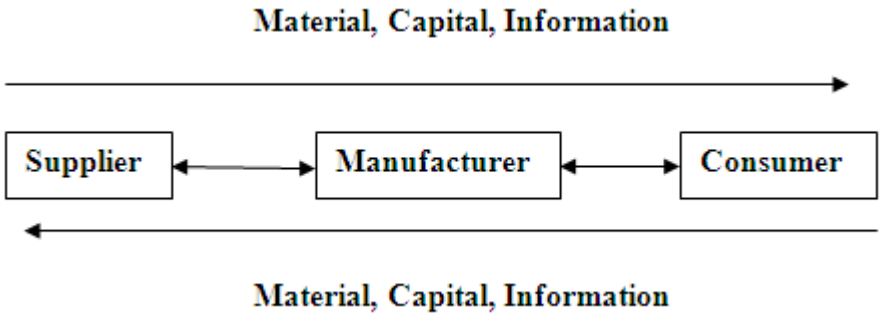
Though it has some drawbacks, the use of pull system of manufacturing helps a firm to be a key player in the market (Stephen N. Chapman, 2006).

5 SUPPLY CHAIN MANAGEMENT

5.1 Introduction

Supply chain management is the active management of supply chain activities and relationships in order to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by a firm or group of firms to develop and run supply chains in the most effective and efficient ways possible (Cecil C. Bozarth& Robert B. Handfield, 2008).Moving things from here to there is common in our daily lives, whether it is a movement of goods within your room or between different organizations to fulfilling customer need. All these activities are covered by supply chain management. Thus the movement of raw materials to manufacturing unit to the end customer and receiving of feedback from customer is known as supply chain. In the process of supply chain there is movement of capital, information, goods, and services from one destination to other. It is a two way process from suppliers to manufacturer followed by end users and vice versa.

Simply the supply chain can be described by the following diagram but it’s not as simple as we see.



GRAPH 9. Supply chain Process (Donald Waters, 2003)

The different activities in supply chain can be listed as follows

- Supplier selection
- Inward transportation
- Outward transportation
- Information management
- Manufacturing of products and development of services
- Warehousing
- Material requirement planning
- Master scheduling
- Reverse flow of goods, service, capital, information management

A supply chain can be designed and managed in the following steps:

- Identify the prevailing & needed resources
- Formulate the strategy
- Implement the strategy
- Evaluate the performance
- Keep on improving
- Maintain the records of each activities for future reference

Supply chain plays an important role in overall performance of an organization. Awell organized supply chain management provides better quality of products or service produced, helps to reduce operating cost, improves customer service, satisfaction, and increases profit. More than this it helps a firm to be competitive in the market with better performance (Donald Waters, 2003).

5.2 Types of bottlenecks in supply chain

Proper management of supply chain is not an easy task. There can be different obstacles in the process of supply chain some of then are listed below:

- Inefficient management
- Poor forecasting
- Inadequate facility in warehouse
- Obstacles in supplier selection and substitution
- Limited supplier
- Warehousing and location problem
- Availability of resources
- Lack of finance
- Quality issue
- Legal issues
- Difficulties in performance measurement
- Problem of inventory management
- Obstacle in flow of Information

5.3 Methods to create flow of products

The aim of the supply chain management is to provide appropriate raw material to manufacturer, right product to the end costumer in a reasonable time with a competitive price. During the process of movement a proper flow of material, capital and information needs to be maintained.

The movement of product during manufacturing process through a series of operations in a forward direction until till the final product is delivered to a desired customer is known as flow of products. It can be better explained with the following diagram.

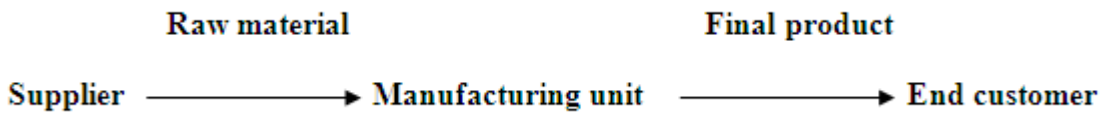


FIGURE 10. Flow of product

In the present world of complex business, requirement of customer is always changing. Hence all the manufacturer of goods and services faces a lot of challenges to create flow of products. Still there are some methods to maintain flow of products in the supply chain, which are as outlined below.

- Creating demand
- By increasing sells
- Implementation of lean production
- Removing bottlenecks

When there is demand for a product or if the manufacturer can creates a demand for its products, there will be an automatic flow of products in several ways but in the market it is rather easy to fulfill the customer needs than creating demand for the product. Though it's a challenging task, if maintained can be a tool for product flow in supply chain.

On the other hand, if a manufactures can boost up its sales by making customer more aware of the products manufactured, ultimately creates demand for the product, which leads to proper flow of products in the supply chain.

Once the demand for product or service is created through boosting sales, the principles like JIT and Lean production plays an important role in flow of products; as the basic objective of JIT and Lean production is to maintain proper flow of products in the supply chain.

Similarly, with the help of methods mentioned in previous chapter it will not be difficult to identify the bottlenecks in the system; with proper planning and implementation any obstacle

in the supply chain can be eliminated. When an obstacle of the system is removed it leads to proper flow of products in the supply chain.

5.4 Supply chain of Bet-ker Oy

To analyze the supply chain I made some questionnaires (see appendix 2) and asked different employee to answer them in details from their perspective. The following description and findings are based on the information provided to these questions.

The supply chain of Bet-ker Oy, can be broadly divided in to different groups on the basis of work done by departments like Purchasing, Sales, Production, R&D, Warehouse. The function of each department is described below:

- **Purchases department**

Production manager is responsible for planning of the purchases. Production manager calculates the required amount of materials regarding the sales orders and forecast. Managing Director however negotiates the prices and the terms of delivery in advance and Secretary carries out orders on the basis of these agreements and instruction given by production manager. In case of main contracts (big ship loads), Managing Director negotiates and makes orders by himself. Production manager also makes orders of raw materials from Finland as required.

Raw materials are stored in warehouse for about few months (in case of big ship load it can last for longer) depending on type of raw materials and requirements. Delivery time plays an important role for making orders of raw materials. Hence the order of raw materials is carried out from days or weeks to few months in advance.

Most of the raw materials are acquired from China and Norway; other import countries are European countries and Russia. Only a small part of the raw materials are acquired from Finland.

Aggregate materials in bulk are shipped to Kalajoki Rahja harbor, where Bet-Ker Oy also has bulk storage. The raw materials are unloaded from ship to storage then later transport to manufacturing unit as and when necessary. Some of the raw materials are directly transported to the customers depending upon customers requirements. From Kalajoki to Ylivieska and to customers, the transportation is handled with private enterprises trucks and tank trucks.

Most often the raw materials with smaller loads i.e. truck loads (24mt to 26mt) come directly to Ylivieska for example from Helsinki or Oulu harbor.

- **Sales department**

Sales manager and Managing director makes the offers and also negotiates sales with clients. They also actively visit clients as well as product advisor and development manager. Then sales orders are prepared in office according customers requirements and incentives offered. During the process of making a sales order the delivery time is confirmed with production manager or supervisor.

The invoicing of goods is made at the same as delivery or next day most of the times, latest in few days.

- **Production department**

Manufacturing is based on the orders and sales forecasts. Very few products are manufactured in advance and stored in warehouse. The big potential customer has long tern contract, hence deliveries are known and can be predicted in advance. In case of element production, goods produced are stored in warehouse so that a bigger load can be transported.

Production plan is based on orders and forecasts and prepared by production manager and supervisor. During the process of production planning it is important to know which type of mixture is good to be produced in a row, this helps to make similar types of mixture at the same time. Some time small quantities are prepared in advance and stored in warehouse if needed.

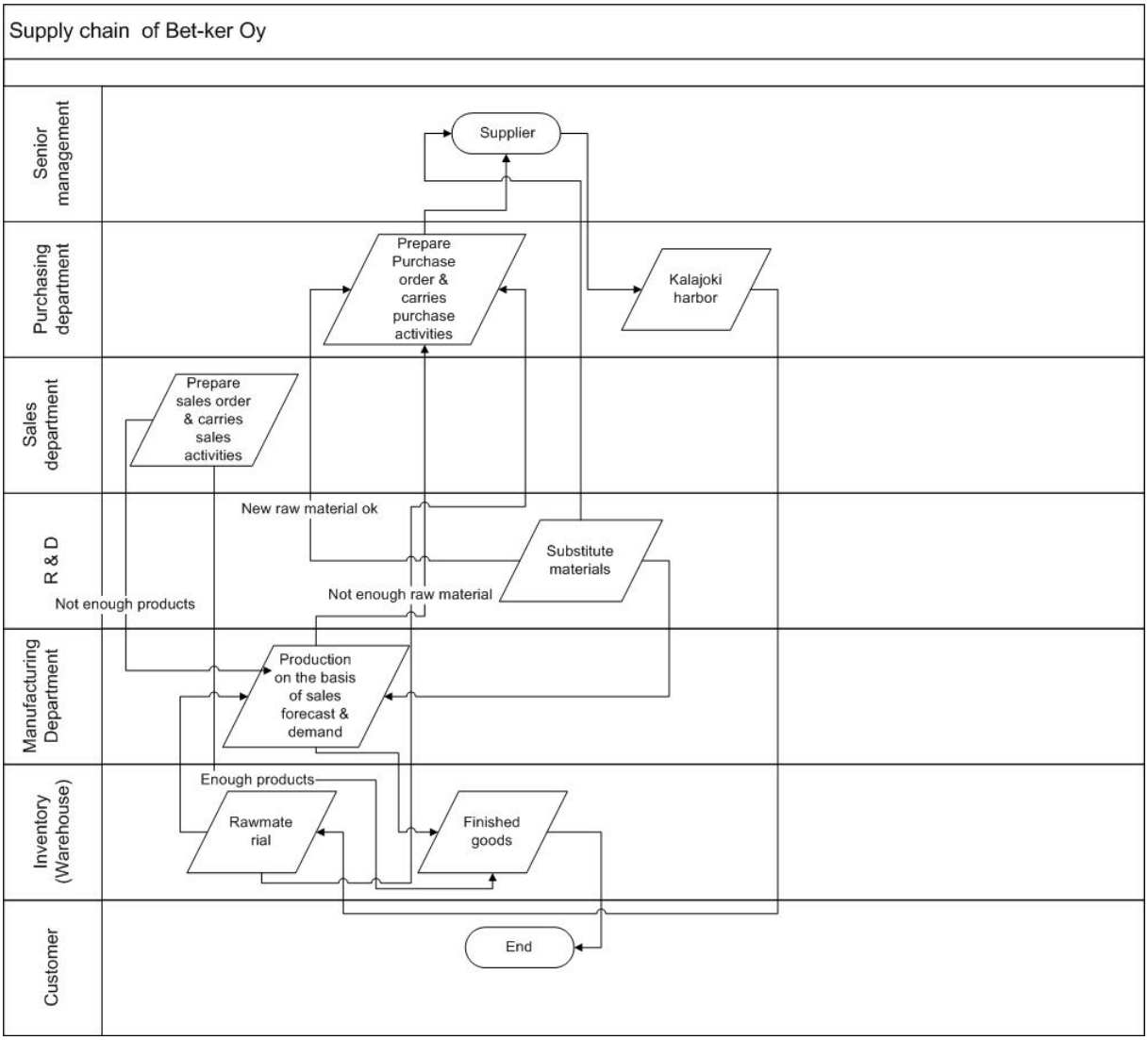
- **Research and development department**

Development manager often orders samples of substitute or new trail materials which then are tested in laboratory. Also new batches are always tested in laboratory as well as own products during the production.

- **Warehouse**

Employee of warehouse carries of reception of materials, sending products and agrees transports with carriers. Inventories are revised on monthly basis, which helps in production planning and purchase planning. It also helps to tally the data maintained in the computer system.

This is how supply chain is carried out in Betker Oy (Bet-kerOy, 2012).



GRAPH 11. Cross functional chart of Supply chain in Bet-kerOy

5.5 Analysis of supply chain in Bet-ker Oy

In case of Bet-ker Oy, the supply chain is not very complicated as it follows a simple path from raw materials supplier to manufacturing unit and from manufacturing unit to the desired customer. As the raw materials supplier and the customers are also limited it does not faces complex problems; however there are several activities which need significant improvements.

There are no major distinguished bottlenecks in the supply chain e.g. related to raw material supply. But in some cases the lead time for raw materials can take up to two months. Related to aggregates shipped by vessel to Kalajoki harbor, a cold winter season has to be taken into consideration when ordering raw materials. In some winters the harbor is closed for about 1–2 months due to the cold environment. These are the uncertain and unpredictable problems of supply chains which need to be solved according to time and situation; a proper speculation and forecasting could be an advantage. At the same time the company has well experience of such cases well prepared for when to order and for how long time.

On the other hand the product delivery supply chain seems to be fine; there are not any significant problems. At the same time the delivery of products has been challenging as regards cost of transportation. Sea transport would be most effective, but requires big quantities and suitable locations of the customer.

Domestic supply chain has found to be top quality i.e. the company is able to provide flexibility and quick service, short lead time, strong customer service, while the overseas operations have been comparatively weak.

In general the different activities of supply chain at Bet-ker Oy can be categorized in the following two groups on the basis of importance of each activity in supply chain.

TABLE 2. Classification of different activities of Bet-ker Oy

Particulars	**Highly important**	**Important**
Reception of raw materials		X
Manufacturing time	X	
Customer lead time	X	
Information flow	X	
Management of warehouse	X	
Level of inventory		X
Sales forecasting		X
Warehouse facility		X
Suppliers selection		X
Availability of raw materials		X
Availability of suppliers		X
Quality of supply chain		X
Performance measurements		X
Number of orders received		X
Production/ distribution scheduling	X	
Flexibility* in supply chain	X	
Ordering batch size	X	
Cost of supply chain	X	
Planning of supply chain		X

* supply chain responsiveness, manufacturing/ production flexibility, delivery flexibility etc

5.6 Findings of analysis

In general all activities and management of the supply chain in Bet-ker Oy are well organized, according to my research and analysis there are not any huge bottlenecks in the system which are creating obstacles in the process. However, there were following issues which need management attention.

- More overseas customer needs to be found
- There is no significant retail segment for most of the products
- Limited availability of warehouse space
- Lack of proper supply chain strategy to compete with foreign rivals

5.7 Recommendations for improvements

After analyzing the supply chain of Bet-ker Oy, I came up with the following recommendations in order to improve overall efficiency of supply chain.

- Benchmarking of supply chain of foreign competitors in relation to own performance
- In-depth analysis of supply chain is to be done in order to reduce the cost of supply chain
- Improvement in the warehouse facility
- National and international retail segment needs to be identified
- Operational improvement objective needs to be formulated
- Improvement targets needs to be determined
- Regular analysis of supply chain and continuous improvement must be performed

5.8 Tools to reduce cost in supply chain

The cost of supply chain includes cost of all the activities that are associated with procurement of goods and services from collection of raw materials to delivery of final goods or services to the end customer. Total cost reduction is the greatest challenge of supply chain. The following tool helps us to reduce the cost of supply chain to some extent.

5.8.1 Product portfolio planning/Product lifecycle management

There always is possibility for improvement and new development in the products. So Product portfolio planning/Product lifecycle management helps to know the present market needs and shows the way to find new product in order to sustain and be key player in the market. In fact it provides the basis for R&D of the company starting from product conception, manufacturing and decline from the market. In product portfolio planning product rationalization is the key to cost reduction in supply chain because it helps to identify new products or ways to reduce cost of production (Michael R. Czinkota, Ilkka A. Ronkainen & Bob Donath, 2004).

5.8.2 Recycling the waste and faulty products

Products' recycling is also a good approach for cost reduction in supply chain. Under this approach the products which are recyclable should be collected from the market and also waste coming from the production needs to be recycled in order to reduce manufacturing and raw material cost.

In case of Bet-ker Oy, there is a lot of potential in the reclaimed refractory materials in many senses. Meanwhile there are important projects going on.

5.8.3 Lean manufacturing

It is a manufacturing philosophy developed by Toyota, this system of manufacturing is based on maximizing the value that a customer willing to pay and reducing waste in the process of manufacturing. It provides the benefits such as

- On time production
- Optimizing utilization of resources
- Reduces the waste
- Low cost of production
- Continuous improvement

The success of lean manufacturing depends upon the mutual co-operation of the management and employee (Jack B. Revelle, 2002).

Hence the Lean manufacturing is a toll to reduce cost in supply chain.

5.8.4 Just in time (JIT)

Just in time (JIT) is a classical approach in production planning and inventory management, under which the goods required for manufacturing are received only just before they are needed to meet the customer requirements. The main advantages of JIT are

- It helps to minimize waste in manufacturing.
- Continuous improvement.
- Helps to reduce batch size and machine equipment setup time.
- Redesign of shop floor layout etc

Even though the JIT requires a accurate demand forecasting, is a good tool to reduce cost in supply chain (Thomas E. Vollmann, William L. Berry & D. Clay Whybark, F. Robert Jacobs, 2005).

5.8.5 Direct shipment

When the manufacturer sends the goods manufactured directly to the end customer it is known as direct shipment. Under this method the retailers are bypassed in the process of shipment, but the reverse logistic follows the path through retailer. In order to achieve benefits from direct shipment manufacturer need to know the value of demand so that the supply chain can provide right goods on right time with minimum level of inventory (Sunil Chopra & Peter Meindl 2010).

5.8.6 Some other ways to reduce cost of supply chain

Generally there can be a number of ways to reduce the cost of supply chain some of them are given below:

- Right product in first time
- Reduce material use and waste
- Benchmark practices and cost against an extensive database of comparable companies
- Define new cost savings and performance matrix
- Use of proper manpower and machine equipment
- Be aware of lowest rate of different cost drivers in supply chain
- Reduce claim

(Tompkins associates, 2012; The journal of commerce, 2012).

6 PROJECT MANAGEMENT

6.1 Introduction

“A specified task in a specific time frame with specific aims and objectives to be achieved in a specified way can be defined as a project. The project can be anything from a simple task (e.g. birth day celebration) in our daily life to a complicated research and development. “A project is a temporary endeavor undertaken to create a unique product or service. Temporary means that every project has a definite beginning and a definite end. Unique means that the product or service is different in some distinguishing way from all similar products or services” (William R. Duncan, 1996, 4).

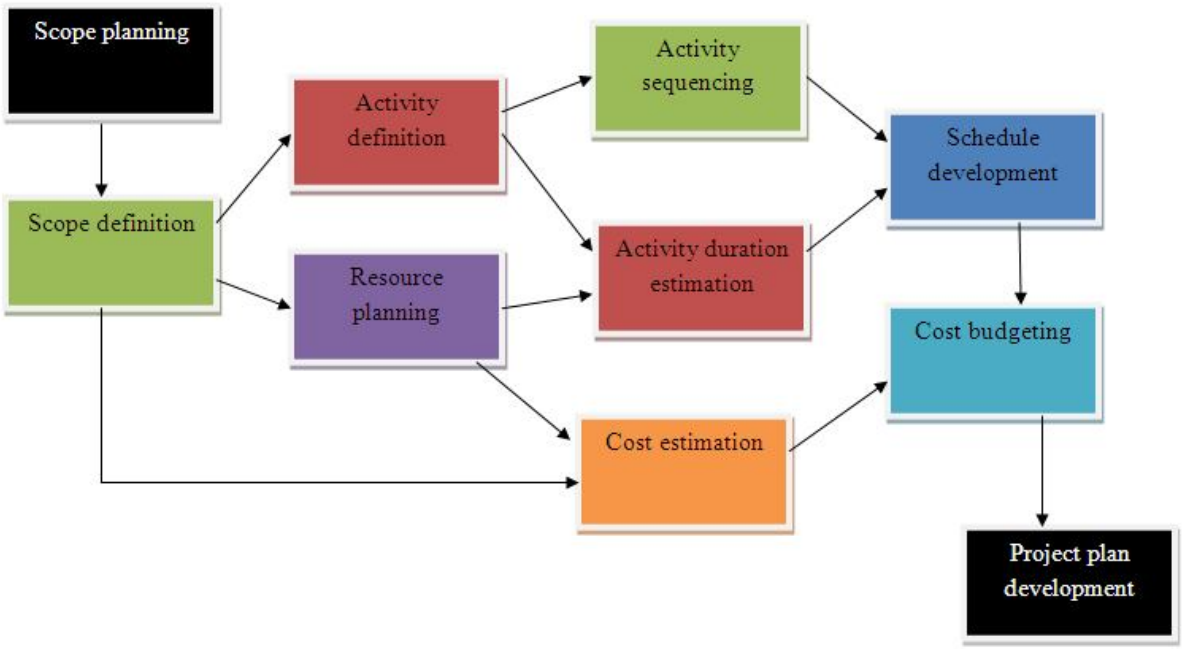
In Bet-ker Oy there are several projects running, some examples are listed below

- New product development
- Creating new market
- Supply chain management
- Handling quality issue
- Process development
- Training and personal development of employee
- Work safety handling
- Design of process layout etc.

The act of managing recourses (capital, manpower, time, material etc) needed for the completion of a project is known as project management. According to investopedia “Project management typically involves a one-time project rather than an ongoing activity, and resources managed including both human and financial capital”.

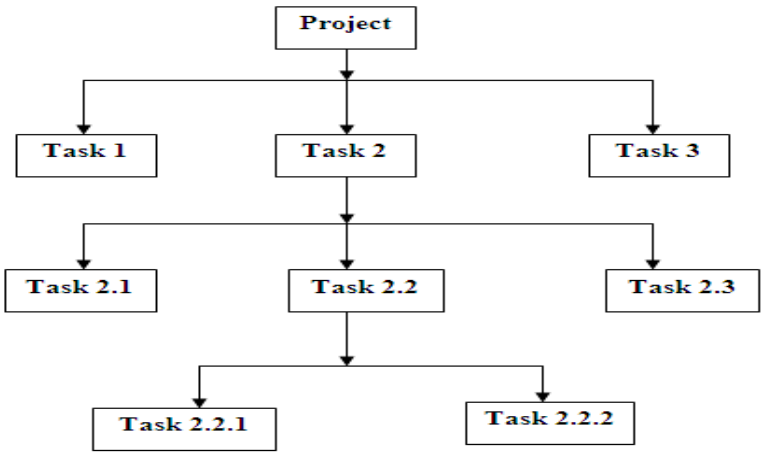
Project management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder’s needs and expectations from a project (William R. Duncan, 1996, page no.6).

Basically every project has the similar pattern for development and execution. A project can be planned as shown below:



GRAPH 12. Steps to crate project plan (William R. Duncan, 1996, 31)

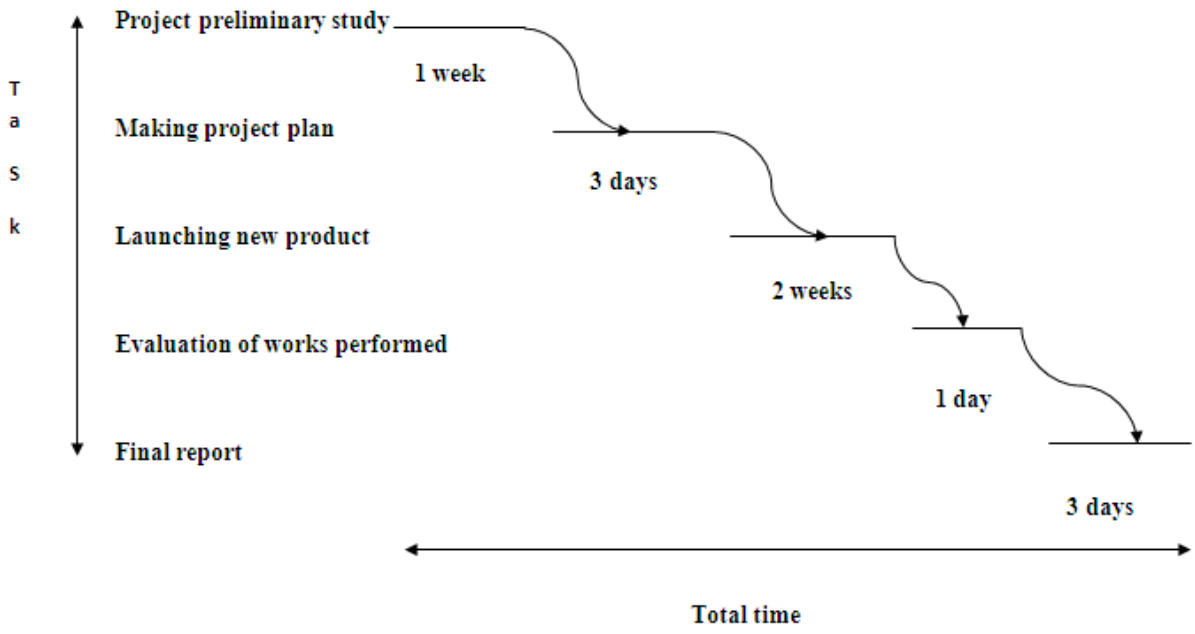
Once the project plan is formulated it is better to make work break down structure (WBS), it is a process to divide different task in to precise and manageable form. WBS also helps to control the task, define several work packages with time line along the cost estimation and budgeting (Thomas W. Grisham, 2010, published by John Wiley & Sons).



GRAPH 13. Example of WBS

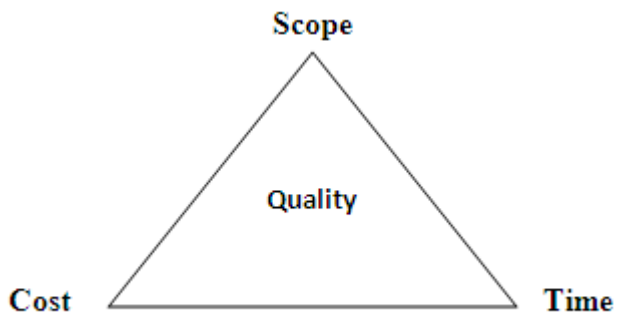
Similarly, Gantt chart is also a good tool to represent the whole project graphically. It helps to schedule, co-ordinate and track specific task in a project. In a Gantt chart total estimated time is shown in the horizontal axis in the forms of days, weeks or months depending on the type of project while the different tasks are shown in vertical axis (University of Southampton, 2012).

A simple example of Gantt chart is shown below:



GRAPH 14. Example of Gantt chart(University of Southampton, 2012)

In conclusion the project management can be summarized by a triangle, each vertex representing Scope of project, Cost of project and Schedule of the project. Each of these components are interrelated to each other and has direct influence on other two if any of them is changed. It can be shown as below with Quality as central frame for three dimension of the project.



GRAPH 15. Three dimension of project management (Project smart, 2012)

Hence the project must be completed within the scope, estimated time and cost maintaining the desired quality of the work to be completed (Project smart, 2012).

6.2 Types of bottlenecks in project management

Successful execution of every project is challenging as constraints are common in each task. The general obstacle in project management is to make tradeoff between time, cost and schedule. During the process of project planning, possible risks need to be identified. Once the risk is identified the possible measure to overcome the problem also needs to be identified even though the solution may needs to be changed according to time, cost and schedule. But a proper planning would be an advantage over the period of time.

Constraints identification and the way of tackling with it is an ongoing process along with the project works. In each type of project, risk management procedure needs to be documented. The bottlenecks in project management can be internal and external. The internal bottleneck means the problems cause by the internal resources like employee, resources and so on while

external bottleneck means the problems caused by the external environment like change in customer needs, change in rules and regulation, increase in the price of raw materials and so on. The common challenges in a project are

- Lack of resources
- Not enough time to complete the task
- Flow of information
- Unclear roles and responsibilities
- Unclear working methods or procedure
- Right person at right position
- Right work at right time
- Occurrence of unexpected situation
- Commitment by customer
- Conflict or misunderstanding within team
- Pressure of work i.e. high individual work load
- Management problems etc

Hope for the best and be prepared for the worst is the key for identifying, solving and successful execution of the project.

6.3 Measurement of overall efficiency

"How to say a project is successful project?" Is a common question in the measurement of overall efficiency of a project. A project is said to be successful if the aim and objective is achieved within the planned cost, expected time frame and allotted resources with out any unexpected problems. The over all efficiency of the project is determined by the out come of the project in relation to inputs in the project (time, cost and resources).

According to the U.S. Accounting general office (GAO), Performance measurement is the ongoing and reporting of program accomplishments, particularly progress towards pre-established goals. It is typically conducted by program or agency management. Performance

measures may address the type or level of program activities conducted (process), the direct products and services delivered by a program (outputs), and/or the results of those products and services (outcomes). A “program” may be any activity, project, function, or policy that has an identifiable purpose or set of objectives.

The performance measurement provides us guideline for the control & monitor, improvement, directs towards goals and objective, check the effectiveness of the work or task of an organization. A well planned and organized performance measurement tool gives the following information

- Are we performing well?
- Are we achieving our goals and objectives?
- Are our customers or the targeted group happy?
- Are our all of the works is under control?
- Are our monitoring processes effective?
- Do we need further improvements? If yes where?

According to “The performance- Based Management Handbook, Volume two (Establishing an integrated performance measurement system), September 2001” most of the performance measure can be grouped in the following six groups:

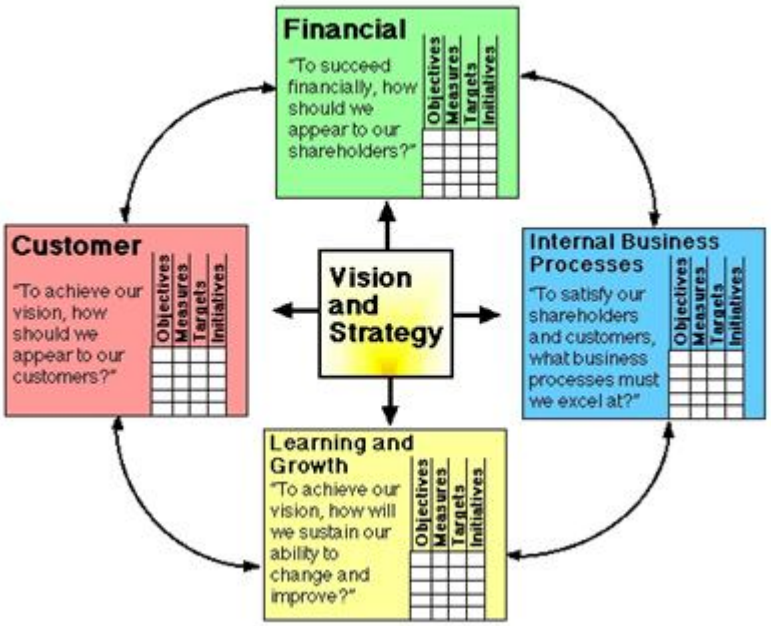
- Effectiveness: It indicates whether the project output is according to desired standards.
- Efficiency: It indicates the utilization of resources with the minimum cost.
- Quality: It indicates whether the quality of product or service is according to customer requirements and expectation.
- Timeliness: It indicates whether the work is completed on time or not.
- Productivity: It indicates effectiveness of the process. It is calculated by dividing value added by the process to the value of labor and cost incurred.
- Safety: It helps us to measure the overall health and safety issues of the organization and the working environment of its employee.

6.4 Tools to measure overall efficiency

In order to be more profitable it is necessary to utilize all the resources in a proper way. But in the process of working in real life it is quite often that the assets and resources are not utilized effectively either by this or that reason. In general the overall efficiency of the project can be measured with the help of following tools.

6.4.1 Balance score card

Balance score card is a management tool can be used by any type of organization whether it is private, government, profit motive or non-profit motive organization. It helps an organization to make a balance, between time, money, resources, mission, vision and objective as well as control & monitor organization's performance. It was developed by Dr. Robert Kaplan and Dr. David Norton in the early 1990s. Balance score card is a management and measurement approach to analyze organization's performance in four different dimensions like financial analysis, customer analysis, internal analysis and learning & growth analysis (The balance scorecard institute, 2012).



GRAPH 16. Balance score card (The balance scorecard institute, 2012)

6.4.2 Earned value analysis

According to user guide for MS project-2003, Earned value analysis is defined as "A method for measuring project performance. It indicates how much of the budget should have been spent, in view of the amount of work done so far and the baseline cost for the task, assignment, or resources."

Earned value analysis is a performance measurement tool designed to measure current performance of a project in terms of time cost and schedule. In fact it shows the relationship between the project plan, works completed and let us know whether we are on the right track or not. Thus helps to schedule our future.

For proper utilization of earned value analysis, a project needs to be divided in to small tasks called work breakdown structure (WBS) along with specific budget for each task. And each task needs to follow certain time schedule. This is considered as planned value while the task

completed is called earned value. These two values are compared with each other to know the present and predicting future results.

The three common terms of earned value analysis method of performance measurement can be defined as follows:

- Budgeted cost of work schedule (BCWS): It is the sum of all allotted budget for different task in the project, which needs to be completed in a certain time frame. This is also called Planned value (PV)
- Budgeted cost of work performed (BCWP): It is the sum of all budgets of the tasks completed in an assigned time frame. This is also called earned value (EV)
- Actual cost of work performed (ACWP: It is the amount of actual cost incurred during the completion of task in an assigned time frame. This is also called actual cost(AC)

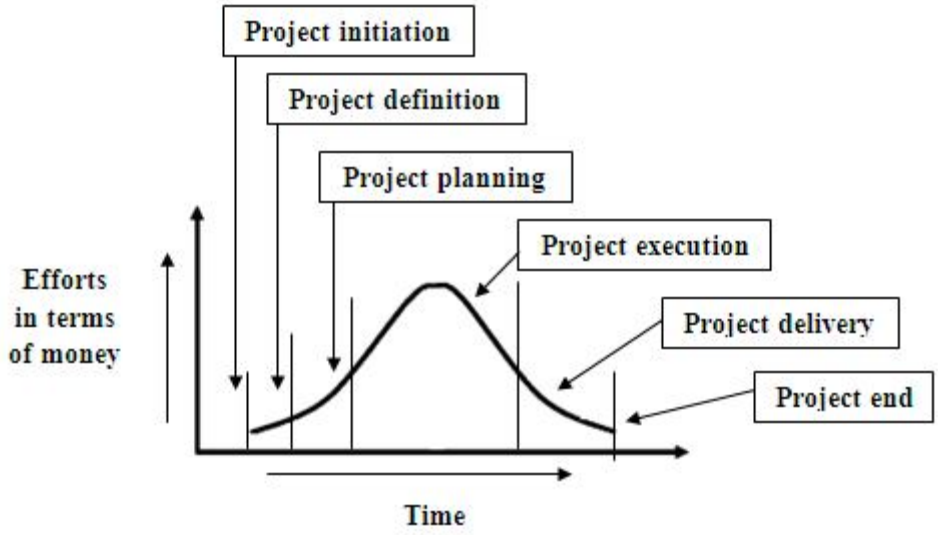
By utilizing these values cost performances index (CPI) and schedule performance index (SPI) can be calculated as

- Cost performance index (CPI) = BCWP/ACWP; this ratio gives the measure of success towards reaching the schedule budget. If the ratio is less than 1, it means that the value earned from spent budget is less than expected. And if the ratio is equal to 1, the value earned from the expected budget is equal to expected.

- Schedule performance index (SPI) = BCWP/BCWS; this ratio gives the measure of work progress in relation to plan. If the ratio is less than 1, it means that the work progress is not as planned. And if the ratio is equal to 1, the work progress is according to plan (Project management, Denish Lock, 2002).

6.4.3 Project life cycle

A project starts with project initiation and ends with handing over of liability. As a life cycle it can be divided into six phases i.e. project ignition, project definition, project planning, project execution, project delivery and project end. A successful project follows the path of normal distribution. Different stages in project lifecycle also can be used as a tool for management, control and monitor a project (William J. Stevenson, 2009).



GRAPH 17. Project life cycle (William J. Stevenson, 2009)

6.5 Analysis of works under value added and non-value added

The activities for which customer is willing to pay can be referred as value added activities, while the activities for which customer is not willing to pay comes under non-value added activities.

Better profit can be achieved through low cost of production, producing quality goods, responding to customer requirements and so on. All these works add value. In the same time

non-value added activities (e.g. long lead time, poor quality goods, high production cost etc.) or waste needs to be eliminated with best practice of works (Hubpages,2011).

To analyze the project management of Bet-ker Oy, I made some a form (see appendix 3) and asked different employee to complete it from their perspective. The following description and findings are based on the information provided to these questions.

Non value added works carried in Bet-ker Oy, are grouped under different activities and shown in the following table.

TABLE 3. Non-value added works in Bet-ker Oy

Group of Activities	**Non-value added work**
Logistics/Supply chain management	i. Transportation problem ii. Delayed or missing information iii. Arrival of raw material in wrong time
Production/Manufacturing	iii. Misplaced material iv. Meshed workplace a. Leads to accidents b. Causes defects in production v. Unsafe working environment a. Lack of safety equipment b. Lack of knowledge and education vi. Lack of information vii. Lack of raw material viii. Not doing things right at the first time ix. Breakdown of machines &equipments a. Anticipatory service missing x. Long setup time xi. Lack of planning a. Wrong production order sequence b. May cause extra cleaning

	c. May cause contamination d. May cause extra raw material loading work into silos or reload xii. Too much waste & scrap xiii. Mistakes in production e.g. Human errors xiv. Over processing xv. Unscheduled machine maintenance or repairs xvi. Long lead time xvii. Defects in manufacturing a. Wrong recipe b. Wrong material in the silo c. Wrong definition of silo parameters d. Wrong fine dosing parameters e. Wrong forward clip in material dosing f. Defects in process computer programs xviii. Waiting xix. Contamination a. Raw materials i. Contaminated when received ii. Contaminated during processing b. Intermediate products and products i. Contamination during processing
Quality control	i. Too much or too less sampling ii. Inadequate documentation iii. Poor management of in-house reclamations iv. Poor management of client reclamations
Ware house management	i. Too much or too less inventory ii. Unorganized warehouse

	iii. No safety stock /too much safety stock
Management and administration	1. Lacks in leadership skills a. Economy b. R&D, customer service and Engineering c. Handling personnel d. Marketing, outsourcing and raw material purchasing e. Net-working f. Language skills g. Computer & communication skills h. Lack in encouraging i. Suitable challenges missing ii. Tedious work iii. Bonus is missing i. Defects in preparing future challenges i. Legislation 1. Environmental & working environment related 2. Product related 3. Raw material related ii. Changes in the customer market iii. Changes in the supplier market

It is seen that there are number of visible non value added works carried out in Bet-ker Oy, all these works either this way or that, wasting the resources of the company. So in my opinion by developing a quality manual for the overall operation of the company would be a good way to over come non value added works in the system. At the same time more value can be added to a product or service produced by the application of principles like Just in time manufacturing (JIT), Lean manufacturing, Six sigma methodology.

7 CONCLUSION

Degree of removing bottleneck is directly proportional to the volume of production, which means once the bottleneck is identified and removed; its direct effect can be seen as increase in production capacity. What to do when the production is increased? Of course it needs to be adjusted in the market.

At the same time financial expenses made to remove the bottlenecks also play an important role. As for example if a machines capacity is 100 units/hr, but due to lack of power it can only produce 75 units/hr, to run the machines in full capacity there needs an alternative source of power like diesel generator or some other sources, now the question is will it be profitable to install the diesel plant to increase the machine in full capacity (100%). Will those extra 25 units/hr is going to cover the cost of operation? Is firm going to make extra profit? If yes it is worth full to install the diesel plant otherwise it is wise to run the machine in lower capacity. This means while making investments for process improvement, profitability or importance of the works needs to consider while making decisions.

7.1 Road map for the improvement

From my research and findings in case of Bet-ker Oy, there are several things that need to be improved in order to use all the resources of the manufacturing in maximum possible capacity. As follows the courses of actions are listed on the basis of priority.

- Company’s webpage needs to be improved as soon as possible, as it does not provide any useful information.
- Development of quality manual.
- Big potential customer needs to be explored.

- Machine equipment need to be changed e.g. small ball mill machine (grinding machine) needs to be replaced.
- In general manufacturing process, machine equipment need to be examined and evaluated with the help of internal and external experts.
- Benchmarking of supply chain of foreign competitors in relation to own performance is needed.
- In-depth analysis of supply chain is to be done in order to reduce the cost of supply chain.
- Improvement in the warehouse facility.
- National and international retail segment needs to be identified.
- Operational improvement objective needs to be formulated.
- Improvement targets need to be determined.
- Regular analysis of supply chain and continuous improvement must be performed.

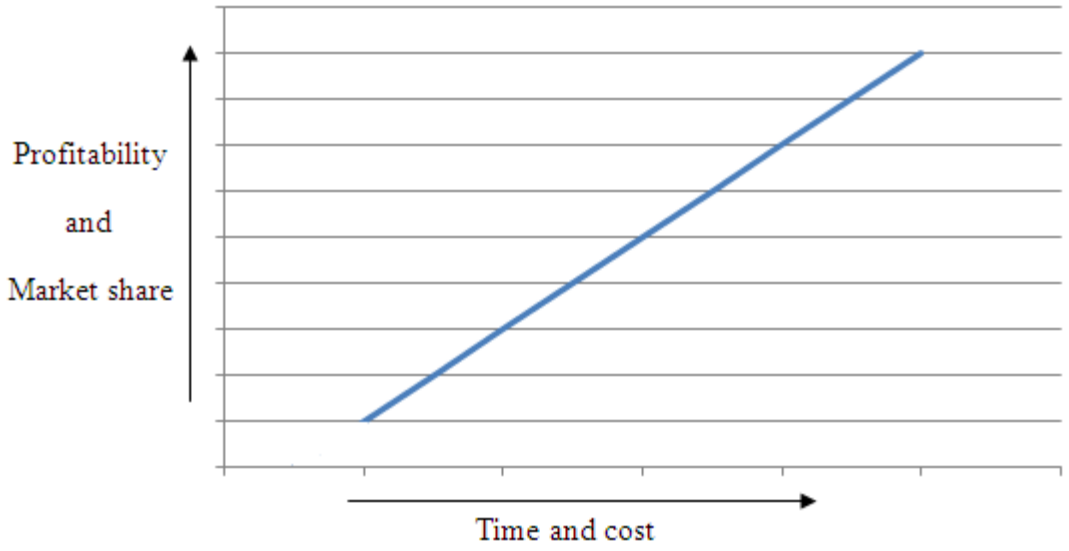
In fact the entire activities of the Bet-ker Oy need in-depth evaluation first by the upper management team and later it may hire external experts if necessary. I believe this will help to increase profitability of the company.

The following table gives a fixed target in view of the improvement in the short run and long run.

TABLE 4. Improvement work in short and long run

Within six months	**Within a year**	**In the future**
Lab. test sieving database (in progress). New large pre-shape mixing unit installation and testing shall be carried out (in progress)	Dosing silo capacity increase possibility should be studied. New customers should be found, especially for big pre-shapes (new mixer and excess drying capacity existing)	New ball mill needs to be installed; warehouse or dosing silo capacity must be increased. New products and production methods needs to be identified.

In my opinion these course of action will definitely help Bet-ker Oy to remove present and future bottlenecks in the system. So the company will be top in the market and among the competitors. The future growth in terms of profitability and Market share verses Time and cost can be shown by following graph.



GRAPH 18. Forecast of future growth of Bet-ker Oy with time

Thus with time there will be increase in investments in order to remove bottlenecks from the system at the same time there will be significant growth in profitability and market share of the company.

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APPENDICES

APPENDIX 1/1

In order to analyze the manufacturing process and activities I made following forms and questions and asked different personnel to answer them.

1. Please complete the following form

Process steps inputs	Potential problems	Effects of problem	Why problem occurred? Give reason	How many times problem has been noted	Current control methods used	Recommendations For future
Receipt of raw materials						
Grinding/Crushing						
Pretreatment at high temperature						
Mixing						
Molding						
Drying						
Firing						
Cooling & Sorting						
Quality check						
Packing						

2. Describe the manufacturing process of BETKER OY
3. Describe the working of Bet-Ker Oy
4. What are the different types of machines used in production process?
5. What are the machines capacities for each machine?
6. Is the production capacity of each machine are in relation to each other? If not what changes you think to make?
7. What would you say about types of man power i.e. qualification; training etc Do you have sufficient manpower? What changes you feel to make in utilization of employee?
8. Is the entire machine working in full capacity? If not what is the reason behind it?
9. What type of changes in production facility can make a difference in production? Give your view.

10. What are the raw materials used?
11. What are the different types of product manufactured by Bet-Ker Oy?
12. Is your production process is equipped with latest machine equipment and technology? What changes you would like to make? Why?
13. What types of problem are prevailing in production? What do you think to solve it?
14. What about the management system? Are there any things to change in your opinion?
15. What makes you to motivate for works?
16. What is the policy of your company?
17. How do you define the environment of your manufacturing unit?
18. How do you evaluate your manufacturing unit in general? Please fill out the following form

1= Poor management
2= Needs to change
3= It's ok
4= Good
5= Excellent

Guide line for ratings.

Particulars	**Ratings**
Materials	
Equipment	
Process	
Management	
Policy	
Environment	
People	

APPENDIX 2

In order to analyze the Supply chain, I made following forms and questions and asked different personnel to answer them.

1. Describe the supply chain process of Betker Oy?
2. How supply chain is maintained?
3. Describe the working of different departments in your company.
4. What are the costs of supply chain? Is there any means to reduce the cost of supply chain?
5. What are the prevailing problems in supply chain management in Betker Oy? How to solve those problems? Give your opinion.
6. What changes can be made in supply chain of Betker Oy?
7. Are you satisfied with the supply chain management of Betker Oy? Give reasons?
8. What are the improvements that can be made in Supply chain process of Betker Oy?
9. What things are good and bad in supply chain in your view?
10. Please fill the following form according to your experience in Betker Oy

Particulars	**Highly important**	**Important**
Receipt of raw materials		
Manufacturing time		
Customer lead time		
Information flow		
Management of warehouse		
Level of inventory		
Sales forecasting		
Warehouse facility		
Suppliers selection		
Availability of raw materials		
Availability of suppliers		
Quality of supply chain		
Performance measurements		
Number of orders received		
Production/ distribution scheduling		
Flexibility* in supply chain		
Ordering batch size		
Cost of supply chain		
Planning of supply chain		

*supply chain responsiveness, manufacturing/ production flexibility, delivery time

Note: Important in terms of reducing cost of production and increasing profit.

APPINDEX 3

I have divided different works in Bet-kerOy, in five different groups as shown in the following table. I tried to include several works under value added work and non-value added work. Please fill out the forms from your perspective.

Group of Activities	**Value added work**	**Non-value added work**
Logistics/Supply chain management		
Production/Manufacturing		
Quality control		
Ware house management		
Management and administration		