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UNIT-I Waste Management

INTRODUCTION

Construction waste is a major challenge because of its tremendous environmental and economic bad effects (Shen, 2004).

 Environmentally: construction waste produces an average of (32%) of the total annual waste that is disposed to landfills.

 Economically: It comprises (10-20%) of the total annual construction materials used. hence (4-10%) of the project total cost is wasted.

1. Construction and Demolition Waste

Definition: Waste building materials, dredging materials that are produced in the process of constructions, remodelling, repair, or demolition of residential buildings, commercial buildings and other structure and pavements.

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- More than 50% waste generated worldwide is C&D
- Many European countries achieving 90%+ recycling
- Other developed countries struggling to improve
- Approx. 95% of waste on typical construction sites can be recycled
- C&D waste shouldn't be disposed of in MSW landfills.

FIG-1 CONSTRUCTION SOLID WASTE

1.2 Classification of Wastes

- Solid waste- vegetable waste, kitchen waste, household waste etc.
- E-waste- discarded electronic devices like computer, TV, music systems etc.
- Liquid waste- water used for different industries eg tanneries, distilleries, thermal power plants
- Plastic waste- plastic bags, bottles, buckets etc.
- Metal waste- unused metal sheet, metal scraps etc.
- Nuclear waste- unused materials from nuclear power plants

1.3 Categorization of the C&D waste

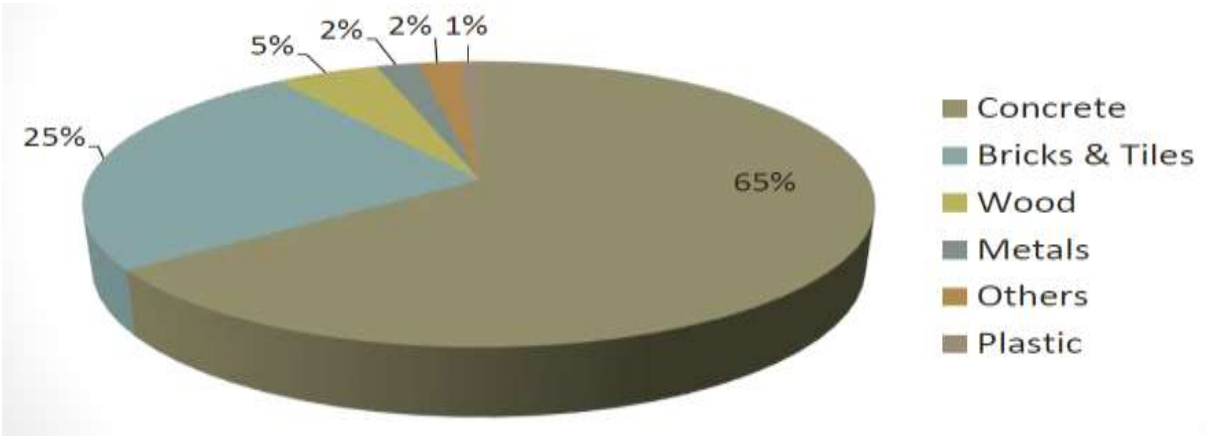
Inert material includes:

□ Rock □ Concrete □ Brick □ Stone □ Earth

Non- Inert material includes:

□ Plastic □ Packaging waste □ Paint etc.

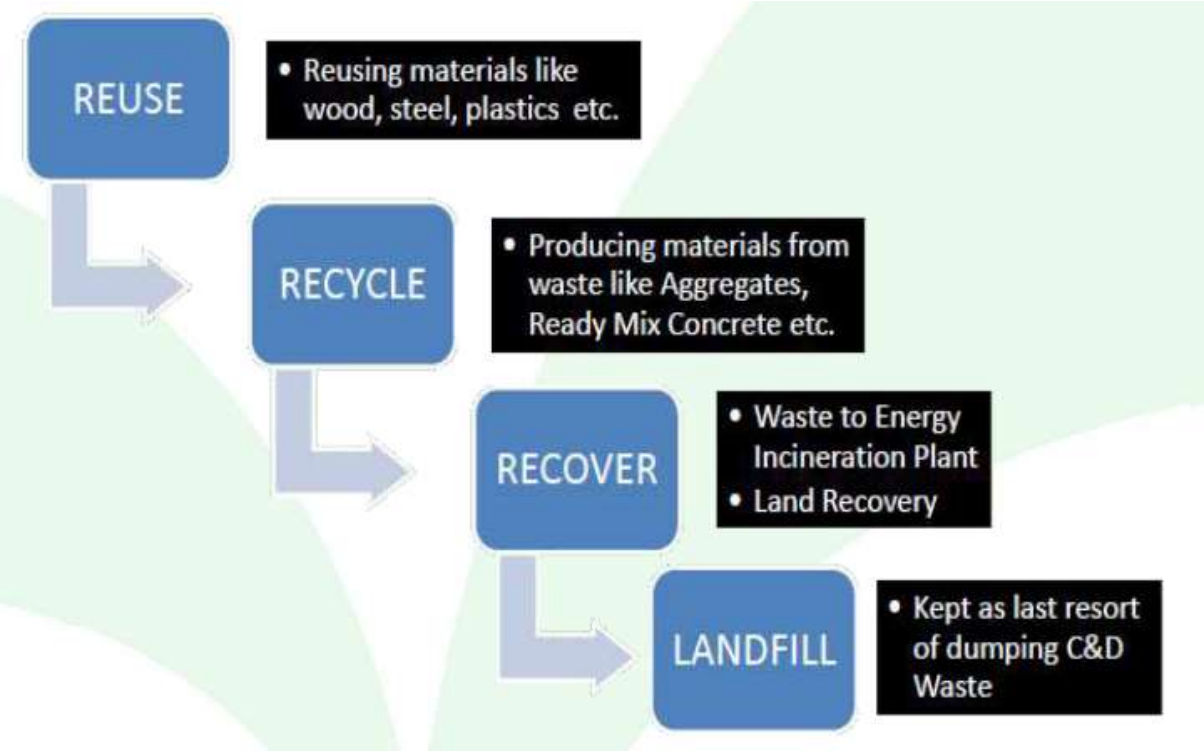
1.4 Composition of Construction & Demolition Waste in India



1.4 Reasons for Increase of Construction & Demolition Waste

- Many old buildings, concrete pavements, bridges and other structures have overcome their age and limit of use due to structural deterioration beyond repairs and need to be demolished
- New construction for better economic growth
- Structures are turned into debris resulting from natural disasters like earthquake, cyclone and floods etc.

1.5 Hierarchy of C&D Handling



1.6 Sustainable Practice

- Plan a separate line of collection and transportation of C&D waste
- Separate storage off C&D waste for different categories of generators (household, institutional, infrastructure)
- Processing for better utilization (even fine material can be used as inert daily cover at sanitary landfill)
- Disposal of only the portion which cannot be gainfully used
- A mechanism to identify and locate generators of C&D waste

1.7 Sorting Process of Construction & Demolition Waste

1.7.1 Chemical-Mineralogical Appraisal

- Recognizes particular grain size
- X-Ray Fluorescence - Invest chemical composition in terms of major elements.
- X-Ray Diffractometry - Recognizes the constitute mineralogical phases

1.7.2 Mechanical Sorting Process

FIG-2 SOILD WASTE RECYCLE MACHINE

1.8 Main Issue for Construction & Demolition Waste Management

- Absence of segregation of waste at source
- Lack of appropriately located recycling facilities
- Indifferent attitude of citizens toward waste management
- Illegal practices performed by contractors to save money

1.9 Key Requirement of Waste Management Plan

- Types, quantities and qualities of wastes
- Measures for reducing waste generation
- On-site waste sorting
- On-site and off-site reuse
- Areas for waste storage
- Quantities of wastes requiring off-site disposal
- Monitoring and auditing program

1.10 Impact of Waste to the society

- Affects our socio-economic conditions
- Affects our climate
- Affects our coastal and marine environment
- Affects our health

2 Methods of Disposal

These are the following methods for disposal of the solid waste.

- LAND FILLS
- BIOLOGICAL REPROCESSING
- RECYCLING
- OCEAN DUMPING

2.1 LAND FILL

 It is the most traditional method of waste disposal.
 Waste is directly dumped into disused quarries, mining voids or borrow pits.
 Disposed waste is compacted and covered with soil to prevent vermin and wind-blown litter.

2.2 OCEAN DUMPING

 Ocean dumping is the dumping or placing of materials in the ocean, often on the continental shelf.
 A wide range of materials is involved, including garbage, construction and demolition debris, sewage sludge, dredge material, waste chemicals, and nuclear waste.
 Sometime hazardous and nuclear waste are also disposed but these are highly dangerous for aquatic life and human life also.

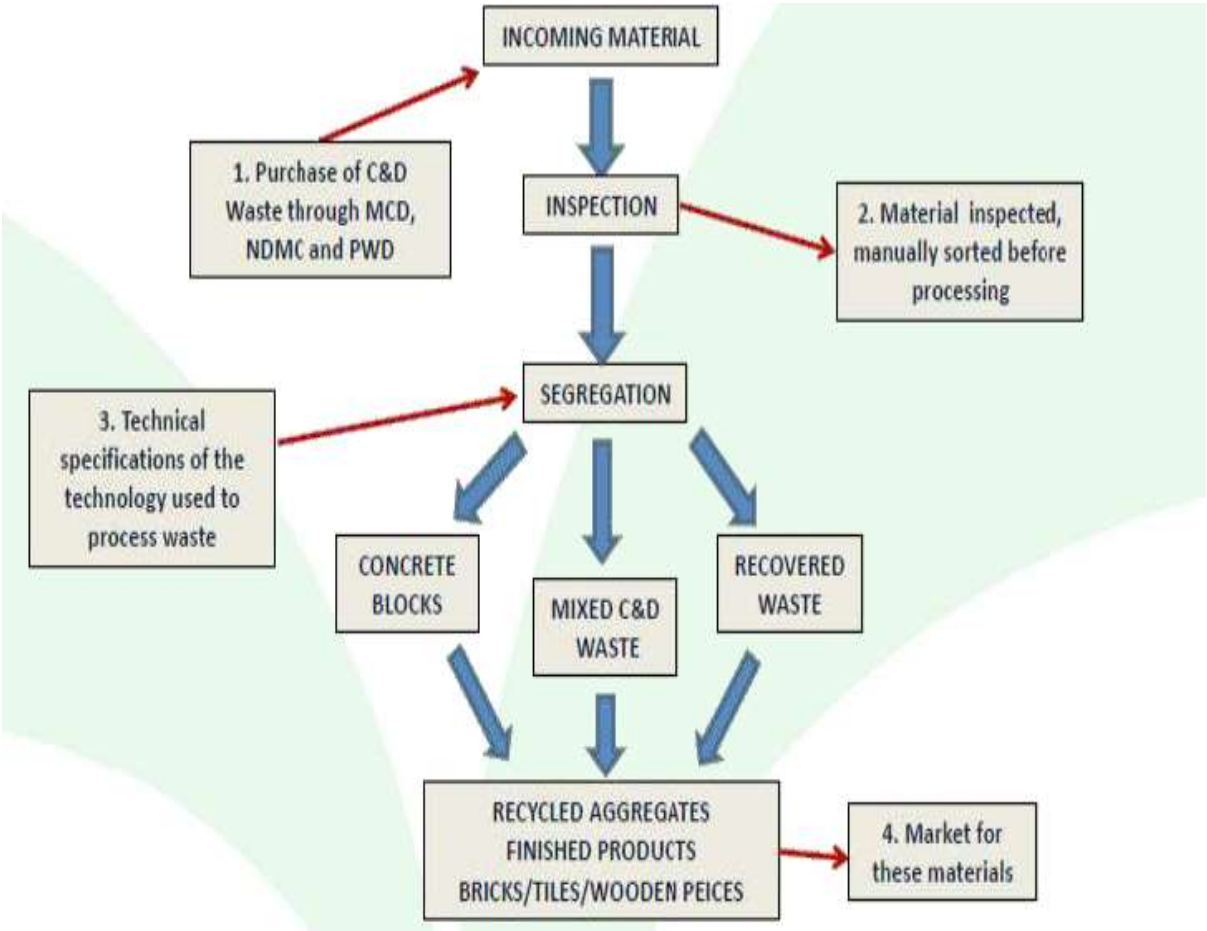
2.3 BIOLOGICAL PROCESSING

 Materials such as plants, food scraps, and paper products can be decomposed into the organic matter.
 The organic matter that is produced from this type of recycling can then be used for such things as landscaping purpose or agricultural uses.
 Usually this method of recycling is done by putting the materials in a container and let to stay there until it decomposes.

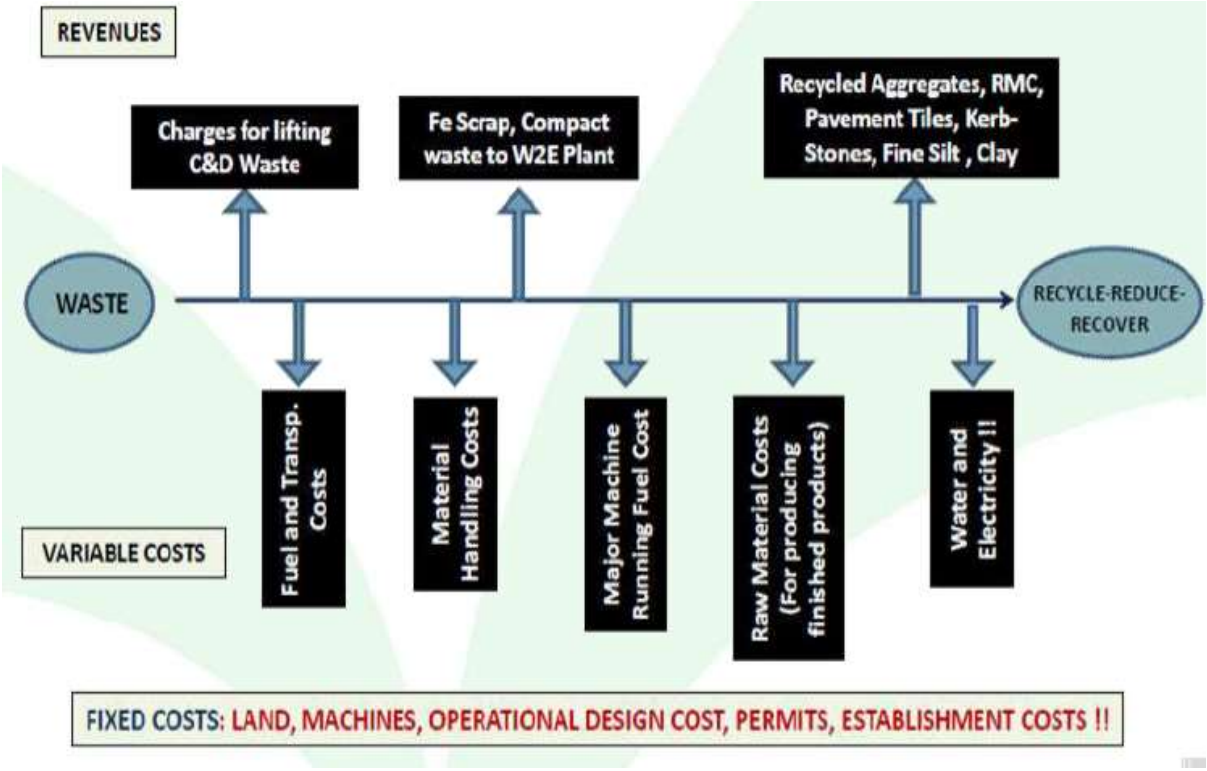
3. RECYCLING PROCESS

• COLLECTION: The first step required for recycling is collecting recyclable materials from communities.
• SORTING: This includes sorting the materials into groups, cleaning them and getting them ready to be sold to manufacturers who will turn the materials into new products.
• MANUFACTURING: The collected material is sent to industries those convert them into new products

3.1 Recycling Process Flow



3.2 Cost Analysis in Waste Processing



3.3 Rate and intended use of the Recycled products

Recycled material	Current issue	Reselling rate
Tiles	For landscaping and crude civil works	NA
Bricks	Non-structural Building Purpose	INR 4500/ 1000 bricks
Brick Bats	Foundation filler material	INR 1000/ Truck load
Fixtures	Sold as Scrap	Scrap iron rate
Scrap Irons	Sold as Scrap	Scrap iron rate
Wooden items	Sold or alternate fuel	NA
Plastics	Recycling or alternate fuel	NA

3.4 Recycling not a solution to all problems!

- Recycling is not a solution to managing every kind of waste material

- For many items recycling technologies are unavailable or unsafe
- In some cases, cost of recycling is too high

3.5 Solution: More Profit with Zero Waste

- Exchanging output that are considered waste
- Waste of one could be input or raw material for others

3.6 Problems in Dealing with Solid Waste

- Education
- Collection of waste
- Technological interventions
- Institutions & regulatory framework
- Absence of mandatory standards for waste reduction
- Market action for waste reduction

4. Duties of the waste generator

Amended C&D waste management rule came into implementation on 29th March 2016.

 Every waste generator is responsible for collection, segregation of concrete, soil, and others and storage.

 The generator shall ensure that other waste (such as solid waste) shouldn't get mixed.

 Generating waste more than 20 tons or more in one day or 300 tons per project in a month shall segregate:

- Concrete
- soil
- steel
- wood and plastics
- bricks and mortar

 Shall submit waste management plan and get appropriate approvals from the local authority.

 Generator shall keep the waste within the premise or get the waste deposited at collection centre.

 Shall ensure that there is no littering or deposition to prevent traffic and drain flow obstruction.

 Generator should pay charges for collection, transportation, processing and disposal if generating > 20 tons/ day or 300/ project/ month.

The concepts of waste productivity and its interrelationship with productivity.

INTRODUCTION

In the INDIAN construction sector, there have been debates concerning what can be done about the current low productivity and the high levels of wastes. During the last few years, it has become more common to utilize principles from lean construction as a way to enhance the problems concerning the levels of productivity and waste.

Production cost in the INDIAN construction industries has increased faster than consumer price index (Jonsson, 2005). Production cost in the INDIAN construction industry for multi-storeyed building has risen by 65% between the years 1995 to 2001 (Statistics Sweden, 2006). Many reports show that there is a major need of improving efficiency in the construction industries (Jonsson, 2005). Byggkommissionen3 (2000) has criticized the INDIAN construction industry and states that the industry structure within the building construction has very low competition due to vertical integration, weak competition in the field of import, and high barriers of entry to the market. These factors cause high prices, low productivity and poor quality. Contractor's cost is 61 % of the total production cost and of this 36% is wages (SCB, 2003). As labour productivity is the ratio between the output and labour input, it is important to produce more per hour in order to reduce contractor's cost. Two principally different ways of reducing the production cost is to either increase the productivity or to reduce waste. These two concepts – productivity and waste – are therefore central when considering improvements. This means that it would be of great importance to compile the present knowledge of the two concepts. The aim of this is to do a literature review on measurement of waste and productivity. The terms waste and productivity will be compared and discussed in relation to lean thinking and will highlight the use of lean philosophy to reduce waste and improve productivity in the INDIAN construction industries.

1.MEASUREMENTS OF WASTE

A study which sought to capture the amount of all types of waste in construction projects was done by Josephson and Saukkoriipi (2005). The data gathering consisted of direct observations in four INDIAN construction projects mixed with interviews, group discussions and studies of project documentation. The inventories showed that the amount of waste was around 30-35% of a project's production cost. The study did, however, not include any waste appearing in the use phase of the buildings.

Waste was divided into four main groups (Josephson & Saukkoriipi, 2005):

ƒ Defects and checks. Besides defect costs, this category also included costs for checks, insurance, theft and destruction of property. Waste in this group accounted for more than 10% of the projects' production cost.

ƒ Use of resources. This category included inefficient use of labour, machines and materials. This waste corresponded to more than 10% of the projects' production cost.

ƒ Health and safety. Waste associated with work-related injuries and illnesses represented about 12% of the projects' production cost. The greatest portion of the cost was for rehabilitation and early retirement, which indirectly add extra cost to projects via taxes.

ƒ Systems and structures. Waste related to the structure of the construction industry, such as long land use planning processes, extensive purchasing processes and a great deal of documentation, together corresponded to approximately 5% of the projects' production cost, although this category was thought to be underestimated in the inventory to a high extent.

A conclusion that can be drawn when reading publications of previous studies is that their measurements of waste have mainly been limited to production at site. Is this a relevant view of wastes in construction? Since a large part of the resources are consumed in the production at site, it is naturally important to consider waste among these resources. But if the measurements are limited to these parts, it means that wastes occurring at other parts are overlooked. Such other parts which usually are overlooked are: work done in the supply chain of the material suppliers;

the use phase; work done in supporting activities such as administration; and other activities which are financed by construction projects, e.g. all activities in the public sector, trade organizations, insurance companies, etc. Since the concept of 'lean', and thereby the term 'waste' as well, in the past primarily has dealt with factory physics (i.e. how the production should be structured) it is perhaps not very surprising that measurements of waste also primarily have focused on production. But this should be no excuse for not considering waste being present in other parts of the involved organisations.

2. MEASUREMENTS OF PRODUCTIVITY

There is disagreement about the proper definition of productivity within the construction industry. Jergeas et al. (2006) describe productivity as a comparison of input and output. They furthermore mention that an increase of productivity is when the input is reduced to achieve the same output. Calvert et al. (1995) describe work measurement or labour productivity as the determination of the time required for an average operative to carry out a particular task in accordance with a specified method and standard of performance. Productivity or lack of it is a major challenge facing in the construction industry (Adrian, 1999). Construction is a labour-intensive process and in absolute terms labour is the only productive resource in construction (Jergeas et al., 2000). As we mentioned earlier 36% of total contractors cost is to cover labour wages. Therefore, construction productivity greatly depends on human performance (Laufer et al., 1982). But unfortunately, labour productivity in the INDIAN construction industries is very low compared to other industries (Lutz & Gabrielsson, 2002). Time used by a worker on productive activities averages about 30% of the total time available for construction work (Alinaitwe et al., 2005). Hammarlund and Rydén (1988) performed a similar study in the field of HVAC. According to their research, a worker in this field produces value to the work during 3.5 hours of his 8 hours shift. Strandberg and Josephson (2005) show that less than 20% of the workers' time is spent on directly value-adding activities. It can be questioned about their methodology in measuring labour productivity.

"It is important to remember that productivity is often more of a marathon, not a one-hundred-yard dash!

3. RELEVANCE OF MEASURING WASTE

There are several problems with measuring waste. It is difficult to measure the cost of some negative aspects that do not have a clear monetary value, e.g. drawbacks of the structure of the construction industry, the mental and physical pain due to ill health and environmental costs. Besides, there can be a demoralizing effect on employees if they hear that their work tasks are wasteful. There is also a problem with using the term “waste”, since it does not give an accurate description of the cost reduction potential. First of all, there can be cost reductions by rendering the value adding tasks more efficient. Secondly, there are costs that do not add any direct value, but which indirect value can be significant, e.g. some managerial tasks and non-value adding activities that result in increased knowledge. Thirdly, the focus on costs is one-sided. A total economic analysis should as well consider the revenues and the costs for alternative solutions in order to know what actions to take. With all these problems with measuring waste one could question whether these kinds of measurements are relevant? It is most likely not meaningful to conduct complete measurements in every building project since this would cost too much and thus increase the amount of waste. However, this does not mean that there never should be any measurements. Measuring waste leads to facts that can be used when a company, an industry or the entire society decides how to render activities more effective. Without this kind of facts, it is difficult to know what measures to take. Thus, it is important that some measurements are performed. In addition, it can be valuable to think about which activities are wasteful without actually doing any detailed studies. Just considering about activities in terms of value and non-value adding could be helpful when trying to achieve cost reductions.

4. RELEVANCE OF MEASURING PRODUCTIVITY

Since construction is something that concerns most people and labour cost is a large part of the contractors cost, labour productivity has become a subject for debate (Jonsson, 2006). Manufacturing industries has taken the advantage of reducing production cost by improving productivity; the question can be asked whether the construction industries can do so. SBUF4 has started a project to find out whether the INDIAN construction industries measure labour productivity or not.

Labour productivity measurement provides useful information to contractors for scheduling and estimating purposes on future projects (Alinaitwe et al., 2005). Construction cost can be best carried out by labour productivity as labour cost is up to 36% of the total contractors cost. A conclusion can be drawn that productivity measurements are an important tool to improve overall company results. However, it is not enough only to perform measurement. The results of the measurements should also be used to improve productivity.

5. COMPARISON OF WASTE AND PRODUCTIVITY

One way of comparing 'waste' and 'productivity' is to see where the terms originate. The aim to reach high productivity is strongly correlated to traditional mass production or what is called the transformation concept of production. Koskela (2000) states that "it is also instructive to note that the [transformation] model is directly associated with the notion of productivity, e.g. the ratio of output to the input (or a particular part of it) in a given time period". A focus on solely productivity would therefore result in the aim to efficiently produce as much as possible with the given resources. It is such a focus on productivity alone that the literature of lean thinking strongly criticizes since this kind of focus tends to result in huge amounts of waste in the production process (e.g. Liker, 2004; Womack & Jones, 1996).

During the last 15 years the term 'waste' and its synonym 'non-value adding activity' have been used as an integral part of various concepts such as poor-quality costing (Harrington, 1999), activity-based costing (Tsai, 1996), business process redesign (Knorr, 1991), and the value-creation model (McNair et al, 2001). The term 'waste' has, however, most frequently been used in the lean literature. Even though the term was referred to already in 1921 in the "Report on Elimination of Waste in Industry" (Anonymous, 1921) it is within lean thinking that the idea of eliminating waste has grown into a fundamental cornerstone (Womack & Jones, 1996).

When trying to optimise production it is important to consider aspects of both flow and transformation. Shingo (1988) points out that processes (flow of products) and operations (transformations done by workers and machines) are both essential. Traditional mass production is usually

heavily criticized in the lean thinking literature (e.g. Womack & Jones, 1996), but despite the criticism there are basic principles in mass production that are worth considering, even from a lean perspective. To reach an efficient work on the value-adding tasks is such a principle that should be important to all companies, no matter how lean they are. Likewise, it should be of significance for all companies to eliminate waste.

CONCLUSION

Measurements of productivity and waste can complement each other. The fundamental reasons to study waste and productivity are the same, which is to get more information about the current state so that improvements can be achieved. Therefore, considering the levels of waste and productivity can both be useful. As the INDIAN Construction Industries have been criticized for its low labour productivity and high level of waste, it is important to highlight the issue to do something about it. Expenses like labour wages and cost of material is difficult to control because of high level of construction demand caused by the strong economic growth in the INDIAN economy in the recent years. Hence labour productivity can be improved by improving human performance. Some studies states that measurement of waste and labour productivity is closely related to lean thinking and in a near future they will apply lean philosophy in their production process for additional improvement of labour productivity. The INDIAN construction industries need to change their way of thinking. A continuous process of labour productivity measurement and an effective analysis of the measurement results are important. Furthermore, these results should be used in order to improve productivity. A better level of labour productivity will automatically upgrade the level of value-added activities and thereby can reduce waste and cut down production cost. The INDIAN construction industries have an old and substandard organisation structure and need an updating. A better understanding of lean thinking is necessary in the executive level so that the flow of change can reach the production level.

REFERENCES

Bossink, B. A. G. and Brouwers, H. J. H. (1996). Construction Waste: Quantification and Source Evaluation, Journal of Construction Engineering and Management, Vol. 122, No. 1, pp 55-60 Burati, J. L.,

Farrington, J. J. and Ledbetter, W. B. (1992). Causes of Quality Deviations in Design and Construction, Journal of Construction Engineering and Management, Vol. 118, Issue 1, pp 34

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UNIT-2

Explain the term Total Quality Management in construction. What are the benefits of Quality Management in construction projects?

Ans:- This is a standard definition of quality used by ***Juran.***

- It involves everyone in an organization and associated business processes cooperating to furnish products and services that meet their customer's needs and expectations.
- It's an all-encompassing dynamic process in an organization to promote never-ending improvement in the effectiveness and efficiency of all elements of a business.
- TQM is a philosophy, a set of tools and a process whose output yields customer satisfaction and continuous improvement. It expouses "win-win" attitude differentiates cost versus price and provides added value.
- TQM is the integration of functions and processes within an organization in order to achieve continuous improvement of the quality of goods and services. The goal is customer satisfaction.

A Company's continued success requires repeat business, which in turn depends upon the customers. A strong customer focus is therefore imperative. TQM is a means to this end, and an attribute of good management. TQM is essentially customer driven. It takes a total system view. TQM measures are not merely confined to traditional reject reworks, down grades and the like. It also includes global, balance sheet parameters such as profits, stock in trade, market share, etc. The approach touches every operation, every individual and every activity. Each is a link with the ultimate purpose to provide durable satisfaction to the existing and potential customers.

Major Objectives of a TQM system

- Specific quality policies and objectives.

- Strong customer focus.
- Organization of quality activities.
- Organization wide integration of people, machine and information.
- Specific vendor control activities..
- Continuous control of TQM systems by comparisons of standards with actual performance.
- Periodic audit of system activities.

Some common principles that run through TQM interpretations;

- Every one in the organization is involved continuously improving the process under his or her control and takes responsibility for his or her own quality assurance,
- Each person is committed to satisfying his or her customer (internal or external),
- Teamwork is practiced in a number of forms. There is a commitment to the development of employees through involvement.
- Participation by everyone in the business is positively encouraged and practiced.
- A formal program of education and training is in place and this is viewed as an investment in developing people's ability and knowledge and helping them realize their potentials.
- Suppliers and customers are integrated into the improvement process.
- Honesty, sincerity, and care are an integral part of daily business life and Simplicity in process, systems, procedures and work instructions is pursued.

THE KEY ELEMENTS OF TQM

The following is the brief outline of the key elements of TQM:

- Commitment & leadership of the chief executive officer
- Culture Change
- Planning & Organization
- Education and Training
- Involvement, recognition and measurement
- Customer focus and Satisfaction
- Strategic Quality Planning
- Cost of quality
- Supplier involvement
- **Commitment & leadership of the chief executive officer**

Without the total commitment of the CEO and his or her immediate executive and other senior managers, nothing much will happen and anything that does will not be permanent. They must take personal charge and exercise forceful and personal leadership. There is a strong relationship between an organizations business achievements and the CEO's understanding of the TQM philosophy and commitment to continuous and company wide quality improvement. In superior performing companies, TQM is a way of life, and people within the organization are observed with quality, only the CEO can ensure that this becomes a reality. Survey shows the cost of nonconformance is likely to be 5 to 25% of annual sales turnover and when compared to profit as a percentage of sales turnovers the key question is: can the CEO afford not to get involved in TQM?

The CEO is the primary internal change agent for quality improvement and in this capacity he has two key roles. Shaping organizational values, and establishing a managerial infrastructure to actually bring about change. To show commitment, top management should make sure that everybody within the organization from top to bottom is clear about the long term goals - this affects management style, the quality of communications and everything that is done within an organization.

➢ Culture Change

What is Culture? Concept of culture is defined as a pattern of artifacts, behaviors, and values, beliefs and assumptions that a group develops as it bands to cope with internal and external problems of survival and prosperity.

An organizational culture which is conducive to continuous quality assurance needs to be integrated into all the processes and functions of an organization.

This requires changing people's behaviour, attitudes and working practices in a number of ways such as –

- Accept that there is no ideal state, and never take the view that their level of process, performance and service is as good as it possibly could be;
- Inspect their own work;
- Not pass on defects to the next process;
- Recognize the internal customer relationship (everyone for whom you perform a task or service is a customer) ;and
- View mistakes as an improvement opportunity – in the words of the Japanese, every mistake is a pearl to be cherished.

Considerable thought needs to be given to facilitating and managing culture change. Changing people's behaviour and attitudes is one of the most difficult tasks facing management, who must develop their powers and skill of motivation and persuasion. Managers must realize that cultural forces operate within organizations just as in the larger Society.

Culture emerges in organizations, because of the organizations need to deal with the external and internal problems of survival and prosperity. Achieving

external adoptions and achieving internal integration can do this emergence of culture.

- **Planning & Organization**

Many facets of the quality improvement process, feature planning and organization for building product and service quality into designs and processes,

- Developing prevention based activities,
- Putting into place quality assurance procedures that facilitate closed loop corrective actions,
- Planning the approach to be taken to the use of quality systems, procedures and quality management tools and techniques,
- Developing the organization and infrastructure and allocating the necessary resources to support the improvement activities.
- Standardization, systematization and simplification of work instructions, procedures and systems.

The typical company operates with a vertical; functional organization structure based on reporting relationship, budgeting procedures, and specific and detailed job clarifications. Departmentation is by function and communication, rewards, and loyalties are functionally oriented. Processes are forced to flow vertically form of the top, down, creating costly barriers to process flow.

The system approach to organizing suggests three significant changes, one and two requiring organizational realignment.

- The concept of the inverted organizational chart
- A system of intra-company internal quality
- Horizontal and vertical integration of functions and activities.

Construction Industry being a service Industry with the end product to be created in situ planning starts right from the inception and scheduling of the projects is required for its execution in the scheduled time period to avoid delays in the project completion. Organization varies with each site and nature of project thus there is no tailor made organization structure but it has be developed as per the project requirements.

- **Education and Training**

Employees need to be provided with the right level of education and training to ensure that their general awareness of quality management concepts, skills and attitudes is appropriate and suited to the continuous improvement philosophy. Education and Training also provide a common language throughout the business. Training needs to be planned and provided on a timely and regular basis to enable people to solve increasingly complex problems. Without it changes in behaviour and attitude will not take place. The training must also focus on helping managers to identify improvements available in their areas of responsibility. Every organization must keep aside certain percentage of their budget annually for training.

The benefits of training can be included as -

i) Improved communications.
ii) Change in corporate culture.
iii) Demonstration of management's commitment to quality.

Top companies commonly address the following topics in quality training curricula:

- Quality awareness
- Quality measurement (performance measures/quality cost, bench marking, data analysis)

- Process management and defect prevention.
- Team building and Quality Circle Training
- Focus on customer and markets
- Statistics and statistical methods.

The international quality study (I.Q.S) was conducted among 584 companies representing four industries. Quality training was found to have the greatest impact when coupled with other practices, such as measurement and reward system.

It must also be recognized that not all employees will have the necessary education levels. The structure of the training may incorporate some updating of basic educational skills in numeracy and literacy, but it must promote continuing education and self-development. This will help to release the latent potential of many employees and the best use made of each individual's ability.

Construction Industry needs revamping with education and continuous training to deal with its complex nature with work specifications from planning, design to completion stage, construction techniques, Soft wares, Workmanship quality, source of materials etc. changing from project to project depending on the sight conditions. e.g. Take the example of bituminous road construction …. If the compaction of sub-grade, sub-base layers is not properly done as per the specification and the methods specified for quality it can lead to severe problems of road maintenance.

- **Involvement**

All available means, from suggestion schemes to various forms of team work, must be considered for achieving broad employee interest, participation and contribution in the process of quality improvement, management must be prepared to share some of their powers and responsibilities. This also involves seeking and listening carefully to the views of employees and acting upon their

suggestions. Part of the approach to TQM, is to ensure that everyone has a clear understanding of what is required of him or her and of each job's relevance to the business as a whole. The more people understand the business, the greater the role they can play in the quality improvement process. People must be encouraged to manage and improve the processes within their sphere of responsibility.

The managerial role must shift towards teamwork for continuous improvement, flexible team participation, integration for synergy and continuous learning about the constituents and the systems of the organizations.

- **Recognition**

Positive performance and achievement must be recognized, and success rewarded. People must see the results of their activities and be constantly encouraged through active communication. For TQM to be successful it is essential that management must communicate as never before.

Recognition, promotion, compensation, reward and feedback process supports quality and performance objectives. Any organization must recognize both business success and personal growth. Each department can have its own instant recognition program consisting of a thank you card and small gifts (e.g. gift cheques etc.)

Managers should look for positive behaviors to recognize and reward, rather than for negative conduct to criticize. It is a question of emphasis – applauding success rather than always berating failure.

- **Measurement**

Progress must be continually measured against a series of key results indicators, internal & external. A total quality program needs to be regularly

evaluated in order to create an environment for continuous improvement. Also measurements are vital where customer focus and satisfaction is to be measured. The key measures of customer satisfaction or dissatisfaction must be identified. Customers must be continuously asked whether they are satisfied with the output or the customer requirements have changed.

There are seven generic ways (in addition to the cost of quality) in which the quality outputs can be measured:

1) Defects (work not to specification)
2) Rework (work requiring correction)
3) Scrap (work thrown away)
4) Lost items (work done again)
5) Backlogs (work behind schedule)
6) Late deliveries (work after agreed time)
7) Surplus items (work not required)

The above measurements apply to 'outputs' (such as defects left in concreting, Inadequate prestressing of girders, Scrap in the form of steel bars, work repeated because of wrong technique used etc.) as well as to the outputs of finished structure (such as leaking slabs, pots and ruts on bitumen concrete roads, cracks in the concrete pavement etc.).

There are five key measurements for each output,

i) Target: the budget or target level of performance to be achieved.
ii) Forecast: the forecast level of performance, which may be better or worse than the target depending on current business situation. The forecast also shows when the target will be reached.

iii) Actual: The actual level of performance achieved to date.

iv) Problem: The difference between the actual and target level of performance where 'actual ' is worse than 'target'.

v) Opportunity: The opportunity for improving quality better than target at no extra cost.

- **Customer focus and Satisfaction**

TQM companies focus on customers and on satisfying their needs. TQM emphasizes a concept called 'market in' which focuses on customer satisfaction as the purpose of work, in contrast to the olden concept of 'products out', which focuses on the product as the purpose of work, wherein customer is not at focal point but whereas 'market in' concept focuses on input from the market and says that the job isn't done well until the customer is satisfied. The 'market in' concept says, the customer is god (as per Japanese) As per the same concept every employee has customer i.e. external customer, who is outside the company and internal customer each person in the company, no matter how far from the external customers, also has customers. Who ever use the product of your work is your customer.

Customer requirements change, so it is necessary to take feedback from the customer and processes to improve the product overtime. The Japanese call this improvement as Kaizen.

Finally the market-in concept includes the idea of a process for improvement aimed at continuing customer satisfaction. TQM companies offer have an explicit process or set of guidelines for dealing with customers e.g., the steps can be

i) Who are my customers?

ii) What are their needs?

iii) What is my product or service?

iv) What are my customer's measures or expectations?

v) What is my process for meeting their needs?

vi) Does my product or service meet their needs or expectations?

vii) What actions are intended to improve my process?

Therefore, Market – in needs to be institutionalized by senior executives through proper planning & sequencing the activities concerned. In our country, Construction industry has got a boost in the residential sector because of this market in concept the flat schemes are planned and developed by keeping customers at the focal point. Now the residential areas are being developed with the concept of town planning with parks, gardens, gymnasium, open areas, schools, temples roads communication networks, security arrangements etc.

- **Supplier Involvement**

A revolution in the relationship between buyer and suppliers has emerged in the form of supplier partnerships. Research shows that poor quality of supplier items results in almost half of the quality problems. Also with just in time, inventory management concept, it's imperative that purchased product meet quality requirements.

For modern products, quality-planning starts before a contract is signed. Such planning must recognize two issues.

i) The buyer must transmit to the supplier a full understanding of the use to be made of the product communicating usage requirements can be difficult even for a simple product.

ii) The buyer must obtain information to be sure that the supplier has the capability to provide a product that meets all fitness for use, requirements.

Supplier selection is an important decision, with a decision to buy the number of suppliers for each item are then decided upon. Assessment of supplier quality capability is also an important step, which involves one or both of two actions.

i) Qualifying the supplier's design through the evaluation of product samples.

ii) Qualifying the supplier's capability to meet quality requirements on production lots through supplier quality survey and supplier's manufacturing process.

Every construction company has to be particular about the supplier because it's the input quality which will contribute to the final product. Variety of materials from various sources is required for construction projects eg. Construction of residential building requires materials ranging from sand, cement aggregates, wood to door, windows, flooring tiles, plumbing materials, paints etc. from different sources and having different characteristics.

- **Strategic Quality Planning**

Preparing for the future is crucial. In today's highly competitive and changing market place the margin for error is decreasing, hence planning for the future is necessary for survival and successful planning and executing the plan are key activities in a company done by its managers. If done well, this process will give the desired results. Formal strategic planning provides many benefits, including systematic thinking, better co-ordination, sharper objectives, improved

performance standards, and management involvement. All of these result in a planned approach to tackling the market place that can end in higher sales and profits. For construction industry Strategic Quality Planning is the foundation which can efficacy of any organization can be measured.

A good planning process needs to exist throughout an organization. It should be standard process, and everyone should be a trained in it. Once in place it provides a common planning language with common formats. As managers and employee's transfer or move within the company, they need only worry about the planning content, the process having been standardized. A good planning process will consist of a long-range plan and an annual plan. The long-range plan includes analysis of current situation (reviews of strengths and weakness, competitors, customers, opportunities) and then defines broad objectives and strategies that must be pursued.

Before any planning starts, the organization's purpose and vision should be prepared and clearly understood which define the fundamental set of reasons for the organizations existence. It should be inspiring, give a clear sense of direction and provide a basis for decision making.

a) Customer needs issues and channels of distribution.
b) Rigorous analysis is required, based on data of customer needs and trends. This analysis allows us to discover new market segments and to build a data based model of the market.
c) Competitive situations: Here the focus is on a competitive analysis. We need to understand the competition, their strategies, how they differentiate their products and services, and their financial strengths.
d) Products and services: Based on customer needs and target market segments, we determine our proposed products and services. This includes continuing with current offerings and planning for new offerings with the help of key technologies or core competencies.

e) Development of partners and purchase plan: A plan is defined for developing products and services that we need to purchase from third parties and partners. In addition to products, this may include services, such as after sales support and product distribution.

f) Financial Analysis: Here analysis is done of revenues, cost of goods, expenses, investments, (including R & D), overhead costs, and profits. We must also determine the return on investment for the proposed products and services. Five years projections for these items should be available.

g) Potential problems Analysis: It's important that a risk analysis be conducted and appropriate contingency plans proposed. Areas of risk and the possible competitive response should be reviewed.

Five-year plan: 5-year plan according to major functions of the organization is listed. This would include product plans and objectives for marketing, design and manufacturing along with plans for quality and human resource development.

- **Quality Circles**

This isn't a device of top management to seek improvement as per target and plans. Management constitutes QIT and deploys them to work towards customer – driven targets and objectives. Top management however, welcomes and nurses QC, aids and motivates them for enhancing the morale and promoting knowledgeable participation in-group improvement exercises.

QC started in Japan in 1961 and JUSE (Japanese Union of Scientists and Engineers) was a nodal agency in this effort. A group normally consisting of four to eight workers with the foreman as its nucleus was termed a quality circle. It is voluntarily formed with people in the same work area. Each circle conducts improvement activities independent of several such circles. The circles objectives is to:

a) Increase the level of worker consciousness to wards improvement and quality,
b) Manage and improve construction, and
c) Develop the managerial capability of the foremen

Imparting appropriate training to workers is an essential step. To train the workers in troubleshooting, simple data collection and evaluation procedures could form the core of training. Control charts, graphical methods of presentation and analysis such as tally, Ishikawa, Pareto and scatter diagrams, frequency distribution and histogram are useful tools for the workers. Such programs in construction industry will surely help to improve the quality awareness level of the labour force actually performing the task.

- **Cost of Quality**

Historically there was the mistaken notion that achievement of better quality requires higher cost. It was this false myth that prevented many company's to invest strongly into quality activities and programs. However, the fact of matter is that poor quality implies waste of material, waste of the effort of labor and waste of equipment utilization and thereby results in higher costs. On the other hand good quality ensures optimum utilization of man, machines and materials and thereby lowering costs.

The costs can be primarily divided into two major categories

i) Costs of control which includes prevention costs and appraisal costs.
ii) Cost of failure of control which includes internal failure costs and External failure cost.

The prevention cost component in costs of control is meant to prevent unsatisfactory quality products to be manufactured and include costs on quality and organization and training of employees on quality concepts. In many

organizations some employees will need to be convinced that their senior management are serious about TQM. Quality costing is a way of highlighting to all employees the importance of product and service quality to business profitability.

Usefulness of quality costs display the importance of quality related activities in meaningful terms. They can also be used to educate staff in concept and principles of TQM and explain why the organization is insisting on it. Knowledge of quality related costs enable business decisions about quality to be made objectively. It permits the use of sensitivity analysis, discounted cash flow and other accounting techniques for the evaluation of expenditure projects, as in any other area of the business. In this way it helps companies to decide how, when and where to invest in preventive activities and/or equipment.

Construction Industry must control and slash down it's project cost and TQM can surely help to move towards zero defects and hence help to compete in the national and international bidding and contracting.

- **Supplier Involvement**

A revolution in the relationship between buyer and suppliers has emerged in the form of supplier partnerships. Research shows that poor quality of supplier items results in almost half of the quality problems. Also with just in time, inventory management concept, it's imperative that purchased product meet quality requirements.

STEPS OF IMPLEMENTING TQM

- Organize a workshop to appraise top management about the concept, principles, tools and techniques of TQM.
- Conduct another workshop similar to above for senior managers.
- Senior managers to identify key areas where management actions are required.

- Set up a cross-functional team of departmental heads to address areas of actions.
- Appoint a committee consisting of top management and TQM co-ordinator to monitor TQM progress.
- Publicize results of success of TQM.
- Set up improvement groups/task forces.

The participation of all people in the organization begins with training and preparing their supervisors. Most individuals ultimately, receive training in, and opportunities to apply quality tools.

The benefits of Quality Management in construction projects:-

Construction Industry is service Industry, whose responsibility to convert plan and specification into finished product; it's exceedingly complex and highly individual in character. The impact of construction industry on economy of our country is considerable. There are large numbers of companies, ranging in size from small proprietorships with one to two employees to huge design/ construction firms employing many thousands of employees and handling work in billions of rupees. Construction projects are to be executed at site and in-situ the final product is not under stringent factory control but it faces unpredictable problems under varying circumstances. It employs huge labor force (may be skilled or unskilled) and engineers have to work under tough job conditions unlike glamorous Air Conditioned office jobs of software engineers. It also involves a good team work with proper coordination between Architects, Engineers, supervisors, labor force and the client. Meeting target schedule by execution of projects under such complex conditions with expected cost, time and quality is a Herculean task.

Implementation of TQM philosophy can provide a solution which is all encompassing. It aims at work culture, Employee empowerment, SQC techniques

and finally customer satisfaction. It is not limited to material testing or quality assurance of end product only but it aims at the process of quality planning, quality improvement and quality control at each and every phase. TQM is not a structured certification process like ISO 9000 series which emphasizes on procedural aspect only, it in-fact emphasizes the human element and processes to achieve quality.

An engineer must understand the application of TQM to technical activities. TQM is the application of the scientific method to business (pick an important problem, get the facts, analyze the facts, find the underlying truths, systematically test it to verify that it works, standardize the new method, and then cycle round again). The complexity of modern business and technology requires a teamwork approach rather than each engineer doing his own thing, thus TQM needs to be applied to the business of the company and to engineering methods.

Q:-What are Quality assurance and Quality control inspection reports prepared for construction ? Explain ISO-9000 series for Quality management.

Ans:- Construction Quality Control Process

Quality: A degree or grade of excellence or worth.

Assurance: The act of giving confidence, the state of being certain or the act of making certain.

Quality Assurance: The planned and systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled.

Control: An evaluation to indicate needed corrective responses; the act of guiding a process in which variability is attributed.

Quality Assurance (QA): Responsibility?? Involves REGULAR BUT RANDOM

TESTING OF MATERIALS and workmanship (time-based or work-based intervals) Prevent, identify, and correct quality-related problems During the construction process, QA instructors mostly provide guidance and leadership to the

construction people construction quality control process quality control (QC).

 The Construction contract defines the quality standards and the quality control testing requirements.

 The contractor must prepare a detailed quality control plan for each definable feature of work detailing on how the quality standard will be achieved. (Do we apply?)

 The quality control plan must be approved before the start of the particular work.

 The contract requires that the QC testing lab be validated by the approved

source (Institutions, consultant, competent testing house /firm or agency..etc).

The ISO 9000 series was created by the International Organization for Standardization (ISO) as international requirements and guidelines for quality management systems. It was originally introduced in 1987 and over the years has established itself in the global economy having been adopted in over 178 countries with over one million registrations.

The phrase "ISO 9000 family" or "ISO 9000 series" refers to a group of quality management standards which are process standards (not product standards).

- ISO 9000 *Quality management systems – Fundamentals and Vocabulary*, referenced in all ISO 9000 Standards.
- ISO 9001 *Quality management systems – Requirements*, contains the requirements an organization must comply with to become ISO 9001 certified.
- ISO 9002 – ***Guidelines*** for the application of ISO 9001:2015
- ISO 9004 – *Managing for the sustained success of an organization*, provides ***guidelines*** for sustaining QMS success through evaluation and performance improvement.

ISO 9001:2015 is the current version of the ISO 9001 standard. ISO 9001 lists requirements, while the other standards in the 9000 family provide guidelines and information. People often say "**ISO 9000 certified**", but what they mean is they have met the requirements of the ISO 9001 standard. Read more about ISO 9001 Certification.

The ISO 9000 Series of Quality Standards is not industry specific and is applicable to any manufacturing, distribution or service organization. It is managed by Technical Committee (TC) 176, comprised of international members from many industries and backgrounds.

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UNIT-3

Explain the importance of store management. How does store management helps in reducing wastage of materials on site?

The importance of store management:-

Store is an important component of material management since it is a place that keeps the materials in a way by which the materials are well accounted for, are maintained safe, and are available at the time of requirement. Storage is an essential and most vital part of the economic cycle and store management is a specialized function, which can contribute significantly to the overall efficiency and effectiveness of the materials function. Literally store refers to the place where materials are kept under custody.

The main processes of store are (i) to receive the incoming materials (receiving), (ii) to keep the materials as long as they are required for use (keeping in custody), and (iii) to move them out of store for use (issuing). The auxiliary process of store is the stock control also known as inventory control. In a manufacturing organization, this process of receiving, keeping in custody, and issuing forms a cyclic process which runs on a continuous basis. The organizational set up of the store depends upon the requirements of the organization and is to be tailor made to meet the specific needs of the organization.

Store is to follow certain activities which are managed through use of various resources. Store management is concerned with ensuring that all the activities involved in storekeeping and stock control are carried out efficiently and economically by the store personnel. In many cases this also encompasses the recruitment, selection, induction and the training of store personnel, and much more.

The basic responsibilities of store are to act as custodian and controlling agent for the materials to be stored, and to provide service to users of these materials. Proper management of store systems provide flexibility to absorb the shock variation in demand, and enable purchasing to plan ahead.

Since the materials have a cost , the organization is to manage the materials in store in such a way so that the total cost of maintaining materials remains optimum.

Store needs a secured space for storage. It needs a proper layout along with handling and material movement facilities such as cranes, forklifts etc, for safe and systematic handling as well as stocking of the materials in the store with an easy traceability and access. It is to maintain all documents of materials that are able to trace an item , show all its details and preserve it up to its shelf life in the manner prescribed or till it is issued for use. Store is to preserve the stored materials and carry out their conservation as needed to prevent deterioration in their qualities. Also store is to ensure the safety of all items and materials whilst in the store which means protecting them from pilferage, theft, damage, deterioration, and fire.

The task of storekeeping relates to safe custody and preservation of the materials stocked, to their receipts, issue and accounting. The objective is to efficiently and economically provide the right materials at the time when it is required and in the condition in which it is required. The basic job of the store is to receive the materials and act as a caretaker of the materials and issue them as and when they are needed for the activity of the organization.

Once the material has been received and cleared through inspection and accepted for use, it needs safe custody of the stores. The role of custody is to receive and

preserve the material. A stage comes when the material is needed for use. Store at that time releases the material from its custody to the user department and the process is called 'issue of goods. It might also happen that after partial use , some materials having useable value in future are returned to the store and thus they also become part of the custody again.

Storekeeping activity does not add any value to the materials. In fact it adds only to the cost. The organization is to spend money on space (expenditure on land, building passage and roads), machinery (store equipment), facilities (e.g. water, electricity, communication etc.), personnel, insurance, maintenance of store equipment, stationary etc. All of these get added to the organizational overheads and finally get reflected in the costing of the finished product. However, it is an essential function in any organization.

Store management helps in reducing wastage of materials on site as:-

To rise to these challenges, progressive managers are focusing on reducing, reusing, recycling and efficiently disposing of waste through effective management of construction waste costs, including:

1. Minimising Landfill Costs

With both Landfill Tax and disposal charges growing each year, consigning large volumes of waste to landfill is becoming an even greater drain on already tight budgets.

To counter the threat:

- Plan in advance what materials are required for the build to reduce the risk of over-ordering
- Order standard sizes wherever possible to reduce off-cut levels – and if you are left with off-cuts, use them first before ordering any new materials
- Check that all materials are handled correctly on site to avoid damage that could inadvertently lead to waste.

2. Segregating Waste Efficiently

How waste is separated and stored is essential for effective construction waste costs management:

- Introduce a secure on-site waste storage area that features clearly labelled and colour-coded skips, bulk bags or wheelie bins for different types of waste
- If applicable, deploy a mini crusher and screener for leftover bricks, blocks and hardcore
- Train employees in basic segregation procedures, using incentives and rewards to ensure they follow them
- Bring on board a team to exclusively monitor and manage materials and waste either on a full- or part-time basis (depending on your budget).

3. Maximising Waste's Potential

Make waste work for you, not against you, by embracing recycling processes that will help protect budgets on existing and future builds:

- Decide which materials can be recycled or resold. Timber and concrete, for example, require different recycling methods while scrap metal can be sold on to generate revenue.

- Choose recycled materials for your projects. These offer the same quality as new materials but at lower unit costs.
- Send mixed waste skips to a Materials Recovery Facility, and if employing waste contractors, choose the one that offers high but verifiable waste recovery rates.

4. Reusing Existing Materials

Existing materials represent significant opportunities for 'getting more for less' if properly exploited – especially on refurbishment projects:

- Reuse or repurpose existing materials once they've been stripped out, reducing the need for costly new materials
- Collaborate with other businesses and trades to identify potential opportunities for exchanging waste/reusable materials
- Carry out repairs on damaged materials, such as pallets, and reuse temporary materials including plasterboard or fencing
- Stockpile crushed materials from early phases of a project to reuse later on, and consider using any leftover materials on other jobs.

5. Allying With The Right Suppliers

Source suitable suppliers/waste specialists to drive forward your on-site waste management strategy.

They should ideally:

- Offer take-back schemes that enable you to sell/send back excess materials including packaging
- Allow for staggered deliveries, reducing the need for managing costly on-site storage areas

- Submit fully-audited reports on your waste streams, making sure your waste forecasts are based on the most relevant and up-to-date data.

By adopting these practical techniques, building site managers can score wins on multiple fronts quickly and efficiently. Research has shown that effective waste management can lead to landfill diversion rates of up to 95%. Ultimately, by dealing with construction waste costs head on, businesses will not only protect profit margins and enjoy a competitive edge over rivals, but also become part of a growing industry-wide movement aiming to tackle one of the sector's biggest issues – unsustainable levels of waste.

Key Takeaways:

- Minimise landfill charges by planning your materials spending and segregating waste materials more efficiently.
- Maximise your waste's potential via recycling and reusing to make sure no materials are wasted or sent to landfill.
- Work with suppliers and waste specialists who can drive down construction waste costs through take-back schemes and high waste recovery rates.

Q:- Explain ABC and EOQ types of models used for inventory control.

Ans:- ABC MODEL

In materials management, the *ABC analysis* is an inventory categorization technique. ABC analysis divides an inventory into three categories—"A items" with very tight control and accurate records, "B items" with less tightly controlled and good records, and "C items" with the simplest controls possible and minimal records.

The ABC analysis provides a mechanism for identifying items that will have a significant impact on overall inventory cost, while also providing a mechanism for identifying different categories of stock that will require different management and controls.

The ABC analysis suggests that inventories of an organization are not of equal value. Thus, the inventory is grouped into three categories (**A**, **B**, and **C**) in order of their estimated importance.

'A' items are very important for an organization. Because of the high value of these 'A' items, frequent value analysis is required. In addition to that, an organization needs to choose an appropriate order pattern (e.g. 'just-in-time') to avoid excess capacity. 'B' items are important, but of course less important than 'A' items and more important than 'C' items. Therefore, 'B' items are intergroup items. 'C' items are marginally important.

There are no fixed threshold for each class, different proportion can be applied based on objective and criteria. ABC Analysis is similar to the Pareto principle in that the 'A' items will typically account for a large proportion of the overall value but a small percentage of the number of items. Examples of ABC class are

- '**A**' items – 20% of the items accounts for 70% of the annual consumption value of the items
- '**B**' items – 30% of the items accounts for 25% of the annual consumption value of the items
- '**C**' items – 50% of the items accounts for 5% of the annual consumption value of the items

EOQ MODEL

Inventory is the stock of any items or resource used in an organization. The objective of inventory management has to keep enough inventories to meet customer demand and also be cost effective Various costs associated with Inventory are:

a. Purchase (or production) cost: The value of an item is its unit purchasing (production) cost. This cost becomes significant when availing the price discounts. This cost is expressed as Rs. /unit

b. Capital cost: the amount invested in an item, (capital cost) is an amount of capital not available for other purchases. If the money were invested somewhere else, a return on the investment is expected. A charge to inventory expenses is made to account for this unreceived return. The amount of the charge reflects the percentage return expected from other investment.

c. Ordering cost: It is also known by the name procurement cost or replenishment cost or acquisition cost. Cost of ordering is the amount of money expended to get an item into inventory. This takes into account all the costs incurred from calling the quotation to the point at which the items are taken to stock.

There are two types of costs- Fixed costs and variable costs.

Fixed costs do not depend on the number of orders whereas variable costs change with

respect to the number of orders placed. The salaries and wages of permanent employees involved in purchase function and control of inventory, purchasing, incoming inspection, accounting for purchase orders constitute the major part of the fixed costs. The cost of placing an order varies from one organization to another. They are generally classified under the following heads:

(i) **Purchasing:** The clerical and administrative cost associated with the purchasing, the cost of requisitioning material, placing the order, follow-up, receiving and evaluating quotations.

(ii) **Inspection:** The cost of checking material after they are received by the supplier for quantity and quality and maintaining records of the receipts.

(iii) **Accounting:** The cost of checking supply against each order, making payments and maintaining records of purchases.

d. Transportation costs: The expenses involved in moving products or assets to a different place, which are often passed on to consumers. For example, a business would generally incur a transportation cost if it needs to bring its products to retailers in order to have them offered for sale to consumers. Transport costs have significant impacts on the structure of economic activities as well as on international trade. Empirical evidence underlines that raising transport costs by 10% reduces trade volumes by more than 20%. In a competitive environment where transportation is a service that can be bided on, transport costs are influenced by the respective rates of transport companies, the portion of the transport costs charged to users.

e. Inventory carrying costs (Holding cost): These are the costs associated with holding a given level of inventory on hand and this cost vary in direct proportion to the amount of holding and period of holding the stock in stores. The holding costs include.

(i) Storage costs (rent, heating, lighting, etc.)

(ii) Handling costs: Costs associated with moving the items such as cost of labor,

equipment for handling.

(iii)Depreciation, taxes and insurance.

(iv)Costs on record keeping.

(v) Product deterioration and obsolescence.

(vi)Spoilage, breakage, pilferage and loss due to perishable nature.

f. Shortage cost: When there is a demand for the product and the item needed is not in stock, then we incur a shortage cost or cost associated with stock out. The shortage costs include:

(i) Backorder costs.

(ii) Loss of future sales.

(iii)Loss of customer goodwill.

(iv)Extra cost associated with urgent, small quantity ordering costs.

(v) Loss of profit contribution by lost sales revenue.

The unsatisfied demand can be satisfied at a later stage (by means of back orders) or unfulfilled demand is lost completely (no back ordering, the shortage costs become proportional to only the shortage quantity).

Inventory Control-Terminology:

a. Demand: it is the number of items (products) required per unit of time. The demand may be either deterministic or probabilistic in nature.

b. Order cycle: The time period between two successive orders is called order cycle.

c. Lead time: The length of time between placing an order and receipt of items is called lead time.

d. Safety stock: It is also called buffer stock or minimum stock. It is the stock or inventory needed to account for delays in materials supply and to account for sudden increase in demand due to rush orders.

e. Inventory turnover: If the company maintains inventories equal to 3 months

consumption. It means that inventory turnover is 4 times a year, *i.e.* the entire inventory is used up and replaced 4 times a year.

f. Re-order level (ROL): It is the point at which the replenishment action is initiated. When the stock level reached R.O.L., the order is placed for the item.

g. Re-order quantity: This is the quantity of material (items) to be ordered at the re-order level. Normally this quantity equals the economic order quantity.

Inventory Cost Relationships

There are two major costs associated with inventory. Procurement cost (ordering cost) and inventory carrying cost. Annual procurement cost varies with the number of orders. This implies that the procurement cost will be high, if the item is procured frequently in small lots. The procurement cost is expressed as Rs. /Order.

The annual inventory carrying cost (Product of average inventory X Carrying cost) is directly proportional to the quantity in stock. The inventory carrying cost decreases, if the quantity to be ordered per order is small. The two costs are diametrically opposite to each other. The right quantity to be ordered is one that strikes a balance between the two opposing costs. This quantity is referred to as "Economic order quantity" (EOQ). The cost relationships are show in the Fig. 2.1

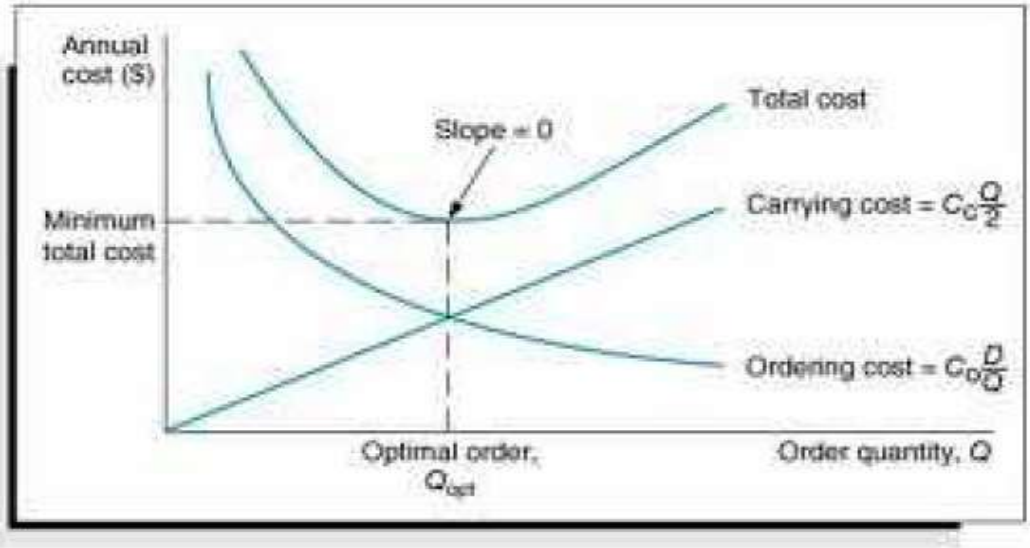


Fig. 2.1 Inventory carrying cost

$C = \text{odering cost} + \text{inventory carrying cost}$

$$\mathrm{C} = C_o N + \frac{C_i}{2N} A = (b)$$

For cost tobe minimum diff.it with N

$$\frac{\mathrm{dC}}{\mathrm{dN}} = C_o N + \frac{C_o A}{2N^2} = 0$$

$$N^2 = \frac{C_i A}{2C_o}$$

$$\text{and } \mathrm{C} = C_o N + \frac{C_i A}{2N} = \frac{2C_i A}{2N} = (a)$$

From equation a and b

$$\text{least inventory Cost} = \sqrt{2C_o C_i A}$$

$$\text{Economiv order Quantity (EOQ)} = \mathrm{Q} = \frac{A}{PN} = \frac{1}{P}\sqrt{\frac{2C_o A}{C_i}}$$

Inventory Models:

One basic problem of inventory management is to find out the order quantity so that it is most economical from overall operational point of view. Here that problem lies in minimizing the two conflicting costs, i.e. ordering cost and inventory carrying cost. Inventory models help to find out the order quantity which minimizes the total costs (sum of ordering costs and inventory carrying costs). Inventory models are classified as shown in Fig. 2.2

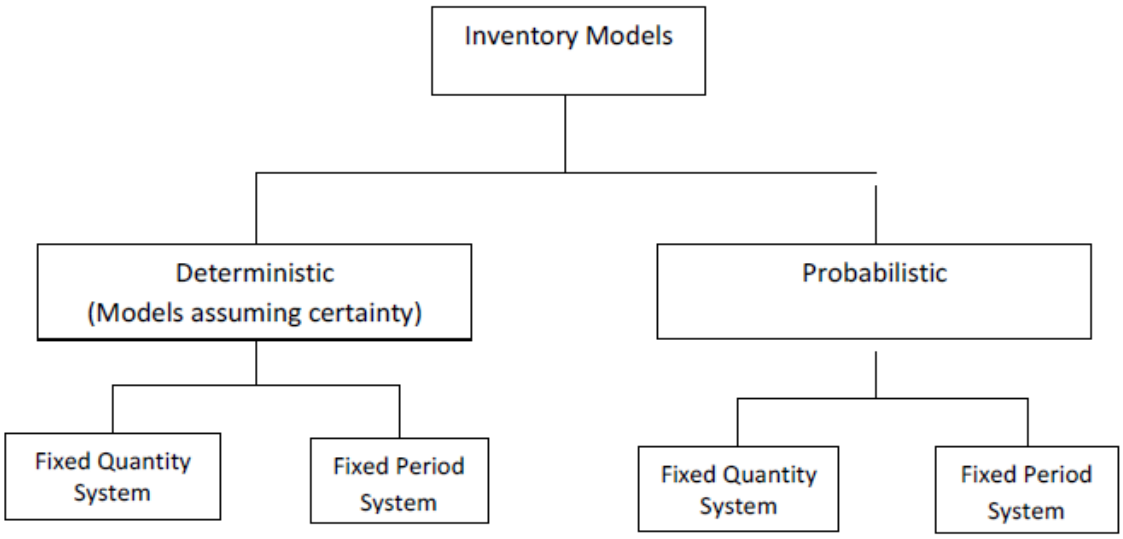


Fig. 2.2 Inventory models

Model I: Economic Order Quantity with Instantaneous Stock Replenishment (Basic Inventory

Model)

Assumptions

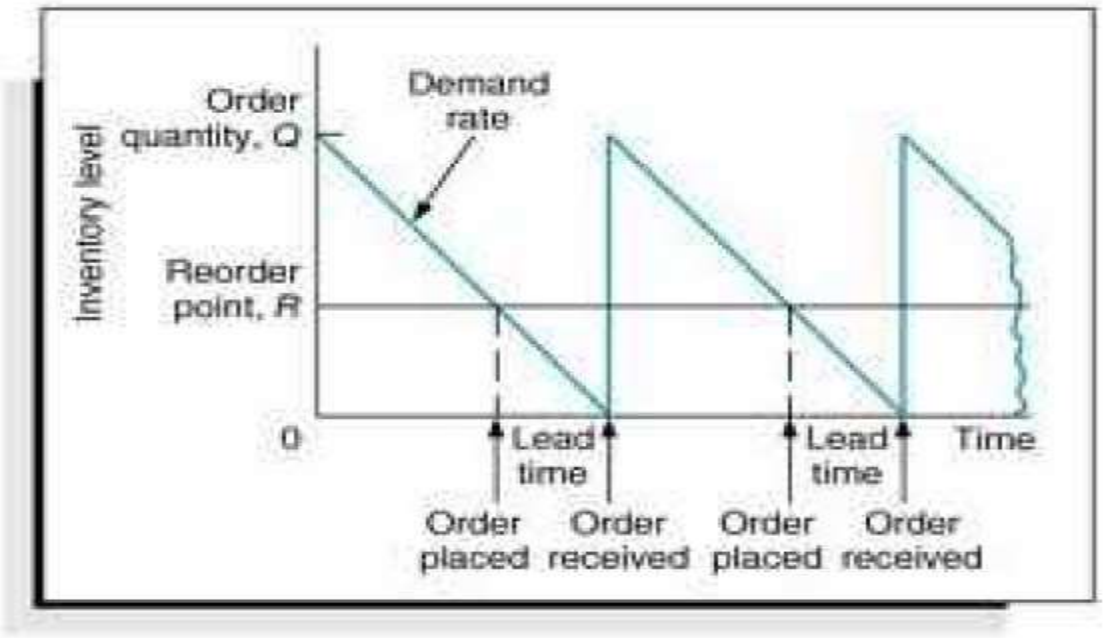
(i) Demand is deterministic, constant and it is known.

(ii) Stock replenishment is instantaneous (lead time is zero)

(iii) Price of the materials is fixed (quantity discounts are not allowed)

(iv) Ordering cost does not vary with order quantity.

Graphical representation of the model is shown in Fig. 2.3



Model II: Economic Order Quantity when stock replenishment is non-instantaneous

(Production Model) This model is applicable when inventory continuously builds up over a period of time after placing an order or when the units are manufactured and used (or sold) at a constant rate.

Because this model is especially suitable for the manufacturing environment where there is a simultaneous production and consumption, it is called "Production Model".

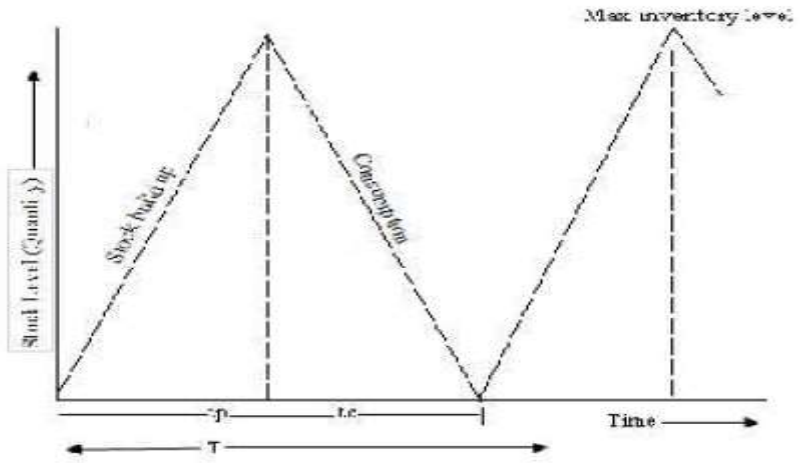


Fig. 2.4 Production inventory model

Assumptions

(i) The item is sold or consumed at the constant demand rate which is known.

(ii) Set up cost is fixed and it does not change with lot size.

(iii) The increase in inventory is not instantaneous but it is gradual.

Production inventory is represented in the Fig. 2.4

Let *p* be the production rate.

d is the demand or consumption rate.

Replenishment of inventory under this system build-up during the period *tp* and consumption takes place during the entire cycle *T*.

$$Q^* = \sqrt{\frac{2DC_0}{(1-d/p)C_h}}$$

$$N^* = \frac{Annual\ demand}{Economic\ Batch\ Qty\ (EBQ)} = \frac{D}{Q^*}$$

Model III: An Inventory Model when shortages are permitted

In many practical situations, shortages or stock outs are not permitted. So, it is must that stocks out situations are to be avoided. There are occasions where stock out are economically justifiable.

This situation is observed normally when cost per unit is very high.

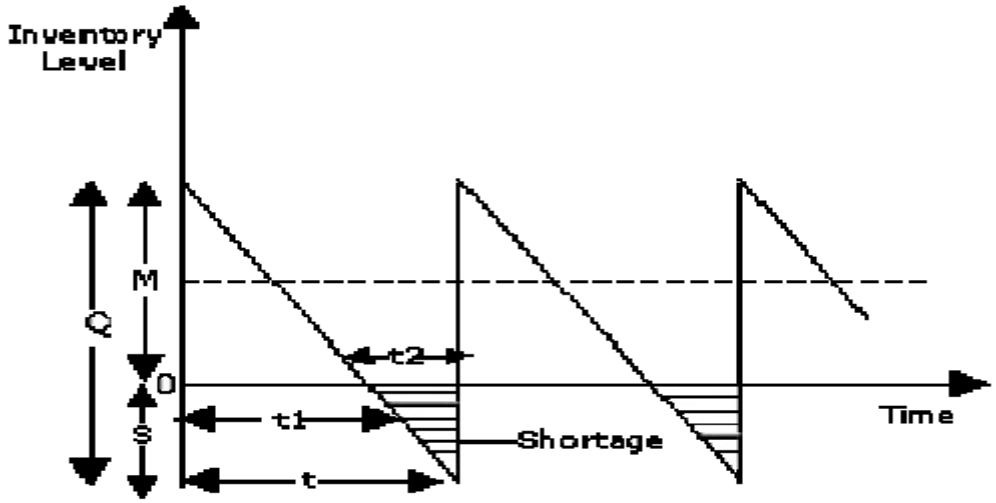


Fig. 2.5 Inventory model with shortages permitted.

Cs = Shortage Cost (Stock out cost) per unit per period.

S = Balance units after back orders are satisfied.

Q - S = Number of shortages per order.

t1 = Time period during which inventory is positive.

t2 = Time during which shortage exists.

T = Time between the receipt of orders.

The basic assumption is that there is no loss of sales due to stick out or shortages.

Model IV: Inventory Model with price discounts

When items are bought in large quantities, the supplier often gives discounts. However, if the material is purchased to take advantage of discount, the average inventory level and so the inventory carrying costs will increase.

Benefits for the purchaser from large orders are, lower cost per unit, lower shipping and transportation cost, reduced handling cost and reduction in ordering costs due to less number of orders.

These benefits are to be compared with the increase in carrying costs. As the order size increases, more space should be provided to stock the items.

A decision is, therefore, to be taken whether the buyer should stick to economic order quantity or increase the same to take advantage that, at large quantities, the production costs per piece are lower (economics of scale) and, hence, part of the savings can be passed on to the customer.

Safety Stock

The economic order quantity formula is developed based on the assumption that the demand is known and certain and that the lead time is constant and does not vary. In actual practical situations, there is an uncertainty with respect to both demand as well as lead time. The total forecasted demand may be more or less than actual demand and the lead time may vary from the estimated time. In order to minimize the effect of this uncertainty due to demand and lead time, a firm maintains safety stock, reserve stock or buffer stock. The safety stock is defined as **"the additional stock of material to be maintained in order to meet the unanticipated increase in demand arising out of uncontrollable factors."**

Because it is difficult to predict the exact amount of safety stock to be maintained, by using statistical methods and simulation, it is possible to determine the level of safety stock to be maintained.

a. FSN analysis: All the items in the inventory are not required at the same frequency. Some are required regularly, some occasionally and some very rarely.FSN analysis classifies items into fast moving, slow moving and non-moving.

b. SOS analysis: this classification is based on the seasonality of the items as seasonal and off seasonal. Seasonal items are available only for a limited period and, hence, they are procured to meet the demand till the next season.

c. XYZ analysis: This analysis is based on the value of the stocks on hand (i.e., capital employed to procure inventory). Items whose inventory values are high are called X category and whose values are low are called Z items. Usually XYZ analysis is used in association with A.B.C. analysis.

(Prepared By: Mr. Saurabh, Assistant Professor, CE)

UNIT-4
INTRODUCTION TO
RISK MANAGEMENT

No construction project is risk free.

 Risk can be managed, minimized, shared, transferred, or

accepted and it cannot be ignored. “

 What happens if it is ignored?

• Increased costs. • Loss or reduction in profit.

• Damage to brand / reputation; and at worst. • Disposal of the business or insolvency.

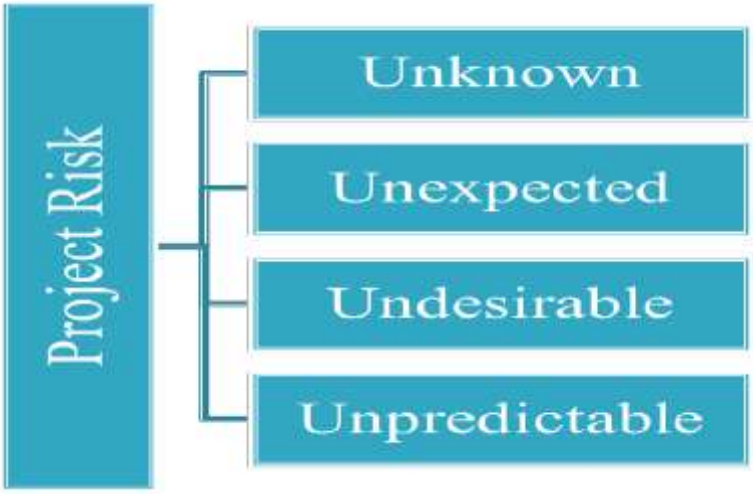
1. What is Risk?

 The likelihood (probability) of occurrence of an undesirable event that will have an impact (positive or negative) on objectives

 A possibility of loss – not the loss itself!

A situation involving exposure to danger.

- Expose (someone or something valued) to danger, harm, or loss.
- Risk is an uncertain event that may have a positive or negative impact on the project.
- May effect: scope, schedule, cost, performance, and quality.


Project Risk
Unknown
Unexpected
Undesirable
Unpredictable


Risks in Construction
Economic Factors
Client
Contractor
Supplier
Architect
Quantity Survey
Engineer
Project Manager
Inspector`
Social Factors
Environmental Factors
Political Factors

(Prepared By: Mr. Saurabh, Assistant Professor, CE)

Types of Risks in Construction

Financial & ECONOMIC

- Inflation
- Availability of funds
- Exchange rate
- fluctuations
- Financial default

DESIGN

- Incomplete design
- scope
- Defective design
- Errors & omissions
- Inadequate
- Specifications

CONSTRUCTION RELATED

- Labour disputes
- Labour productivity
- Different site

- conditions
- Design changes
- Equipment failure

POLITICAL

- Changes in laws and
- regulations
- Requirement for
- permits
- Law & order
- Pollution and safety
- rules

2.What is Risk Management?

Is a systematic method of identifying, analysing, treating, and monitoring the risks involved in any activity or process?

Is to a methodology that minimize the risks of not achieving the objectives.

· Construction Risk Management is the process of identifying and migrating risk.

· Proper Construction Risk Management implies control of possible future events and is proactive rather than reactive.

· Proper Construction Risk Management will reduce not only the likelihood of an event occurring, but also the magnitude of its impact.

· Construction Risk Management Systems are designed to do more than just identify the risk.

· The system must also quantify the risk and predict the impact on the project.

· The outcome is therefore a risk that is either acceptable or unacceptable.

3.WHAT DOES IT INCLUDE?

· Risk Management Planning

- Risk Identification
- Qualitative Risk Analysis
- Quantitative Risk Analysis
- Risk Response Planning
- Risk Monitoring and Control

4.HOW IS IT DONE IN PROJECT?

- Make Risk Management Part of Your Project
- Identify Risks Early in Your Project
- Communicate About Risks
- Consider Both Threats and Opportunities
- Clarify Ownership Issues

4.1 PLAN RISK MANAGEMENT

- Analysis and decision making to implement risk management.
- Defining how to conduct risk management activities for a project.
- Appropriate to size and complexity of the project.
- Stakeholders will be involved in planning risk management.
- The process of how to conduct risk management Activities.
- Success of the other five risk management processes will be enhanced by careful and explicit planning.

4.2 IDENTIFY RISK

- Generate a list of possible risks through brainstorming, problem identification and risk profiling.
- Determining which risk may affect the projects.
- Documenting their characteristics.
- SWOT Analysis.
- Information gathering.
- Check-list Analysis.
- Assumption Analysis.

4.3 QUALITATIVE RISK ANALYSIS

- To filter the risks to determine which are the significant risks and which are insignificant.
- Assess impact and likelihood of the identified risk.
- Probability and Impact Matrix.
- Risk categorization.
- Risk urgency assessment.

4.4 QUANTITATIVE RISK ANALYSIS

- Data gathering
  - Direct
  - Diagrammatic
  - Delphi
- Probability distribution
- Modelling Techniques
  - Decision tree Analysis
  - Sensitivity Analysis
  - Expert Judgment

4.5 PLAN RISK RESPONSE

- Eliminate threats before they happen.
- Decrease impact of threat.
- Contingency plan (Do something if risk happens).
- Fallback plan (Do something if contingency plans are not effective).
- Negative risk or threat
  - Avoid
  - Transfer
  - Mitigate
  - Accept
- Positive risk or opportunity
  - Exploit
  - Share
  - Enhance

4.6 RISK RESPONSE DEVELOPMENT

-Mitigating Risk
Reducing the likelihood an adverse event will occur.
Reducing impact of adverse event.
-Avoiding Risk
Changing the project plan to eliminate the risk or condition.
-Transferring Risk
Paying a premium to pass the risk to another party.
Requiring Build-Own-Operate-Transfer (BOOT) provisions.
-Retaining Risk
Making a conscious decision to accept the risk.

4.7 MONITOR AND CONTROL RISK

- Risk Reassessment (Scheduled regularly to identify new risk).
- Risk Audit (Examine the effectiveness of planned risk response).
- Trend analysis (Monitor overall project performance).

5.WHAT ARE THE BENEFITS?

- Effective use of resources.
- Promoting continuous improvement.
- Fewer shocks and failures.
- Strategic business planning.
- Raised awareness of significant risks.
- Quick grasp of new opportunities.
- Enhancing communication.
- Reassuring stakeholders.
- Focus on internal audit programme.

(Prepared By: Mr. Saurabh, Assistant Professor, CE)

MANAGEMENT INFORMATION SYSTEM (MIS)

What is MIS?

Management Information System is a computer-based information system which is basically concerned with processing data into information which is then communicated to the various departments in an organization to support the operations, the management and the decision-making function in the organization.

Definition of MIS

• **Management information system**, or **MIS**, broadly refers to a computer-based **system** that provides **managers** with the tools to organize, evaluate and efficiently **manage** departments within an organization

Subhalakshmi Joshi

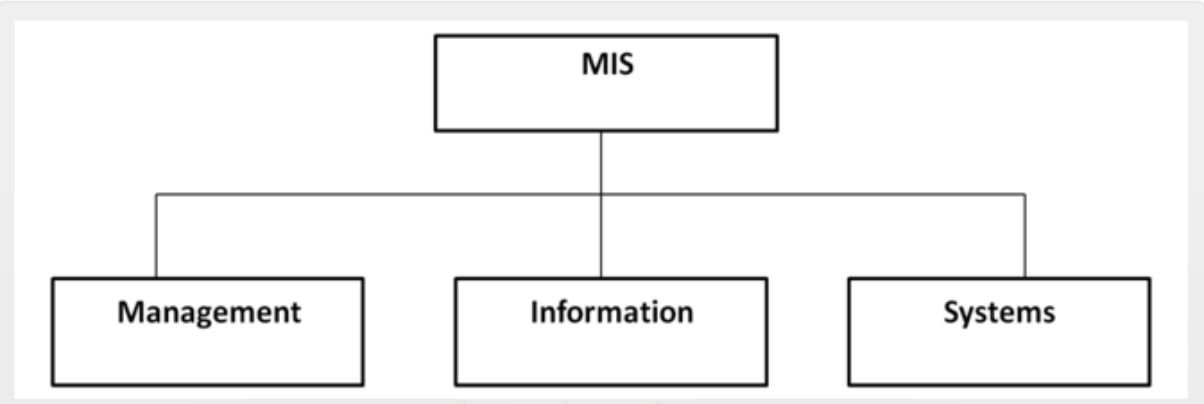


Fig. 1.1–Management Information System

MANAGEMENT

• **MANAGEMENT** is the effective utilisation of human and material resources to achieve the enterprise

objective

• It is a process consisting of the five basic functions:

• 1 Planning

• 2 Organising

• 3 Staffing

• 4 Directing

• 5 Controlling

INFORMATION

• **Information**: Information, in MIS, means the processed data that helps the management in planning, controlling and operations.

• Data means unstructured raw facts, observations or unevaluated messages in isolation. Data involves facts and figures. Information on the other hand is like a finished product.

SYSTEM

. A system is an orderly grouping of interdependent components linked together according to a plan to achieve a specific objective.

. Human body is a system composed of various parts, which are working together towards a common objective, that is to live

Why MIS?

• Manager makes decisions all the time.

• There is an overload of information.

• All information is not useful.

• Anything which helps manager improve his decision-making will obviously lead to better result.

• MIS is a system, where data is the input, which is processed to provide output in the form of information reports, summaries, etc. Which aid the manager's decision-making process?

Types of Management Information Systems

• **Executive Support Systems ("ESS") -**designed to help senior management make strategic decisions. ESS typically involve lots of data analysis and modeling tools to help strategic decision-making.

• **Decision-support systems ("DSS")-**specifically designed to help management make decisions in situations where there is uncertainty about the possible outcomes of those decisions.

• **Knowledge Management Systems ("KMS")-**to help businesses create and share information. These are typically used in a business where employees create new knowledge and expertise - which can then be shared by other people in the organization to create further commercial opportunities.

• **Transaction Processing Systems ("TPS")-**designed to process routine transactions efficiently and accurately. Managers often use these systems to deal with such tasks as payroll, customer billing and payments to suppliers.

• **Office Automation Systems ("OAS")-**that try to improve the productivity of employees who need to process data and information. Wide range of software systems that exist to improve the productivity of employees working in an office (e.g. Microsoft Office XP) or systems that allow employees to work from home or whilst on the move.

How is a Management Information System Useful in Companies?

• **Planning and Control:** MIS improves the quality of plants by providing relevant information for decision – making. MIS serves as a link between managerial planning and control. It improves the ability of management to evaluate and improve performance.

• **MIS Minimizes Information Overload:** MIS change the larger amount of data into summarized form and therefore, avoids the confusion which may arise when managers are flooded with detailed facts.

• **MIS Encourages Decentralization:** Decentralization of authority is possibly when there is a system for monitoring operations at lower levels. MIS is successfully used for measuring performance and making necessary change in the organizational plans and procedures.

• **Costs:** Invest in a consultant to help define your core requirements that include information for strategic planning and project management. To be useful and successful, a management information system should focus on company products and services, customers, operating costs, marketing opportunities and the company's exposure to risk.

• **MIS brings Coordination:** MIS facilities integration of specialized activities by keeping each department aware of the problem and requirements of other departments. It connects all decision centers in the organization.

• **MIS** assembles, process, stores, retrieves, evaluates and disseminates the information.

Impact of the Management Information System

• With a good **MIS** support, the management of marketing, finance, production and personnel becomes more efficient.

• The MIS begins with the definition of a data entity and its attributes, respectively, designed for information generation in the organisation.

• The MIS calls for a systemisation of the business operations for an effective system design.

• This leads to streamlining of the operations which complicate the system design.

• MIS improves the administration of the business by bringing a discipline in its operations as everybody is required to follow and use systems & procedures.

• This process brings a high degree of professionalism in the business operations.

• Since the goals and objectives of the **MIS** are the products of business goals & objectives, it helps indirectly to pull the entire organisation in one direction towards the corporate goals and objectives by providing the relevant information to the people in the organisation.