RAJEEV INSTITUTE OF TECHNOLOGY
HASSAN-573201

TECHNOLOGY & OPERATION MANAGEMENT

As per VTU S2020 Syllabus/scheme for 3rd Semester

VISION & MISSION OF THE INSTITUTE

Vision:

- To be an academic institution in vibrant social & economic environment, striving continuously for excellence in education, research and technological service to the society

Mission:

1. To achieve academic excellence in engineering and management through dedication to duty, offering state of the art education and faith in human values
2. To create and endure a community of learning among students, develop outstanding professionals with high ethical standards
3. To provide academic ambience conducive to the development, needs and growth of society and the industry

VISION & MISSION OF THE DEPARTMENT

VISION

To become a center of excellence for providing quality and value based management education to nurture business managers with a global outlook and contribute for the growth of society and nation

MISSION

- To impart professional skills through transformational learning of theoretical concepts for real world applicability
- To Facilitate acquaintance of the corporate world through interaction with Industry experts.
- To develop globally acceptable competent professionals with Moral, Ethical and Professional standards to serve society and nation.

PROGRAM SPECIFIC OUTCOMES (PSO's)

PSO1: Comprehend the contemporary features and characteristics of Business Management Science and its administration

P**SO2:** Analyse and interpret the dynamic situations for making Business Management strategies and decisions at the national and global level

PSO3: Handle responsibility with the ethical values for all actions undertaken by them.

PSO4: Adapt and focus on achieving the organisational goal and objectives with complete zeal and commitment.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO1: MBA is a two-year full-time programme, aimed at nurturing and training young minds with contemporary skills of management, adept in handling diverse sectors of the economy.

PEO2: The programme intends to inculcate leadership qualities in individuals to strategically position themselves in all emerging platforms of idea generation, creation of pragmatic knowledge, skills and competency development.

PEO3: The diverse course curriculum enables a high degree of academic flexibility for fostering innovation and creativity. It instills resilience and adaptability in students for facing the challenges of the contemporary business world.

PROGRAM OUTCOMES

PO1: Apply knowledge of management theories and practices to solve business problems.

PO2: Foster analytical and critical thinking abilities for data based decision making.

PO3: Ability to develop value-based leadership.

PO4: Ability to understand, analyse and communicate global, economic, legal and ethical aspects of business.

PO5: Ability to lead themselves and others in the achievement of organizational goals contributing effectively to a team environment.

Technology & Operational Strategy

Course Code	20MBA302	CIE Marks	40
Teaching Hours/Week (L:T:P)	3:0:2	SEE Marks	60
Credits	04	Exam Hours	03

Course Objectives

1. To acquaint the student with the basic management principles with respect to production and operations management.
2. To Familiar the student with different types of Production Systems.
3. To explain the students regarding various techniques used in Operations Management.

Module-1 Introduction to Production and Operation Management (POM) 7 hours

Introduction Operations Management: Meaning, Definition, Scope and Functions. Difference Between Production and Operations Management. Management Guru's and their Contribution. The Roles and Functions

of Operations Manager. Industry 4.0; Productions and Operations Management in Indian Context.

Module -2 Process Management Mapping 9 hours

Process Mapping, Process Flow charts, Ishikawa Diagrams, Fishbone Diagram and Cause and Effect

Relationship, 5M, 8P, and 4S Systems, Theory Z Approach.

Module -3 Lean Manufacturing 9 hours

Concept of Lean Manufacturing; meaning of lean manufacturing; History of Lean Operations, Types of Waste, "5S" Technique of Eliminating the Waste, Lean Operations in the service sector, Role of Leadership, Lean Operations and Just In Time(JIT).

Module -4 Production System 9 hours

Production System: Meaning, Types- Batch and Continuous Production, TPS: Introduction, Overview of Toyota

Production Systems – Focused Areas, Techniques: 5S, JIT, JIDOKA, KANBAN, KAIZEN, POKAYOKE, Toyota Production Systems.

Module -5 Total Quality Management(TQM) 9 Hours

Evolution of quality; Concept, Meaning and Features of TQM, Eight building blocks of TQM; TQM tools. Benchmarking: Concepts, Meaning, Benefits, Elements, Reasons for benchmarking, Process of benchmarking,

FMEA; Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Quality Circles. Total Productive Maintenance (TPM) – Concept and need.

Module-6 Quality Systems 7 Hours

ISO: ISO role; Functions of ISO, Quality System Family Series ISO 9000; ISO 14000; ISO21000. Six Sigma: Features of Six Sigma, Goals of Six Sigma, DMAIC, Six Sigma implementation.

Supply Chain and Operations: Supply Chain "KEIRETSU", Core Competency, Relationship of Operations and Supply Chain; Relationship of Purchasing and Supply Chain; Sources, Service Quality and Supply Chain.

Course Outcomes:

At the end of the course the student will be able to:

1. Acquire the knowledge about the concepts of production and operation management
2. Demonstrate the basic concepts of process mapping
3. Evaluate the importance of Lean Manufacturing
4. Develop strategies of Total quality management
5. Understand the roles of ISO standards and production system

Practical Component:

- Students should understand process management
- Students to visit an organization and study the quality management system
- Students has to understand production system
- Study the role of leader in operation management and prepare a Report
- Students need to understand the practicality of the ISO standards

CO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	X				
CO2	X			X	
CO3	X			X	
CO4	X		X	X	X
CO5	X		X		X

CO-PO MAPPING

Question paper pattern:

The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 60.

- The question paper will have 8 full questions carrying equal marks.
- Each full question is for 20 marks.
- Each full question will have sub question covering all the topics under a Module.
- The students will have to answer five full questions; selecting four full question from question number one to seven and question number eight is compulsory.
- 100 percent theory in the SEE.

Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Production and Operations Management	S. N. Chari.	Mc Graw Hill.	6/e

2	Operations Management Theory and Practical	B. Mahadevan	Pearson.	3/e
3	Operations Management	Jay Heizer Barry Render, Chuck Munson, Amit Sachan	Pearson.	12/e
4	Production and Operations Management	R. Panneerselvam.	PHI	3/e
Reference Books				
1	The Goal: Process of Improvement	Eliyahu M. Goldratt	North River Press	3/e
2	The Toyota Way	Jeffery Liker.		

ONTENTS

Unit 1-Operation management

The primary objective of production and operations management is to effectively manage and utilize those resources of the firm that are essential for the production of goods and services. **Production management** refers to the management of activities related to the production of goods.

On the other hand, **operations management** is a step ahead of production management, or it can be said that the production management is a part of the operations management. Operations Management, as the name suggests is the administration of business operations, by the managers of the organization.

The difference between production and operations management is very thin and blurred, which is simplified in this article in a detailed manner.

Content: Production Management Vs Operation Management

Comparison Chart

BASIS FOR COMPARISON	PRODUCTION MANAGEMENT	OPERATIONS MANAGEMENT
Meaning	Production Management connotes the administration of the range of activities belonging to the creation of products.	Operations Management refers to the part of management concerned with the production and delivery of goods and services.
Decision Making	Related to the aspects of production.	Related to the regular business activities.
Found in	Enterprises where production is undertaken.	Banks, Hospitals, Companies including production companies, Agencies etc.
Objectives	To produce right quality goods in right quantity at right time and at least cost.	To utilize resources, to the extent possible so as to satisfy customer wants.

Key Differences between Production and Operation Management

The difference between production and operation management, are presented hereunder:

roduction Management can be defined as the administration of the set of activities concerning the creation of goods or transformation of raw material into finished goods. Conversely, Operations Management is used to mean that branch of management which deals with the administration both production of goods and provision of services to the customers.

In production management, the manager has to make decisions regarding the design, quality, quantity and cost of the product manufactured by the department. On the contrary, the scope of operations management is larger in comparison to the production management wherein the operations manager looks after the product design, quality, quantity, process design, location, manpower required, storing, maintenance, logistics, inventory management, waste management, etc.

Production Management can only be found in the firms where production of goods is undertaken. Unlike, one can find operations management in every organization, i.e. manufacturing concerns, service-oriented firms, banks, hospitals, agencies, etc.

The basic objective of production management is to provide the right quality goods in the right quantity at right time and best price. In contrast, operations management aims at making the best possible use of organization's resources, in order to fulfil the customer's wants.

Principles of Operations Management

Randall Schaefer, CPIM, described The 10 Principles of Operations Management at his presentation at the 2007 conference of the American Production and Inventory Control Society (APICS).

- Reality: There is no universal solution to the problems in your business.
- Organization: You must organize all aspects of production into a coherent whole.
- Fundamentals: Adhere to fundamentals, such as accurate inventory records.
- Accountability: People try harder when they're held accountable.
- Variance: Variance is part of every process.
- Causality: Problems are often symptoms. Get to the root cause.
- Managed Passion: People with a passion for their jobs will drive your company.
- Humility: You don't have to know everything.
- Success: Define success, and change with the market.
- Change: Every manufacturing solution is temporary.

Another set of operations management principles comes from author Dr. Richard Schonberger. His 16 principles are:

- Team up with customers. Know what they buy and use.
- Engage in continual, rapid improvement.
- Maintain a unified purpose. Involve employees in strategy.
- Know the competition.
- Focus.
- Organize resources.
- Invest in HR.
- Maintain equipment.
- Use the simplest, *best* equipment.
- Minimize human error.
- Cut times. Shorten the product path to the customer.
- Cut setup.
- Pull the system. Improve the workflow and cut the waste by producing on demand.
- Employ total quality control.
- Fix root causes.
- Manage visibility. Let the market know about your achievement.

FUNCTIONS OF OPERATIONS MANAGER

Finance- Finance plays a main function in operations management. The operation manager should not waste finance in unproductive tasks. He should ensure that all finance of the organization is utilized for the manufacturing of useful goods or services which may satisfy consumer wants.

Operation– The function of operation management is basically concerned with planning, organizing, directing and controlling of daily routine operations of an organization. The operation manager ensures that all activities are going effectively and efficiently.

Strategy– The strategy formulation is also the main function of operation management. The operation manager should have pre-planned tasks. Formulation of plans and tactics helps the organization in optimizing their resources and developing a competitive edge over competitors.

Product Design– It is the duty of operations manager to design the product according to the market trends and demands. He should ensure that innovative techniques are incorporated within the product and its quality is maintained.

Maintaining Quality– Operations managers should ensure a better quality of products. The manager should not compromise with the quality of Products. They should work on quality management and should supervise all tasks. If any defects are found they should take steps to rectify such defects.

IMPORTANCE OF OPERATIONS MANAGEMENT

Helps in achievement of objectives: Operations management has an effective role in the achievement of pre-determined objectives of an organization. It ensures that all activities are going as per plans by continuously monitoring all operations of organization.

Improves Employee productivity: Operation management improves the productivity of employees. It checks and measures the performance of all people working in the organization. Operation manager trains and educate their employees for better performance.

Enhance Goodwill: Operation management helps in improving the goodwill and presence of the organization. It ensures that quality products are delivered to all customers that could provide them better satisfaction and makes them happy.

Optimum utilization of resources: Operation management focuses on optimum utilization of all resources of the organization. It frames proper strategies and accordingly continues all operations of the organization. Operation managers keep a check on all activities and ensure that all resources are utilized on only useful means and are not wasted.

Motivates Employees: Operation management helps in motivating the employees towards their roles. Operation managers guide all peoples in performing their roles and provide them with better atmosphere. Employees are remunerated and rewarded according to their performance level.

SCOPE OF OPERATIONS MANAGEMENT

Increase Productivity: Operation management played an important role in increasing the productivity of business. It manages all aspects of production activities to achieve highest efficiency possible. Operation manager are responsible for designing production plan for carrying out the operations. They ensure that all inputs used by organisations are efficiently transformed into outputs that is products or services. It is crucial for all business for properly managing their day to day activities and efficient utilisation of all its resources which helps in raising productivity.

Raises Revenue: Operational management directly influences the profitability of the business. It works on reducing the cost of operations to business by reducing the wastage of resources. Operations managers monitor every production activity and take all necessary steps for

maintaining efficiency in the organisation. They try to maintain an appropriate balance between cost and revenue. Maintenance of quality of products and delivering them as per customer needs is another function played by these operation managers. It helps in attracting more and more customers which increase the overall revenue of business.

Achievement Of Organisation Goals: Every organisation strives towards achievement of its desired goals. Proper management of production activities helps business to properly implement their strategic plans in their operation. Operation management ensures that all operations of business are going in desired direction. It regularly monitors every activity and takes all corrective measures as required according to prevailing situations. Proper functioning of business as per strategic plans helps in achievement of desired goals.

Improve Customer Satisfaction: Customer satisfaction is necessary for every business to improving its relations with its customers. It helps them in retaining them for the long term. Operation management monitors the quality of products manufactured by organisations. It ensures that high-quality products are produced in accordance with the requirements of customers. When products manufactured by business completely fulfil the needs of customers, their satisfaction level will improve.

Reduce Investment Need: Operation management reduces the additional capital requirements of the business. It ensures that all capital employed in the business are efficiently used. Management of operations ensures that all production activities go uninterrupted without any shortage of capital. By increasing the efficiency and avoiding the wastage of employed resources, it avoids any deficiency of capital in business. Businesses are not required to invest more in their production activities.

Enhance Goodwill: Maintaining proper goodwill in the market is the goal of every business. Operation management focuses on improving the position of the organisation in the market. It ensures that business works for providing better services to its customers. Business should manufacture durable and high-quality products that may provide better satisfaction to users. Customers will gain confidence in their products which will improve their market image.

Improve Innovation: Operation management helps in implementing innovative changes in organisational activities. All decision regarding production planning is taken by operation managers by doing research and analysis of prevailing market situations. It takes into account all technological changes and builds a strong base of knowledge and operations. This helps in bringing various innovations in operations of the business.

Industry 4.0

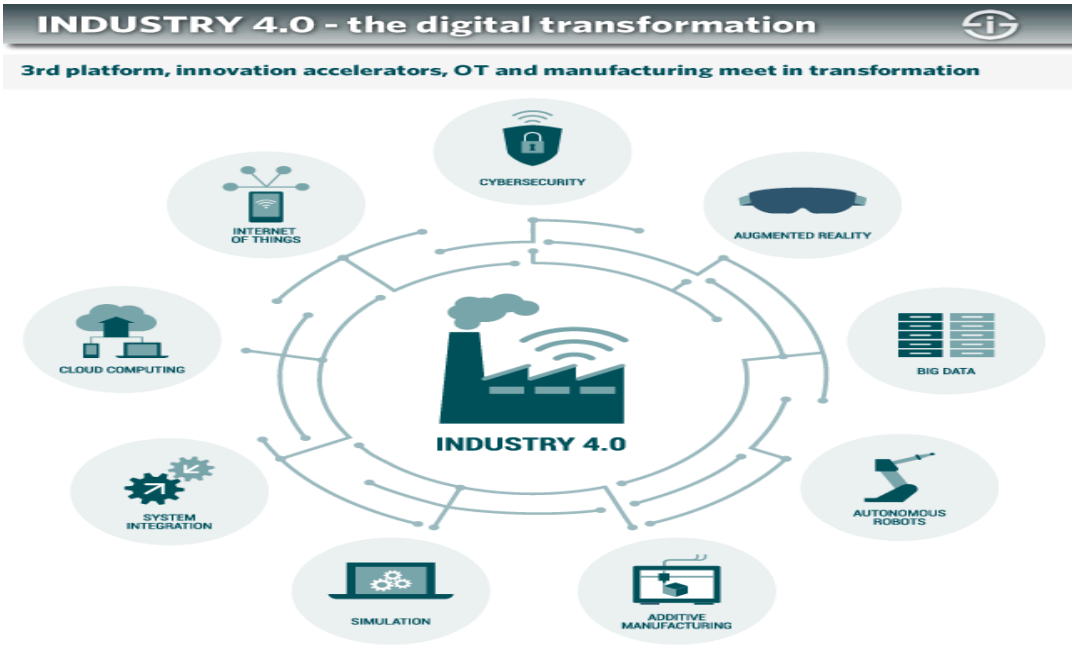
Industry 4.0 is the digital transformation of manufacturing/production and related industries and value creation processes.

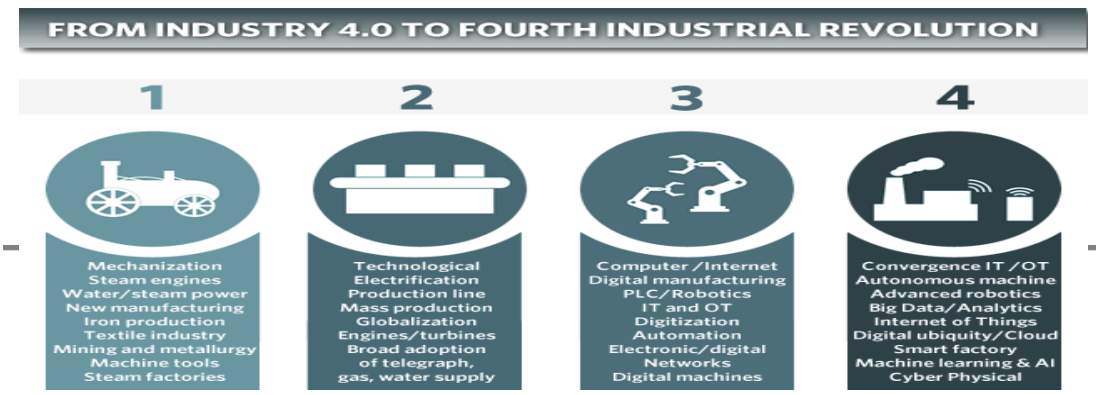
Industry 4.0 is used interchangeably with the fourth industrial revolution and represents a new stage in the organization and control of the industrial value chain.

The original definition of Industry 4.0

The definition of Industrie 4.0 as proposed in 2011 was pretty lengthy. In a paper, entitled "Industrie 4.0 – Smart manufacturing for the Future", GTAI *(Germany Trade and Invest)* **looked at the questions what is smart industry** *(a synonym of Industry 4.0)* **and what Industrie 4.0 means.**

An extract: Smart industry or "INDUSTRIE 4.0" refers to the technological evolution from embedded systems to cyber-physical systems…INDUSTRIE 4.0 represents the coming fourth industrial revolution on the way to an Internet of Things, Data and Services. Decentralized intelligence helps create intelligent object networking and independent process management, with the interaction of the real and virtual worlds representing a crucial new aspect of the manufacturing and production process".





The goal is to enable autonomous decision-making processes, monitor assets and processes in real-time, and enable equally real-time connected value creation networks through early involvement of stakeholders, and vertical and horizontal integration.

Industry 4.0 is a vision, policy, and concept in motion, with reference architectures, standardization and even definitions in flux.

The fourth industrial revolution and the impact of the drivers and technologies behind Industry 4.0 have been looked at from the perspective of various sectors after the concept was launched. This has led to more '4.0' terms, often based on academic work. Examples include Logistics 4.0 *(logistics and transportation)*, Construction 4.0 *(construction industry)*, Energy 4.0 *(energy and utilities industry)*, and more.

Most Industry 4.0 initiatives are early-stage projects with a limited scope. The majority of digitization and digitalization efforts, in reality, happen in the context of third and even second industrial revolution technologies/goals.

In essence, the technologies making Industry 4.0 possible leverage existing data and ample additional data sources, including data from connected assets to gain efficiencies on multiple levels, transform existing manufacturing processes, create end-to-end information streams across the value chain and realize new services and business models.

What's the Difference Between Industry 4.0, Digital Transformation, and Smart Manufacturing?

As already mentioned, there isn't an agreed-upon formal definition for Industry 4.0. The same goes for digital transformation and smart manufacturing. Many organizations and standards bodies have been working on attempting to define this new space, not yet with any luck. Joint Working Group 21 between IEC and ISO standards is probably the furthest along, and they still have arguably years to go. Currently, they have chosen to focus on the phrase "smart manufacturing" as a way of taking a piece of Industry 4.0 and narrowing the focus. So far, their current definition (still in draft stage) for smart manufacturing is, "Manufacturing that improves its performance aspects with integrated and intelligent use of processes and resources in cyber, physical, and human spheres to create and deliver products and services, which also collaborates with other domains within enterprises' value chains."

The National Institute of Standards and Technology (NIST), as another example, defines smart manufacturing systems as "fully-integrated, collaborative manufacturing systems that respond in real time to meet changing demands and conditions in the factory, in the supply network, and in the customer needs."

There are countless other groups attempting to define these concepts and put their stake in the ground with a specific term. At the International Society of Automation

(ISA), we recognize that these terms and their associated concepts are evolving and will continue to change. Thus, we have decided (for now) to focus on the concept of "smart manufacturing" and think of it as an ecosystem which enables factories, warehouses, supply chains, and so on to be fully integrated and agile to fulfill customer demand for product or service delivery. Although arguments can be made to differentiate between other big buzzwords like "Industry 4.0" and "digital transformation," they are often used interchangeably.

Regardless of the semantics, these concepts boil down to collecting and harnessing a tremendous amount of data to make better decisions, telling business leaders what to do and when to do it. The goal of most Smart Manufacturing initiatives, therefore, are to identify opportunities for automating operations and use data analytics to drive better agility, increase efficiency,, improve quality, and reduce a company's time-to- market. What makes all this possible is the collective application of different cutting- edge technologies that make manufacturing more connected, more intelligent, and more dynamic.

Table 1: Industry 1.0 to 4.0

Industry Revolution	Period	Features
Industry 1.0	1760-1840	Water and steam powered mechanical manufacturing
Industry 2.0	1870-1914	• Mass production using electricity • Assembly line – division of labor
Industry 3.0	20th century	Digital Revolution – Extensive use of Computers
Industry 4.0	21st century	Virtual System, Cyber world, Internet of Things, Artificial Intelligence

BUILDING BLOCKS OF INDUSTRY 4.0 are:

1. Internet of Things (IoT): establishes a connected value chain by networking machine to machines.

2. Cloud Computing: provides huge storage, networking and computational capabilities enabling interaction between technologies.

3. Big Data and data analytics: creates capabilities to support intelligent and real-time

decision-making, and reducing the downtime and wastage.

4. Additive Manufacturing or 3D Printing: Reduces lead time from product design to release, permitting customization, and small batch production in a cost effective manner.

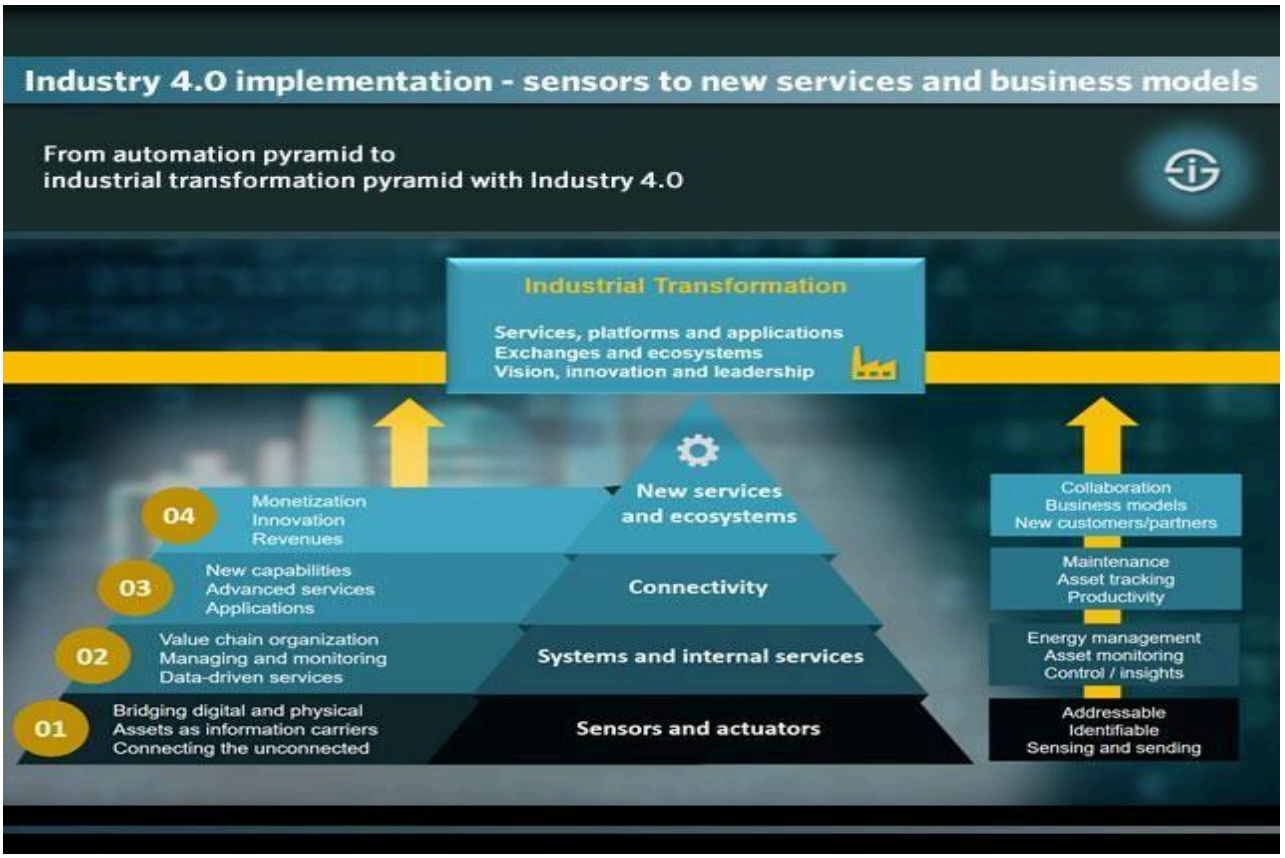
5. Augmented Reality: Uses mathematical modelling, artificial intelligence and virtual reality to enhance business generation.

6. Robotics: Improves efficiency through automated manufacturing processes.

7. Cyber security: ensures secured communication protocols enabling data security.

8. Machine Learning: exploits industrial sensors and instruments to record and communicate data directly with software.

9. Simulation: the imitation of the operation of a real-world process, which would help to visualize the design and identify the problems that might occur in a much earlier stage.



A key role is indeed played by the Internet of Things or IoT, in the scope of Industry 4.0 Industrial IoT with its many IoT stack components, from IoT platforms to Industrial IoT gateways, devices and much more.

Yet, it's not just IoT of course: cloud computing (and cloud platforms), big data (advanced data analytics, data lakes, edge intelligence) with (related) artificial intelligence, data analysis, storage and compute power at the edge of networks (edge computing), mobile, data communication/network technologies, changes on the level of, among others, HMI and SCADA, manufacturing execution systems (MES), enterprise resource planning (ERP, becoming i-ERP), programmable logic controllers (PLC), sensors and actuators, MEMS and transducers (sensors again) and innovative data exchange models all play a key role.

Additionally, the same technologies, such as Robotic Process Automation (RPA), AI (AI engines, machine learning), the meeting of both and so forth that pop up in close to all software areas such as enterprise information management, business process management and applications in the sourcing market are of course showing in IoT- enabled industrial/manufacturing applications and IoT manufacturing platforms as well.

Industry 4.0 is not 'something' you realize overnight. Just as is the case with IoT deployments you need a strategic and staged approach.

This is exactly the same as with digital transformation strategy and gets covered in depth when we look at Industry 4.0 strategy and implementation and at the state of Industry 4.0 and maturity of organizations as they move from initial stages and pilots to more innovative approaches on top of the traditional low-hanging fruit in terms of optimization and automation. If you are in a hurry, there is a chapter on Industry 4.0 maturity models and roadmaps.

Data and optimization across the value chain

As you will discover in this guide Industry 4.0 is conceived as the next stage of organization and control in the full life cycle of the product value chain.

The cyber-physical systems are the basis and enable new capabilities in areas such as product design, prototyping and development, remote control, services and diagnosis, condition monitoring, proactive and predictive maintenance, track and trace, structural health and systems health monitoring, planning, innovation capability, agility, real-time applications and more.

These latter capabilities also lead to the types of use cases and deployments as well as the benefits of industry 4.0 which we cover later and include personalization capabilities, real-time alerts and interventions, innovative service models, dynamic product improvement, increased productivity, higher up-time and, ultimately, new business models.

The new capabilities of Industry 4.0 lead to the 'smart anything' phenomena which often get most attention: from smart grid, smart energy and smart logistics to smart facilities, including smart buildings, smart plants, and smart offices to the mentioned smart manufacturing, smart

factories, smart cities and so on.

Challenges of Industry 4.0 are:

1. Huge investment - With the emergence of Industry 4.0, industry's functioning has become more processdriven, which demands for large investment for smooth digital transition and transformation . In addition, in training the existing workforce.

2. Need to consider new business models -With Industry 4.0, companies are in a new industrial paradigm wherein there is a need to transform the way we interact with the customers, understand business cases, changing operations for manufacturers and how customers receive and engage with products.

3. . Resistance to change - There is need to examine the company culture and enhance the flexibility in adopting the change for the good. There is lack of courage to launch the radical digitalization plan.

4. Reorganizing the processes- For Industry 4.0, there is a need to automate and integrate horizontal andvertical value chains. Therefore, it is essential to understand where there is a need for action [14]. In addition, it is required to conduct pilot study to leverage better outcomes.

5. Workforce- Current technological trends are bringing about the change at an unprecedented rate and there is a lack of inhouse talent to meet those changes. To improve quality and efficiency it is essential to develop and train the existing employees as the skill sets, they possess are getting obsolete. New categories of jobs will emerge and there is a need to hire new breed of techsavvy employees. According to the 2018 Global Trends report released by World Economic Forum, 76% of recruiters and hiring managers think that Industry 4.0 will have a significant impact on the recruitment industry.

6. Standardization - The world is undergoing a digital transition phase that will enter and change all areas of industry. Industries require norms and standards to ensure that the individual components are compatible and interoperable.

7. Data Management - Industries are generating a lot of real-time production and quality data. There is a need to make data readily available and accessible.

8. Competition- Increasing competition is driving an integration between the customer and manufacturer at various stages of product.

9. Data security - Industry 4.0 deals with large amount of data. To achieve the true potential of Industry 4.0 security is a major concern. It is essential to implement end- to-end

encryption to avoid vulnerability, phishing and various other attacks.

UNIT 2

Process

Management

Mapping

The process map is a tool that graphically shows the inputs, actions and outputs of a process in a clear, step-by-step map of the process. This is tollgate # 3 of Define in the DMAIC. The purpose of process mapping is to help team members and others within the process to understand the process.

What is Process Mapping?

Process mapping is the graphical representation with illustrative descriptions of how things get done. It helps the participants to visualize the details of the process closely and guides decision making. One can identify the major areas of strengths and weaknesses in the existing process, such that the contribution of individual steps in the process. Further, it helps to reduce the cycle times and defects in the process and enhances its productivity.

The major components of a process map include the inputs, outputs and the steps in the process. A good process map should illustrate the flow of the work and the interaction with the organization. It should make use of common language (symbols) that are easily understood by everyone. An ideal process map should contain proper detail with respect to multiple paths, decisions and rework loops.

Why do businesses need process maps?

Process mapping provides the visual glimpse of different processes of the business. **It provides the necessary information and helps to determine the Who, What, Where, Why, When and How aspects of the process and problem, and even guides towards possible solutions**. Some of the reasons for the need of a process map are:

- **Pictures guide better than words**. The use of graphs, charts, tables and images guides

better than a big compiled report with lot of data fixation issues in it.

- **Process maps facilitate improvements in the process**, since it becomes easy to pin point the specific areas that need changes, like bottlenecks, delays, capacity constraints etc. in the light of efficiency and effectiveness of the process.
- **Decision making becomes fast** as it deals with the 'show me' aspect and not the 'tell me' aspect of the process and the problem areas.
- **The improvements made in the process can easily be tracked** using process maps since it becomes possible to audit and understand different areas in the process as well as the organization.
- **Visual illustration for training would be much more effective** than any oral tools. The visual examples register faster in human brains and help them understand the things better and fast.
- In the need of change, when the organization moves on making the changes without understanding the current working process, it is likely to commit more mistakes or deploy its resources in creating more troubles. Process maps provide a **detailed outlook of the current process and guides the effective management of change.**
- Process maps **serves as a measurement tool for a process** that is very much necessary to manage and finally improve it.

How to Start Process Mapping

Before beginning the process mapping, you must have clearly established boundaries to make sure the scope of the flowchart that will be created will be manageable. The boundaries must be established first so the team knows what tasks, activities and decisions should be included in the flowchart.

Steps to follow

Business managers can develop an effective process map that facilitates continuous improvement in the business processes by following some simple steps. The steps for developing the process map are identified as under:

Step 1: Select the process

Firstly, the managers must identify the reason for creating the process map. Is it that the process is not performing up to its mark? Or firm wish to plan a new service? Or the goal is to augment the value derived from the process?

Secondly, the beginning should be identified, that is the events that create the demand for the process map and trigger behind the process.

Thirdly, the end needs to be uniquely defined, that is what parameters or conditions will finally satisfy the demand.

Lastly, the business managers must develop a document containing information about details of the specific process, business problem, shareholders expectation, business objectives and scope of the process.

Step 2: Identify the scope of the process steps

The business managers must observe the entire process and collect data and information. The observed process and collected data must then be properly

documented. It is also essential to identify all the parameters that are involved in the process like the machinery, suppliers, etc. it is also vital to identify and verify the inputs involved and outputs of the process. This can be done through effective brainstorming, industry standards, work instructions and experience of the operators and managers.

Step 3: Plan and schedule resources

Identify the systems that are involved in the process. It is necessary that the mindset of the managers should be shifted from functional to process- oriented while designing the process map and this can be done by focusing on the roles and not the jobs. Based on the systems and roles, proper scheduling of the people involved, task involved and estimated time needs to be done.

Step 4: Select Mapping techniques

The next step is to select the mapping technique, like process flowchart or deployment flowchart. Next would be to plan the process interviews with individuals as well as focused groups. It is also advised to review any previous documented process map to understand previous mapping efforts, organizational charts and job descriptions.

Step 5: Conducting interviews

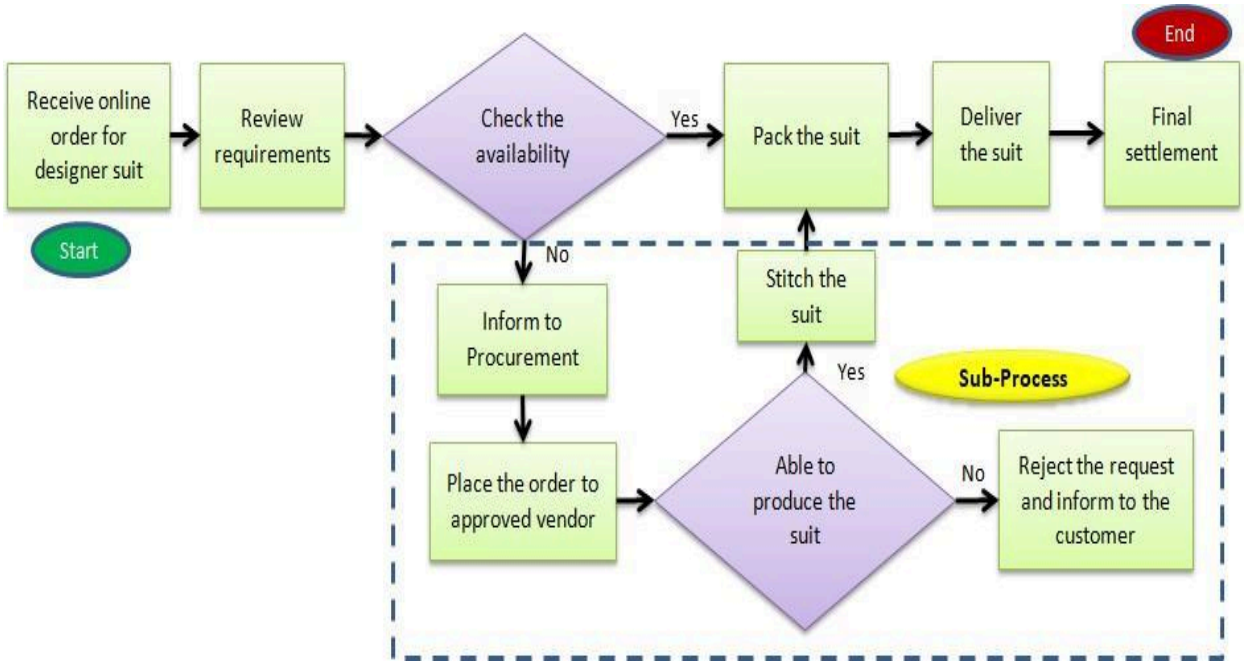
Now it is time to conduct the interviews! Plan and conduct the interviews in the sequence of roles established in the process map. Explain the purpose, objective and scope of the interviews as well as the process maps to the participants in order to reap effective results. While conducting the interviews, it is vital to identify and establish the input tasks, roles, output tasks, decisions, task performed and linkage to other processes. During this step, every task and decision are uniquely identified.

Step 6: As-Is process

Describe the activities that help to transform inputs to outputs. It is time to map the actual process without considering the ideal 'should be process' or as per 'standard operating procedures (SOP)'. Some of the points that need to be considered are the major activities of the process, decisions and source of approvals of one step before moving to the next one, areas where multiple methods occur, causes of bottlenecks, extra works and wastes and factors that obstruct process members from performing effectively and efficiently. Carefully list and match all the steps of the process with their respective roles. Assign correct flowchart symbols and review process map for proper flow.

Step 7: Analyze, evaluate and Sign- off

Review the process steps thoroughly to learn any redundancies, delays, unnecessary steps, ambiguous roles, cycle time, activity lapse, repeated activity flows, bottlenecks and rework loops. Next is to evaluate the performance of the process. One can make use of the tools to measure the same using Pareto Charts, Cause and Effect diagram, process behavior charts and process modeling and simulation. Finally, complete the process improvement plan and after a final review by all the stakeholders, it should be signed off.



Things to remember to develop better process mapping:

By following some set of guidelines, the practitioners and business managers can develop effective process mapping. Some of the things that one must remember are:

- **Improvement objectives must be clear and continuous**
- **Use the process mapping only where appropriate**
- **Employ process architecture to develop process maps**
- **Study the impact of organizational structures**
- **Clearly identify multiple responsibilities and tasks**

What is a Process Flowchart?

A process flowchart is a diagram that shows the sequential steps of a process and the decisions needed to make the process work. Within the chart/visual representation, every step is indicated by a shape. These shapes are connected by lines and arrows to show the movement and direction of the process.

Process flowcharts are standardized such that anyone who has an understanding of flowcharts can look at one and know what is happening. They follow the logical flow of information so that business stakeholders have a guide as to how to fulfil processes properly.

One of the best things about process flowcharts is how easy they are to create! You can either

draw a flowchart by hand or leverage easy-to-use, powerful software tools to develop your process flowchart.

Flowchart Symbols

For flowcharts to work universally there is the standardized notation of many shapes and symbols. Use this abbreviated list as a reference when getting started on creating your flowchart:

Shape	Meaning
Rectangle	Represents a process
Oval/Pill	Represents start or end
Diamond	Represents a decision
Parallelogram	Represents an input or output

Why are Process Flowcharts Beneficial?

A process flowchart can help your business in many ways. The purpose of creating one will aid you in:

- **Standardisation:** Stakeholders will know how to achieve intended business goals by following the process

- **Process improvement:** When you depict a process, you can pinpoint missing steps, bottlenecks or unnecessary steps to apply process improvement. Data automation tools are a great way to improve processes in this way. It can find and remove weaknesses in processes,

  by mapping out the process on the system, making tasks clearly defined removing critical staff dependency and improving compliance.
- **Defined operating procedures:** Flowcharts help achieve better quality control, training and employee understanding.

When Should I Use a Flowchart?

How do you know when it is right to use a flowchart? You can incorporate process flowcharts for a variety of reasons, including:

- To review a process with the goal of improvement.

- To document a process.
- To plan a new project.
- To better communicate across your organisation, how something is to be done.
- To train new employees on processes.
- To introduce and explain new processes to existing employees.

How to Create and Use a Flowchart

Now that we've covered the basics of flowcharts let's get into the fun. Follow these steps to create your process flowcharts.

First, ask yourself "Do I need a flowchart for this?" If you aim to define and detail each step of a process, then the answer is yes. If your main goal is to deeply analyze how a process is operating to determine optimal efficiency, later you should try other methods like a SIPOC diagram, perhaps.

Once you've determined that a flowchart is a right tool for the job, continue with these steps:

1. **Identify tasks:** The process may seem straightforward from a broad perspective. But, if you're not the one in the weeds, then rely on the team that is to help you outline the steps and tasks with you.

2. **Compile the necessary information:** You should know the *exact steps*, the *variables and events* that may cause the process to deviate, and also *who is responsible* for each step along the way.

3. **Double-check the process:** Gather critical stakeholders to review this outline of events to ensure the information is accurate.

4. **Create the flowchart:** Now, it's time to get to drawing! You can use the basic symbols mentioned above or go into more detail with BPMN, or Business Process Modeling and Notation.

As previously mentioned, you have options as to how to create your process flowchart. You can choose from:

Drawing by hand - you'll need a pen and paper.

Online software - use graphing software to make a flowchart digital

Business process management software - create digital flowcharts that can then go a step further and be analysed or even executed by the system.

The **Fishbone Diagram** is also known as the **Cause and Effect Diagram**, **C&E Diagram, or the Ishikawa Diagram, named after its inventor Kauoru Ishikawa**, organizational theorist and engineering Professor at The University of Tokyo. It is used to first brainstorm the potential causes of a problem, then narrow potential causes to find the root cause and move on to a solution.

It's called a Fishbone Diagram, because it looks like a **fish skeleton** with the symptom, or effect of the cause, as the head and potential causes branching out from the spine. Each branch is a category.

For each category, brainstorm specific things that could be causing the effect, or symptom (i.e. how the problem is showing up on the manufacturing floor). Once you've added enough data to be helpful, dive into evaluating each one with a series of questions – Why's. This helps you narrow the possibilities to a list of most likely causes and test from there. Eventually, you'll come up with the root cause. Along the way, you may also discover other issues or causes for other effects.

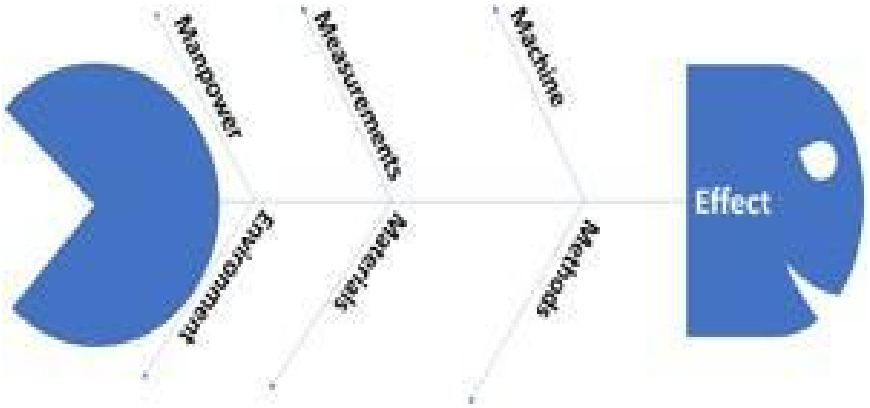
Resources to build a Fishbone Diagram

There are the variations that can tailor the cause and effect diagram to your specific situation. ASQ also offers a Fishbone Diagram builder to make the setup process easier. Scroll to the bottom of that page to download the Excel template. Minitab and Visio are also good options. Canva, a free graphic design platform, will also help you make a Fishbone Diagram in exchange for your email address.

Existing types of Fishbone Diagrams

5M/1E (Standard Manufacturing) Fishbone Diagram

Most of the time, manufacturing teams will use these six categories in their Fishbone Diagrams: Machine, Methods, Measurements, Materials, Manpower, and Environment. It covers all the major aspects we come across in a manufacturing setting.



Here are a few more you may find helpful.

Manpower:

Was the document properly interpreted?
Was the information properly disseminated?
Did the recipient understand the information?
Was the proper training to perform the task administered to the person?
Was too much judgment required to perform the task?
Were guidelines for judgment available?
Did the environment influence the actions of the individual?
Are there distractions in the workplace?
Is fatigue a mitigating factor?
How much experience does the individual have in performing this task?

Second: Machine:

Was the correct tool used?
Is the equipment affected by the environment?
Is the equipment being properly maintained (i.e., daily/weekly/monthly preventative maintenance schedule)
Was the machine properly programmed?
Is the tooling adequate for the job?

Does the machine have an adequate guard?
Was the tooling used within its capabilities and limitations?

Third: Measurement:

Does the gage have a valid calibration date?
Was the proper gage used to measure the part, process, chemical, compound, etc.?
Was a gage capability study ever performed?
Do measurements vary significantly from operator to operator?
Do operators have a tough time using the prescribed gage?
Is the gage adequate?
Does the gage have proper measurement resolution?
Did the environment influence the measurements taken?

Fourth: Material:

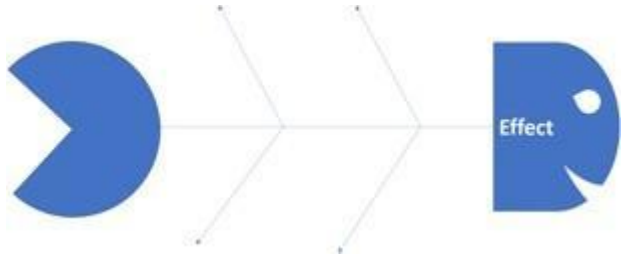
Is a Material Safety Data Sheet (MSDS) readily available?
Was the material properly tested?
Was the material substituted?
Is the supplier's process defined and controlled?
Were quality requirements adequate for part function?
Was the material contaminated?
Was the material handled properly (stored, dispensed, used & disposed)?

Fifth: Method:

Was the canister, barrel, etc. labeled properly?
Were the workers trained properly in the procedure?
Was the testing performed statistically significant?
Have I tested for true root cause data?
How many "if necessary" and "approximately" phrases are found in this process?
Was this a process generated by an Integrated Product Development (IPD) Team?
Was the IPD Team properly represented?
Did the IPD Team employ Design for Environmental (DFE) principles?
Has a capability study ever been performed for this process?

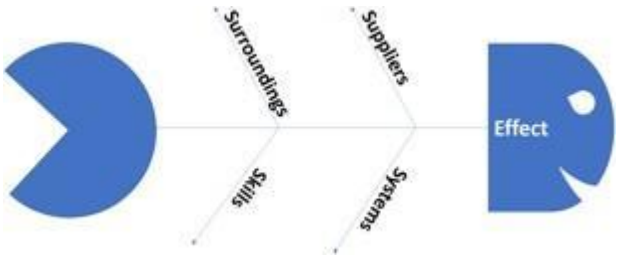
Simple Fishbone Diagram:

This version doesn't have any predetermined categories, so it is the most flexible. Rather than starting with the method, materials, etc. the team starts by thinking of their own categories. It leaves everything open to be specific to the topic at hand. That means any team could use it for any reason.



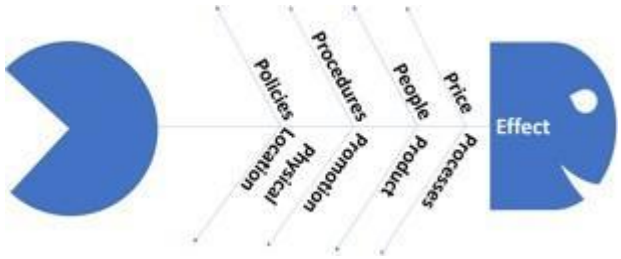
The 4S Fishbone Diagram

This is often used in a service organization and include categories like systems, surroundings (like environment or mother nature in other versions), skills (people), suppliers. It could also be helpful in the internal services in a manufacturing plant, which can be especially helpful if your goal is to include the entire facility in using the Fishbone Diagram as a problem-solving tool.



8P Fishbone Diagram

As you might imagine based on other Lean Manufacturing tools, the 8P Fishbone Diagram got its name from its eight categories and they all begin with "P:" Price, processes, people, product, procedures, promotion, policies, physical location or place. This is also popular in administrative functions and the service industry.



8P Method Used in Problem Solving

Generally speaking, the causes of a certain problem can be classified into some groups according to their common natures. The service industry typically needs workplace and workforce to produce product (service). Based on this industry's common features, a problem's reasons can be grouped as 8Ps: Physical Evidence, Personnel, Place, Product (Service), Price, Promotion, Process, and Productivity & quality. Here is a general template. The 8Ps will be further explained one by one so that the problem can be understood deeply. Such explanations are primary causes of the diagram.

Theory Z is an approach to management based upon a combination of American and Japanese management philosophies and characterized by, among other things, long-term job security, consensual decision making, slow evaluation and promotion procedures, and individual responsibility within a group context. Proponents of Theory Z suggest that it leads to improvements in organizational performance. The following sections highlight the development of Theory Z, Theory Z as an approach to management including each of the characteristics noted above, and an evaluation of Theory Z. Realizing the historical context in which Theory Z emerged is helpful in understanding its underlying principles. The following section provides this context.

DEVELOPMENT OF THEORY Z

Theory Z has been called a sociological description of the humanistic organizations advocated by management pioneers such as Elton Mayo, Chris Argyris, Rensis Likert, and Douglas McGregor. In fact, the descriptive phrase, "Theory Z." can be traced to the work of Douglas McGregor in the 1950s and 1960s. McGregor, a psychologist and college president, identified a negative set of assumptions about human nature, which he called Theory X. He asserted that these assumptions limited the potential for growth of many employees.

McGregor presented an alternative set of assumptions that he called Theory Y and were **more positive about human nature as it relates to employees**. In McGregor's view, managers who adopted Theory Y beliefs would exhibit different, more humanistic, and ultimately more effective management styles.

McGregor's work was read widely, and Theory Y became a well-known prescription for improving management practices.

But in the 1970s and 1980s, many United States industries lost market share to international competitors, particularly Japanese companies. Concerns about the competitiveness of U. S. companies led some to examine Japanese management practices for clues to the success

enjoyed by many of their industries. This led to many articles and books purporting to explain the success of Japanese companies. It was in this atmosphere that Theory Z was introduced into the management lexicon.

Theory Z was first identified as a unique management approach by William Ouchi. Ouchi contrasted American types of organizations (Type A) that were rooted in the United States' tradition of individualism with Japanese organizations (Type J) that drew upon the Japanese heritage of collectivism. He argued that an emerging management philosophy, which came to be called Theory Z, would allow organizations to enjoy many of the advantages of both systems. Ouchi presented his ideas fully in the 1981 book, Theory Z: How American Companies Can Meet the Japanese Challenge. This book was among the best-selling management books of the 1980s.

Professor Ouchi advocated a modified American approach to management that would capitalize on the best characteristics of Japanese organizations while retaining aspects of management that are deeply rooted in U.S. traditions of individualism. Ouchi cited several companies as examples of Type Z organizations and proposed that a Theory Z management approach could lead to greater employee job satisfaction, lower rates of absenteeism and turnover, higher quality products, and better overall financial performance for U.S. firms adapting Theory Z management practices. The next section discusses Ouchi's suggestions for forging Theory Z within traditional American organizations.

THEORY Z AS AN APPROACH TO MANAGEMENT

Theory Z represents a humanistic approach to management. Although it is based on Japanese management principles, it is not a pure form of Japanese management. Instead, Theory Z is a hybrid management approach combining Japanese management philosophies with U.S. culture. In addition, Theory Z breaks away from McGregor's Theory Y. Theory Y is a largely psychological perspective focusing on individual dyads of employer-employee relationships while Theory Z changes the level of analysis to the entire organization.

According to Professor Ouchi, Theory Z organizations exhibit a strong, homogeneous set of cultural values that are similar to clan cultures. The clan culture is characterized by homogeneity of values, beliefs, and objectives. Clan cultures emphasize complete socialization of members to achieve congruence of

individual and group goals. Although Theory Z organizations exhibit characteristics of clan cultures, they retain some elements of bureaucratic hierarchies, such as formal authority relationships, performance evaluation, and some work specialization. Proponents of Theory Z suggest that the common cultural values should promote greater organizational commitment among employees. The primary features of Theory Z are summarized in the paragraphs that follow.

LONG-TERM EMPLOYMENT

Traditional U.S. organizations are plagued with short-term commitments by employees, but employers using more traditional management perspective may inadvertently encourage this by treating employees simply as replaceable cogs in the profit-making machinery. In the United States, employment at will, which essentially means the employer or the employee can terminate the employment relationship at any time, has been among the dominant forms of employment relationships. Conversely, Type J organizations generally make life-long commitments to their employees and expect loyalty in return, but Type J organizations set the conditions to encourage this. This promotes stability in the organization and job security among employees.

CONSENSUAL DECISION MAKING

The Type Z organization emphasizes communication, collaboration, and consensus in decision making. This marks a contrast from the traditional Type A organization that emphasizes individual decision-making.

INDIVIDUAL RESPONSIBILITY

Type A organizations emphasize individual accountability and performance appraisal. Traditionally, performance measures in Type J companies have been oriented to the group. Thus, Type Z organizations retain the emphasis on individual contributions that are characteristic of most American firms by recognizing individual achievements, albeit within the context of the wider group.

SLOW EVALUATION AND PROMOTION

The Type A organization has generally been characterized by short-term evaluations of performance and rapid promotion of high achievers. The Type J organization, conversely, adopts the Japanese model of slow evaluation and promotion.

INFORMAL CONTROL

WITH FORMALIZED MEASURES

The Type Z organization relies on informal methods of control, but does measure performance through formal mechanisms. This is an attempt to combine elements of both the Type A and Type J organizations.

MODERATELY SPECIALIZED CAREER PATH

Type A organizations have generally had quite specialized career paths, with employees avoiding jumps from functional area to another. Conversely, the Type J organization has generally had quite non-specialized career paths. The Type Z organization adopts a middle-of-the-road posture, with career paths that are less specialized than the traditional U.S. model but more specialized than the traditional Japanese model.

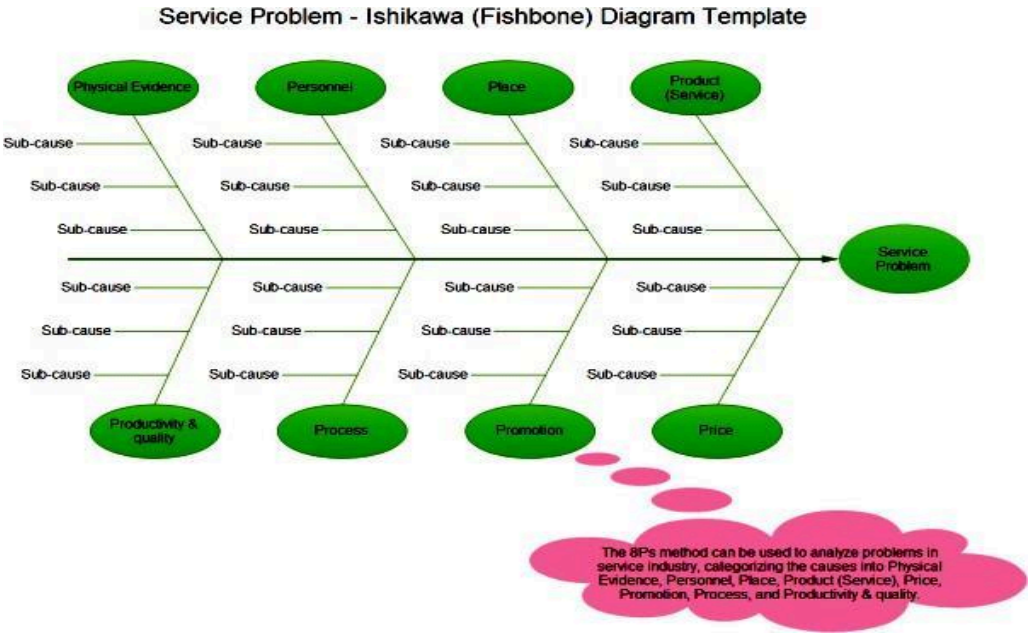
HOLISTIC CONCERN

The Type Z organization is characterized by concern for employees that goes beyond the workplace. This philosophy is more consistent with the Japanese model than the U.S. model.

EVALUATION OF THEORY Z

Research into whether Theory Z organizations outperform others has yielded mixed results. Some studies suggest that Type Z organizations achieve benefits both in terms of employee satisfaction, motivation, and commitment as well as in terms of financial performance. Other studies conclude that Type Z organizations do not outperform other organizations.

Difficulties in the Japanese economy in the 1990s led some researchers to suggest that the widespread admiration of Japanese management practices in the 1970s and 1980s might have been misplaced. As a result, Theory Z has also received considerable criticism. It is unclear whether Theory Z will have a lasting impact on management practices in the U. S. and around the world into the twenty-first century, but by positioning target research at the organizational level rather then the individual level, Ouchi will surely leave his mark on management practice for years to come.



Tips on leading a brainstorm:

One of the most critical parts of using the Fishbone Diagram is your team's ability to brainstorm. To help you get that started on the right foot, here are a few tips you might find helpful.

Give people multiple ways to contribute, such as sticky notes on a board or brainstorming in small groups first.

Give people time to prepare before they arrive. Think of it as priming their minds.

Stick the "no idea is a bad idea" mantra. All it takes is one idea getting shot down to discourage others from contributing an idea they aren't 100% certain about.

Invite the right people to the brainstorm and don't be afraid to think outside of the regular team.

MODULE 3 - LEAN MANUFACTURING

Lean operations management is a process that focuses on minimizing waste and maximizing value within an organization. In other words, it is a continuous improvement methodology that is designed to help organizations improve their performance by reducing waste and increasing efficiency. In this context, the meaning of lean relates to eliminating waste in all forms. **Waste** refers to anything that impedes production time or adds unnecessary cost. There are seven common forms of waste, as follows.

However, as the adjective 'lean' indicates, the operations are to be shorn of any excess fat. 'No fat, only meat' or in other words 'no wasteful elements' in the operations is the goal. Lean operations do not tolerate any 'waste'.

VALUE AND WASTE

In lean operations, 'value' and 'waste' are central concepts. Importantly, these are defined with reference to the customer. At every step, lean methodology checks for value and waste. Waste is to be constantly shed. But, what is 'waste'? In lean manufacturing, "waste" is defined as **anything that doesn't add value to a product**. "Value" in manufacturing is defined as anything that a customer would be willing to pay for. So, waste is any cost incurred in a process that does not benefit the customer.

The main focus of lean operations management is efficiency. This means reducing waste and maximizing value in order to improve organizational performance. Lean operations management can be used in any type of organization, but it is particularly well suited for manufacturing and production-based businesses. When implemented correctly, lean operations management can help organizations achieve their goals and improve their bottom line.

What is 'value'?

According to the 'lean' thinking, value exists only when the customer is willing to 'pay' for a product or service. Any operation or part of it has to be tested on the criterion of "Will the customer be willing to pay for it?" In fact, any part of the product or any element of the service has to prove against this test-stone. Sans customer's willingness to pay, value cannot independently exist. Those tasks that the customer is not willing to pay for are 'non-value added' or 'waste' and these tasks should be designed out of the process or operation, simplified or reduced.

Just because the customer is 'made to pay' (built into the price of the product or service) for the expenses on these quality controls, it does not mean s/he is 'willing' to pay for it. In fact, s/he would want the organisation never to make any errors if they could. The organisation may think of the tough multiple quality control measures as a testimony to its commitment to quality. But, the customer is interested in only a quality product or service being delivered to him/her and not in what the organisation does in order to get that product or service. In short, the quality-related explicit costs are a 'waste'.

One may summarise the above discussion by saying that the amount of waste in our operations has no relation to the customer value. So, we must learn to separate 'waste' and 'value' in operations.

HISTORY OF LEAN OPERATIONS

The stress on 'lean operations' may be a recent development born out of globalisation of business and competition on an international level where goods and services are able to move and be available across national and regional boundaries with ever-increasing ease, speed and variety. With rapid developments in science and technology, new goods and services are giving a tough competition to the existing ones. In such a scenario, the importance of 'lean operations' cannot be over-emphasised. While historically several visionary businessmen and scientists had understood the importance of keeping operations 'lean', the thought has evolved from 'cost minimisation' to 'improving value to the customer'.

Early 18th century:

- **Importance of Cost Reduction**

Benjamin Franklin mentions that avoiding unnecessary costs could be more profitable than increasing sales: "A penny saved is two pence clear." Regarding unnecessary inventories he says, "You call them goods; but if you do not take care, they will prove evils to some of you."

Early 20th century:

- **Standardisation efforts**

Frederick W. Taylor (1911) enunciates the principles of time study in operations. He speaks of standard method and standard time. These developments help in controlling and improving output. Motion studies by Frank and Lillian Gilbreth (around 1915) suggest economies in motion and resultant enhanced output. They observed bricklaying – why do the labourers have to lift heavy blocks from ground level – wasting time as well as effort. Henry Ford does away with 'fitting' - until

then used for making components and then fitting them on to make the product. With stringent specifications, he standardises the components and eliminates the need for a 'fitter'. It generates huge savings and is a phenomenal development. Assembly line flow would not have been possible without such standardisation.

- **Realisation of the Importance of Smooth Flow**

Henry Ford (1914) starts assembly line mass manufacture of cars with hitherto unimaginable improvements in the outputs. Costs come down drastically. Ford also explicitly realises the importance of arrangement of work places without which an assembly line would suffer. He also comes up with the concept of Design for Manufacture, i.e. the components are so designed that they can be made more easily and fitted more easily to make the assembly. Walter A. Shewhart (1924) writes on statistical quality control. With this systematisation, the job of producing standard parts is facilitated which, in turn, helps smooth flows on the production floor. Wastes are reduced.

Mid 20th century (1960s):

Realisation of the Pervasive Importance of Quality

Joseph M. Juran's expose on costs of quality and Genichi Taguchi's 'loss function' (inverted parabola) explain as to how deviation from acceptable quality could hit various areas of activity and the total economic loss could be very high. Without their explicitly mentioning it, the customer was important in their consideration. Deming with the '14-points' brought in motivational angle in quality while stating the prime importance of customer and society.

The realisation that 1 per cent defectives mean 10,000 ppm pitched the desired scale of improvement very high. Such improvement in quality levels could only be achieved with a complete re-definition of processes and culture within the existing manufacturing systems.

1970s:

Just-In-Time Production System

Toyota Motor Company in Japan tried to utilise the gains of Ford's mass assembly line flow while doing away with assembly line's drawback of being weak on variety of products by devising a unique "Just-In-Time" system that was based on 'pull' by customers on the production system. It was a revolutionary departure from the traditional 'push' system. Toyota might have done this as it had to survive and prosper in a small domestic market in automobiles while facing competition from giants such as Ford and General Motors who had the advantage of economies of scale due to large volume of demand back home.

In order to be flexible to meet varying customer demands promptly and yet have a profitable operation, Toyota's Production System needed small-batch production, quick and simple production information systems (Kan-ban system), very short set-up times, single minute exchange of dies (SMED), zero defects, highly dependable and empowered suppliers supplying materials in small

quantities almost “just-In-time” and of zero defects, machines made highly dependable through total productive maintenance (TPM), multi-skilled workforce who are empowered to take leadership roles when needed and a supportive top leadership that guided the transformation to everything ‘lean’ and ‘fit’ and did so with much sensitivity.

1988 and later:

‘Lean’ thinking

John Krafcik is the first to coin the term ‘lean’ in an article in *MIT Sloan Management Review* (Fall 1988) based on his research on Toyota Production System. Continuing the research further, Jim Womack, Daniel Jones, and Daniel Roos wrote a best-seller book called *The Machine that Changed the World* (1990).

Lean thinking goes beyond Just-in-Time system in being highly explicit about its focus on customer. Any product, process, operation that does not provide value to the customer is a ‘waste’ and should be eliminated. A related question is: Can ‘lean’ thinking and ‘profit’ motive go together? Should improvements be done for enhanced profit for the firm or for the sake of the customer? Should ‘customer satisfaction’ be a sub-set of ‘profit to the firm’ or should profit be a by-product? Lean is a philosophy. Lean is not just a bunch of techniques to reduce waste – although techniques are essential for making ‘lean’ happen.Lean philosophy can have applications in various endeavors other than manufacturing.

TYPES OF WASTE

Toyota, which is the originator of the ‘lean operations’ movement, classifies waste into three broad types, viz. **(1) Muda, (2) Muri and (3) Mura**. All three are Japanese words and are explained below.

1. **Muda**

The rough equivalent of this word is ‘non-value adding work’. ‘Muda’ can be of two types.

Type 1: Non-value-added tasks which seem to be essential.

Type 2: Non-value-added tasks which can be eliminated immediately.

Type 2 ‘muda’ is easier to identify. It is all those operations/aspects that obviously do not add value to the customer. It is the inventory that is unnecessary, production that is in excess of requirements, flow of materials that is sub-optimal, extra work that the customer does not appreciate, transport of the materials that is unnecessary, movement of workers that is wasteful, delays that can be avoided, and defective units that need not be produced.

Type 1 ‘muda’ is not always obvious. It is hidden under the cloak of supposedly essential nonvalue added work. Under a prevailing technology, the prevailing system of work or, more generally, the prevailing business environment, that non-value adding task is necessary to be performed. So, the business conditions need to be changed to eliminate this type of waste.

Shigeo Shingo, a Japanese thinker who has been the best-known exponent of single minute exchange of die (SMED) and error-proofing or poka-yoke, observed that only the last turn of a

bolt tightens it—the rest is just movement. The turns other than the last turn are waste – but these are hidden as work that must be done under the current system. They may be called as 'non-value adding work'. But does it really 'work'? That is the question one must always ask. The point is: 'waste' could be disguised in many ways.

Seven Types of Muda

Taiichi Ohno, credited to be a major contributor in the development of Toyota Production System, lists seven basic 'Muda'. These are as follows.

(1) ***Transport:*** This waste corresponds to unnecessary conveyance. Companies may love to convey products. It may be easy to have a posse of conveying machinery – fork-lifts, overhead cranes, mini-trucks, trucks – instead of thinking hard on how to organise flows. The remedy can only be to reorganise the flows of materials within the plant or even outside. Inside the production plant, the required machines should be placed closer together or one may change to a cellular layout to reduce transportation.

In an office, papers may travel unnecessarily. The waste could be due to: (a) multiple (unnecessary) points/desks to be touched, (b) desks not optimally arranged for efficient flow of the necessary papers, and (c) unnecessary papers/communications. An O&M (Organisation and Methods) study could check the purpose of the papers and the purpose of multiple decision/noting points and eliminate (c) and reduce (a) to the only essential ones. A study of the office layout could reduce (b). Multiple, unnecessary and thoughtless handling of materials/papers causes this 'muda' of transport.

(2) ***Inventory*:** Inventory can be associated with several ills in the organisation as was seen in the chapter on Just-In-Time production system. High levels of inventory are as much a cause as a symptom of things going wrong. Inventories – whether of raw material, workin- process and finished goods – all contribute to heavy costs of carrying them.

They are also a symptom of problems in the value stream because more often they are used to cover up or insure against these problems in the processes, in maintenance, in supply chains, in information flows, in logistics, in the coordination between different departments like marketing and production, and sometimes even in the presentation of finances. When these inventories sit for long, they cause the very same problems that they are supposed to cover up. In short, inventories mostly do a 'cover up' job. They need to be exposed and expelled.

(3) ***Over-production:*** This is a common occurrence with 'push' style of operations. Firms produce products before the customers need them, either in anticipation of demand, or over-calculation of demand, or in order to make up figures for the year-end, or to generate evenness of load on the facilities. This may result in carrying inventories. Sometimes the firm may carry dead inventory that cannot even be used differently. Not only does the firm carry unwanted inventory but would also have wasted good production hours in making that inventory and

in the process would perhaps have also lost out on other opportunities by tying down the operations facilities.

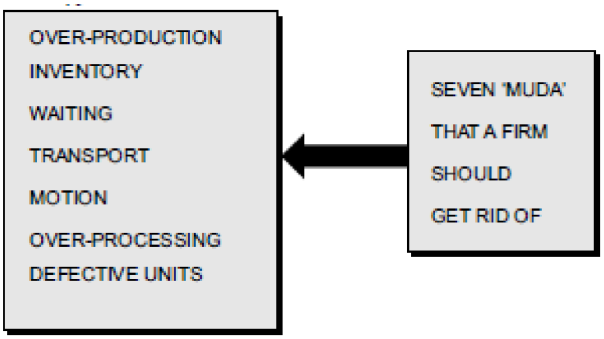
(4) ***Over-processing****:* These are the unnecessary work elements or procedures. The reasons for over-processing could be:
(a) Lack of thought over how the processes could be improved, and
(b) Attempting to over-please the customer with features/embellishments/quality characteristics that the customer really does not appreciate.
The above is like putting three coats of paint when two will be enough. The customer does not care whether there are two coats or three, as long as the paint does its job and retains its characteristics.

(5) ***Motion:*** Movement of people and equipment that does not add value to the product/service causes this waste. For instance, a worker may move back and forth long distances to get a tool. Instead, the necessary tools could be kept close to his workplace thus eliminating this 'muda'.
In some factories, a worker has to go up and down two flights in order to fetch a necessary input material. This is not only a wasted motion and effort but overburdens him/her. This gives rise to another type of waste (Muri) of unreasonable work pushing the worker beyond his/her physical limits and thereby being a source of multiple variations and defects (which is another type of waste Mura or inconsistency).

(6) ***Waiting:*** These are time delays and idle times during which value is not added to the product. If the machines, men and material wait, (1) it is waste of these resources and (2) it demoralises the employees. The latter gives rise to 'mura' of erratic work output from the employees. It may even give rise to uneven workload on the processes and people. This is 'muri'.
Moreover, time is money. Delays in reaching the product/service to the customer will result in loss of credibility and loss of business for the company. Projects have to be completed on time whether they are in hardware or software. When business suffers, unevenness ('mura') is generated in the organisation. It gives rise to erratic overloads on equipment and on people. When natural limits are stretched, quality variations and erratic behaviours can occur ('mura'). The latter can result in bad work from the employees, which is a terrible waste ('muda').

(7) ***Defective units****:* A defective unit means a loss of that much output. If it cannot be reworked, it also means a loss of that much material and the machine life, the human labour, time and attention that have gone into producing it. This is the obvious loss. Of course, the process of rework itself entails cost.
The less obvious loss is the disruption of processes when a defective component is fitted, when a machine or production line grinds to a halt or slows down for a while to allow rectification of the defect, when the defective component gives rise to a problem in the process and thereby produces more defective units to compound the matters. Bad quality generates further bad quality.

Even more serious problem with bad quality is that the credibility with the customers suffers. Faith is an important element of business or of any relationship for that matter. If this takes a hit, the effects on the business/relationship could be long-term. Credibility is fragile; it breaks easily into fragments, but it is difficult to put them back together.



2. Muri

This is the unreasonable work that is imposed on the equipment and people due to poor management.

A machine is made to run faster than its limits, a process is asked for greater level of performance than it can handle, people are made to work harder than their limits and are made to several factories around the world. People do work and stay in abhorrent environments. But, then this has its own negative effects on quality, variations, and productivity.

It can also be a cause of accidents. Bhopal gas tragedy may not have occurred and certainly not with such huge loss of lives, mutilation of limbs and carry-over of genetic effects had the plant not been so close to a crowded part of the city. That in itself was poor planning. The systems and checks were not adequate to take the overload when the accident occurred.

3. Mura

This is the waste of inconsistency and variation in the quality and volume of products and services. When there is unevenness in the flow of operations, it may give rise to several wasteful stocks, stoppages, delays, sudden increases and decreases in speed of work and unmanageable variations in the processes and their outputs. In fact, Just-In-Time system of production tries to remove the unevenness of flows. By having smooth flow of value-adding activities, this production system exposes many problems hidden behind the heap of inventory. Quality related problems, supply related problems, machine maintenance problems, people problems and several other come into the open and these can then be dealt with.

Muda (waste), Muri (overburden) and Mura (unevenness) are Interdependent

The wastes of muda, muri and mura are interdependent or tangled with each other. In a sense, they

cause each other. For instance, muri may cause mura and this, in turn, may cause muda as was mentioned earlier in this chapter. Due to this reason, eliminating wastes is like killing a demon that comes alive after every slaying.

When the machines and men are overloaded ('muri'), they may cause (i) deviations from quality, (ii) deviations in productivity and, therefore, in the output, and (iii) breakdowns (machine breakdowns, employee absenteeism, in serious cases staff strikes). All these cause the production system to go haywire, i.e. cause much unevenness ('mura'). In order to combat the uneven output, the management may strike a panic button and decide to have more inventories of finished goods and work-in-process ('muda') in the hope that these can cover the customer demands despite what happens inside the plant. However, this adds to the 'muda' of inventories and also further complicates the matters by adding to the unevenness of production outputs and flows ('mura') within the plant. Actually, because of the earlier overburdening of the employees and machines, problems in quality had taken root. This would have its ripples in the market. The customers may lose the trust in the firm's product. This may cause a drop in the demand for the product. This causes further unevenness of flows or 'mura'. This further adds to the problem of keeping stocks ('muda') at a time when the demand has fallen. This 'muda' causes problems in working capital and hence the company may cut costs by delaying maintenance or delaying payments to their suppliers or sometimes even delaying wages to the employees. All these thoughtless actions cause further disturbances or unevenness of suppliers not supplying on time or employees not cooperating (output suffers as a result). Thus, 'muda' causes 'muri' and 'muri' causes 'mura' and the 'mura' causes 'muda' once again.

'5S' TECHNIQUE OF ELIMINATING WASTE

'5S' stands for the five words in Japanese that start with the letter 'S' when spelt in English. These words are the five actions that would help remove 'waste' from the operations. At the ground level, these S's seem like simple tips on 'housekeeping'. But, proponents of 'lean' operations believe that any action towards going 'lean' should start from good housekeeping. It is the foundation for lean operations. 5S ensure that in the work area only necessary equipment, tools, materials are present, that there is a place for everything and everything is in its place – neat, clean and ready to use, that the work practices are standardized and the focus on these principles is maintained. A brief description of each one of these S's, to be performed in stages, is given below.

1. **Seiri (Sort)**

Organise the work area by sorting and keeping only the tools, materials and instructions necessary for the process in question, eliminating all the unnecessary items from the work area. Clutter can be a cause for many problems like delays, defective quality, drop in productivity and wrong communication. Imagine a situation when gauges are not calibrated on time because too many are held. Delays, quality problems and productivity loss could result.

2. Seiton (Straighten)

The second stage of 5S involves orderly arrangement of all the necessary items so that they are easy to use and accessible for anyone – not only the present operator but any other substitute person should also be able to locate and use. There should be a place for everything and everything should be in its place. All tools, parts, instructions, supplies, or equipment should be kept close to the point of use and so arranged that the work flow is facilitated. That is, the flow path should be set in order or 'straightened'. Ergonomics, i.e. facilitation of the operator's movement is one of the considerations in suitably arranging the work area. Orderliness has many benefits – improvements in productivity and quality, error-proofing, ease of work, and better safety among other. As one checks for orderliness in one work area, one would discover aspects of orderliness of the flow of current output work into other work area. This could set the ball rolling for an orderly arrangement of all related work areas with respect to each other i.e. facilities layout.

3. Seiso (Shine)

This is the third stage. Cleanliness or keeping everything – machines, equipment and tools – in the work area 'shining' has many advantages. If everything is clean, then that work station is immediately ready for use. This cuts down on the preparation time – because one is sure that equipment that is clean is always available and ready for use.

The concept of cutting down on the preparation time is an important one and one can see its useful extension not only in single minute exchange of dies (SMED) but also in the pit-stops of the Grand Prix where the change of tires and refueling takes just a few seconds. Cleaning reveals or lays bare open many hitherto unnoticed problems. Any non-conformity stands out. Needless to mention that in several cases cleanliness helps in maintaining quality. It is easily understood that the 'clean rooms', which are used in the manufacture of microelectronics and nano-technology based products, need to be clean. They definitely have to be absolutely dust-free. Also in the manufacture of pharmaceuticals or peripherals, cleanliness is of paramount importance.

However, even in the engineering industry, cleanliness helps in the ease of work flow and prevention of errors. Cleaning comes closer to preventive maintenance because systematised cleaning would involve checking or inspecting.

4. Seiketsu (Standardise)

What has been done in the earlier three stages of 5S has to become standardised. Work practices should be standardised and should be identical across all work stations doing the same particular job. This will enable all employees doing the same job to work in any work-station with the same tools and supplies that are in the same location in every station.

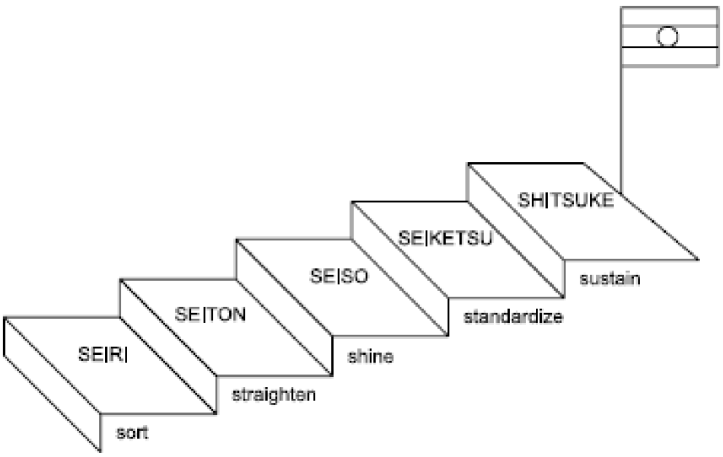
Standard work is one of the important basics of 'lean' operations. Everybody should know exactly what her/his work responsibilities are. Confusion, doubt and subsequent deviation mean unevenness – of quality and of flows – which is the waste 'mura'. It is known that one mura would set the ball rolling for other muda and muri.

5. Shitsuke (Sustain)

5S is not a one-time affair. Any 'lean' system – 5S is a part of it – is a work in progress. The organisation has to continue applying the various S's and continue to improve. Generally, once a problem is sorted out, the organisation shifts its attention to other problem elsewhere. This results in the previous problem-area slipping back to the old ways. 'Shitsuke' measures ensure that the 5S become part of the organisation's work culture.

5S was developed by Hiroyuki Hirano. That 'housekeeping' helps in productivity and quality improvement was already known to many in the industrially developed world. However, Hirano brought home the vital role of housekeeping principles in all operations. It was not just housekeeping, i.e. as it existed but a make-over programme for the house. Moreover, he provided a structure for the improvement programmes pointing out a series of clearly-identifiable steps, each building upon its predecessor. While the Western businesses were doing the operations housekeeping in a haphazard way, Hirano impressed upon the need to break the programme down into a series of steps. There was a definite order as to which step came first and which would come next. For instance, he explained that any effort to consider layout and flow before the removal of the unnecessary items was likely to lead to a sub-optimal solution.

The five steps of 5S technique have been depicted in Fig. 38.6 below. While the organisation's flag can be hoisted after the five steps are climbed, Hirano's last step emphasises that climbing up these steps should be a continuous affair and should become part of the organisation's culture. Again, for the Western business world the concept of organisation 'culture' was quite new and illuminating.



The 5 steps with 5S

LEAN OPERATIONS IN THE SERVICE SECTOR

Services, in a large part, can be intangible. The product offered, unlike in manufacturing operations, may not be a tangible product. For instance, in consultancies, in education, or in entertainment much of the work and the output is not tangible. The work, in these instances, is not amenable to being

defined unambiguously. Moreover, it is not repetitive. In contrast, despite producing a variety of models, automobile production at Toyota is essentially repetitive and the work is measurable.

Comparison of Service and Manufacturing in the Context of 'Lean'

When the work (inputs and operations) or output involves knowledge – gathering, analysis and dissemination or decision, the inputs and/or outputs could defy metrics. How could a top level management consultant's work be clearly defined, let alone being measured? How could a psychiatrist's work be explicitly defined and his output clearly measured? Both these cases involve expertise and judgment that depend on 'tacit knowledge' of the management consultant and psychiatrist. When a management consultant arrives at a solution to a vexing problem and when a psychiatrist diagnoses the state of the patient and deals with him, they both depend upon the knowledge that they have stored in their head over all these years of study and practice. The process and the product in these cases seem so much different from that in manufacturing. Not all 'lean' manufacturing ideas can translate from factory floor to consultant's desk or the doctor's chair. It is, therefore, natural to have reservations regarding the application of 'lean' ideas to knowledge work in particular and to services in general. Service industries tend to lag behind manufacturing in the improvement of operations.

Aspect	*Service Business*	*Manufacturing Business*
Product	Many aspects are intangible.	Most aspects are tangible.
Design of product	Customer involved in design of service.	Company designs the product.
Demand	Two types of demand exist: (1) Value demand (2) Failure demand.	Mostly value demand.
Production	Production and consumption can be / is mostly simultaneous.	Production is distinctly different from consumption.
Customer Involvement in Production	Customer involved in production.	Customer far from production.
Process	Many aspects are individual-based and based on 'tacit' knowledge.	Most aspects can be standard.
Inventory	Non-inventoriable/virtual. But, there can be inventories of personnel or of waiting customers.	Inventoriable items (Supplies, WIP, finished goods) can buffer uncertainty.
Delivery	Considerable variability may be there depending upon the person delivering service.	Some variation can exist.
Standardisation and Variety	Standardisation is difficult. Open universe in variety of service is possible in most cases.	More amenable to standardisation. Predefined variety is offered.
Uncertainty	Uncertainty in task times in demand and in customer's role in production of the service.	Operations far more controllable.

Difficulties to bring lean in services

The differences thought out in the above table give an indication of the difficulties in the transplanting of 'lean' principles applicable in manufacturing business to the service business.

1. *Dichotomy:* The orientation of service business is different from manufacturing. Customer is involved in the design of the product and sometimes in the production itself. Many customers in beauty salon during the hair styling keep telling the hair stylist as to what they want. Master's degree

and Doctoral students design their service 'product' (the research thesis) and participate in a big way in the production itself. While this is happening, the stylist/professor has to ensure that the final outcome or final product is of universally acceptable standard quality. It is a dichotomy of dynamic process versus
standard outcome.

2. *Low Manageability:* In the service business, product itself is intangible in most cases. Processes involve 'tacit' knowledge. Manageability – of operations and of outcome - is, therefore, low in terms of task times, total operation time, and final outcome's quality.
One has to work in an environment of less specificity and more variability; whereas, JIT manufacturing and 'lean' need high degree of specificity – products and processes need to be specified in detail. Standardisation helps maintain operations 'lean'.

3. *Absence of Safety Nets:* In the service business, there are no safety stocks to 'cover up' errors. Mistakes and inefficiencies are nakedly out in the open.

- Difficult to locate 'non-value adding' tasks under a strong current of customer orientation
- Dichotomy of dynamic processes and standard outcome
- Lack of specificity and hence lack of manageability
- Absence of safety nets

Suggestions to implement lean in Services

1. ***There are Elements of Work that are Tangible and Repetitive. Check for 'Waste' in those Parts of Service Work.***

Hospitals, hotels, restaurants, BPOs, IT solution providers, movie houses, railways and almost all services have many and large parts of work – paper work, xeroxing, printing, telephoning, emailing, movement of people, maintenance of equipment, etc. – that are no different than the parts of work in manufacturing. These elements of work can easily be made 'lean' by checking for 'value addition' and 'waste' that includes mura, muri and muda.

2. ***Constantly Search for Waste***

Since services are heavily customer-oriented, there is that much more necessity and urgency to eliminate waste and pass on the benefits to the customer. Services need to constantly search for 'wastes' in all the operations. For instance, the consequences of 'rework' in services could be huge. Services consist of not only 'value demand', usual demand for service from the customers, but also many calls received by 'call centers' are either chasing down enquiries made earlier or to correct earlier work that was not done properly. By treating 'failure demand' and 'value demand' alike, one may get a false picture of greater productivity. So, there is a need to look constantly as to what is going on and remove wastes.

3. Search for Small Waste, Not Just the Big One

Large wastes would already have been removed. Hence, there is a need to care about the small stuff. Constantly ask "Why?" A value stream map would indicate the areas of waste. Track each step and question it. 5 Whys: There is a Japanese technique called '5 Whys'. A 'why' would elicit a reply. This reply needs to be questioned again as to 'why?' The reply to it is further subjected another 'why?' This should go on (5 is only a symbolic large number) until one is satisfied to have found the root cause. Since by their very name and nature services apparently seem to be serving the customer, the nonvalue added work tends to get hidden. Thus, it is hard to locate waste and a persistent 'why?' is essential.

4. Service Jobs Tend to Bloat Over Time. Hence, Periodically Review Structure and Content of Every Job

Since a service job is unstructured and because it could have inputs during its conduct from various quarters including the customer, it has a tendency to expand over a period of time, with more and more low-value tasks added on to it. This leads to (a) too much work (muri) and (b) unnecessary work (muda). This in turn leads to bottlenecks (mura), delays in completing the job, overburdening of employees (muri) and slippages in quality (muda), etc. Hence, a periodic review of the content of jobs is necessary.

5. Specify All Work Including Knowledge Work

Specification of a job would involve putting down on paper all details about the 'what', 'when', 'where' and 'how to' of the job, viz. its micro-contents, interconnections, sequencing, timings, and desired result. At first, knowledge work would seem like a nebulous entity defying any specification because it is supposed to be 'in the head of the worker', consisting considerably of 'intuition', difficult to be put down into replicable and concrete steps.

Not all knowledge is 'tacit': However, a large part of knowledge work can be specified. The key is to challenge the assumption that all knowledge work is inherently tacit.3 Staats and Upton who studied work at Wipro, the IT services giant's facilities in India, found that many aspects of the code writing process like daily builds (integrating all the pieces of code written on a day into the programme), peer review, testing and customer reviews that happen within a project and across projects could be standardised. Whereas, initially everyone thought of each of these code-writing jobs as unique one-time project not amenable to any standardisation. Only when this presumption was questioned that the possibility of specifying the work emerged. Many a time there is a psychological barrier that wants to keep 'knowledge work' in the realm of the cryptic.

Have patience: Moreover, just because certain knowledge work cannot be specified today does not mean that it cannot be standardised tomorrow. What is a relatively stray occurrence today may can be put in a protocol.4 Success (or value addition) can, thus, be repeated. Much of 'knowledge' seems to go from the stage of esoteric to tacit to repeatable to routine.

Specificity helps in most service operations. Take the case of snake-bites in rural India. It is

estimated that more than 50,000 people die in India every year due to snake-bites and most of the snake-bites are occurring in the rural areas. What would help is a clear set of standardised procedures from the Health Ministry. A simple check-list of time-bound do's for any doctor handling a snake-bite patient would go a long way. It is said that most doctors do not know how to handle a snake-bite case; they do not even know the recommended dosage of anti-snake venom serum.5

6. List out Common Errors

Generally, it is thought that 'errors' in service work lack clear definition. A lot of time may get wasted because of it. "What does constitute an error?" may be necessary to be settled right at the outset of a service operation. "What can go wrong?" is as important to know as "What does the work consist of?"

Therefore, a list of common errors and their definition would help in preventing errors.

7.Although the Customer is involved, Service work can be specifies.

A question is generally raised: Wouldn't customer's involvement in the service process make it less specific and more uncertain? Customer may be involved in the design of the service product and the process. But, it can be frozen and can be specified. Hair style need can be finalised, thesis topic and mode of investigation can be finalised, contents of a hamburger or a subway sandwich can be decided upon – even the method of deciding upon the contents can be decided by the subway shop. With adequate effort, many aspects of the customer participation can be standardised; this can reduce the uncertainty in the entire process.

8. Specify 'What' and 'How' Employees will Communicate with the Customer and with Each other

There is little tolerance for errors. There are no safety nets like 'inventories' in service work. In such a situation, the opportunity to directly communicate with customer and possibly his direct participation should be seen as a benefit. With the customer's participation, the work can be finalized and specified. But, the organisation should decide as to who should be communicating, when and how often, what and how. That is a structure for communications – internal between the team members and external with the customers and sometimes suppliers – has to be thought out and decided upon. Large complex projects like technical consulting or management consulting projects would need the various elements of the project specified as much as possible. It is essential to plan for what to communicate, who will communicate with whom, for what purpose, when, how frequently, and how (method or manner of communication). Communications are absolutely critical to service work and these have to be structured as early in the stage of the project as one can. Structured communication lends shape to the job at hand, lowers uncertainty, keeps the customer in the loop, enhances 'value', decreases the possibility of errors, and if errors do occur, it provides some amount of insulation from the effect of the errors.

9. Address Problems as Soon as They Arise

The JIT production system had the employees pushing the 'Andon' button to raise an alarm as soon as a problem occurred. The production came to a halt. The point is: The employees had a responsibility to rectify the error/problem as soon as possible and restore the production line back to life. In the JIT system, interestingly, the operation itself became a problem-solving machine. If the problem is a recent one, it is easier to locate the cause. Older wounds are difficult to heal. This is one of the principles underlying 'lean manufacturing'. This principle can be used in service

10. Write Down the Lessons Learnt

'Lean operations' believe in minimising errors and definitely not repeating them. Therefore, all lessons learnt – problems, causes, rectification actions taken, success rate – have to be noted down and the learning not only in ternalised, but also made explicit. This is all the more important for service work in order to enhance its tangibility and standardisability.

ROLE OF LEADERSHIP

'Lean operations' is not just a bunch of techniques, although techniques are important. Adopting JIT or Toyota Production System requireds a change in the business philosophy. Lean thinking goes a step beyond JIT. It requires a cultural change in the organisation. The lean thinking has to get internalised in the organisation. In this context, the commitment of top leaders to lean philosophy is vital.

Without the inculcation of proper values and organisational behaviour, any effort to make operations lean will meet with only fleeting success. Similar problem is encountered with the introduction of JIT system in an organisation without appropriate preparation of the mindset. Lean operations are a little more rigorous. The lean values have to percolate and touch all people in the organisation. The top leadership has to formulate those values and set the ball rolling.

Team Effort

Lean is a team game. It requires the participation of all in the organisation and even all those connected to the organisation. One of the roles of top leadership is to facilitate team work. They have to create and sustain conditions for it. And, this team has to be gently maneuvered towards the 'lean' way. In a while, the entire team has to start 'eating, sleeping and dreaming' lean.

'Lean' does not requires just the participation, but active participation of all. This requires that the bottom line of workers too take a leadership role with regard to their work. Thus, the job of the top leadership is to ensure that the conditions are right for a second or third line of leaders to emerge in all areas of the organisation. The behavioural values important for the success of lean operations are:

(a) Mutual respect: Care for other's point of view, respect for other's suggestion for improvement.

(b) Team feeling: Put the team above self. Lean operations are about overall solution to eliminate waste.

- ***Continuous Vigil and Continuous Improvement***

In fact, 'lean operations' require participation on a continual basis. 'Lean operations' is not a onetime affair. The leadership has to not only set the ball rolling, but see that the lean game goes on. One has to be constantly on the lookout for waste so that it is removed.

Wastes tend to creep into the processes over time. Methods may evolve, sources and resources get to be different, machines undergo modifications, people and their moves may change. All these may bring in wastes with them. The team – the organisation – has to be vigilant and should eliminate waste as soon as it is spotted.

- ***Kaizen:*** Moreover, the organisation has to strive for continuous improvement. Lean thinking does not accept status quo. Nothing is ever good enough. Kaizen is a vital part of lean philosophy. Learning curve may plateau, but Kaizen continuously looks for opportunities to improve.
- ***Jishu Kanri:*** This Japanese term refers to 'voluntary management' group – a small group that meets regularly to share, study and solve problems related to their area of activity. Jishu Kanri projects may involve waste elimination, and improvements in quality, workplace safety, environment, etc A part of these activities could take place outside of the regular work hours, for which workers are compensated. This is a part of Kaizen although Kaizen need not involve a group; it could be an individual initiative as well.
- ***Gengitsu:*** While this Japanese word translates as 'real thing', what is implied is that the top leadership must go to the 'actual place' of work (also Gemba in Japanese), have a first hand knowledge of the wastes, the improvements taking place and the possibilities of further improvement. 'Real thing' also means that one should know the 'actual facts', i.e. one has to be ever vigilant for opportunities for improvement and should go to the real root of any problem. In short, one must face the facts and go to the root of them. Gengitsu applies to everybody in or connected to the organisation. 'Successful leaders create leaders under them. Winning organisations have leaders at every level': Azim Premji of Wipro has said. Similarly, Deepak S. Parekh of HDFC has said, 'A leader has to be a captain of a football team that has talented professionals. Leadership is not a one-person phenomenon'.6 These sayings resonate in the background of lean operations.

LEAN OPERATIONS AND JIT

JIT system is very close to 'lean manufacturing' in its attributes and hence, both of these are sometimes clubbed together. While JIT is the forerunner of 'lean manufacturing', the two overlap substantially. However, there are some differences between the two, because 'lean operations' are a further improvement on the principles governing JIT.

1. JIT Accentuates Only One Dimension of Lean Manufacturing

JIT relies heavily on improvements in 'flow'. Implementation of smooth flow exposes most of the problems. Waste reduction happens as a consequence. That is, by making all production operations

closer to a line production, it spots and removes the inefficiencies due to stoppages associated with intermittent production. Uniform or 'even' flow compels even (i.e. standardised) processes, even quality (zero defects), even supply of materials, even running of equipment, and even empowerment across the entire manpower. Requirement of even flow also compels nearly single unit production, which forces quickly changeable set-ups and in-time supplies. Thus most of the benefits accrue to JIT because of its even flow. Of course, such even flow would not have been possible if the flow did not originate (get 'pulled') from the customer's end.

Lean operations are about eliminating all kinds of waste – not just the flow considerations. Every activity is under scrutiny – product design, work methods, process design, process flows, transport of material, movements of people, quality checks and procedures, inventories, supply chain, information flows, employee training and empowerment to name a few.

2. Lean Operations Expand Human Capability

Lean goes one step further than JIT and consists of work-systems that expand human capabilities. Lean operations explicitly encourage creative problem solving by the workers. Waste or 'non-value adding activities' are eliminated with mainly an internal effort, i.e. by the employees of the organisation.

In fact, since a lot of waste is small waste, it can generally be noticed mainly by those who are close to the daily operations. Making the operator or handler or mechanic or other worker notice the problem and suggest remedies requires an education of the employees making them capable to shoulder such responsibilities. In order that they take the initiative requires that they be empowered. Moreover, HR policies of lean operations encourage high levels of commitment to the organization and vice versa. This is not to say that JIT does not expand the workers' capabilities or that commitment levels could be low. JIT too depends on these two qualities. But in 'lean operations', the emphasis is significantly higher.

3. Lean is Direct About its Focus on 'Customer Satisfaction'

In 'lean', any operations done for any purpose other than providing value to the customer is waste. 'Pull production' is a bare necessity under this dictum. In fact, nothing is 'push'. Lean operations do not believe in 'push' of any kind. 'Lean' checks for 'value' to the customer at every point and for every action.

JIT is much less direct about its emphasis on customer service. Could it happen that Toyota Motor Company that pioneered JIT, momentarily forget its customers? This sounds strange. But, not too long ago (2009-10), Toyota's reputation seemed to have been tarnished due to a number of recalls of its Prius and Lexus models due to quality related problems. One of the reasons put forward by a professor in University of Tokyo was that "Toyota became so proud of its thing: its customers." The case of Sony may also be interesting. It is said that Sony's digital Walkman was better engineered than Apple's iPod, but was less popular. It is said,Sony overlooked the aspect of

ease of use to the customer.

Lean is, indeed, very concerned with customer service. So much so that one is tempted to ask: What happens to the profit motive? Is profit only a by-product? In this aspect, JIT and Lean may have some conflict.

'Lean operations' seems to be the natural progression of Operations Management as a discipline towards its increasing outward focus on service to customer and service to the society.

5. Lean is an Evolutionary Concept

Main method of 'lean' is not the tools or techniques or a predetermined flow system, but the reduction of Muda, Muri and Mura. Lean is an evolutionary concept.

These differences should not take the credit away from the Toyota Production System or JIT. Certainly, JIT brought in an entirely new emphasis on customer satisfaction. Its concept of single unit flow system – where it combines the benefits of very small lot production and a flow system of production – has been an extraordinary development in the field of manufacturing management. In fact, its attempt to make the flow even has singularly brought out various 'wastes' – of inventory, of over-production, of large production runs and of not having good quality the first time itself, among other. It showed the world as to how a production system could be linked to the customer demand and, therefore, how the production function could play a critical role in organisational strategy. 'Lean operations' is a natural progression from JIT. It has greater claims to being a philosophy.

Module -5 Total Quality Management (TQM) 9 Hours

Evolution of quality; Concept, Meaning and Features of TQM, Eight building blocks of TQM; TQM tools Benchmarking: Concepts, Meaning, Benefits, Elements, Reasons for benchmarking, Process of benchmarking,FMEA; Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Quality Circles. Total Productive Maintenance (TPM) – Concept and need

Total Quality Management (TQM) refers to management methods used to enhance quality and productivity in business organizations. TQM is a comprehensive management approach that works horizontally across an organization, involving all departments and employees and extending backward and forward to include both suppliers and clients/customers.

Quality refers to certain standards and the ways and means by which those standards are achieved, maintained and improved. Quality is not just confined to products and services. It is a homogeneous element of any aspect of doing things with high degree of perfection. For example Business success depends on the quality decision making.

- Time Until 1960s Events Prior to the 20th century Quality is an art Demands overcome potential production an era of workmanship
- F.Taylor 1900s The scientific approach to management resulting in rationalization of work and its break down leads to greater need for standardization, inspection and supervision
- Shewart 1930s Statistical beginnings and study of quality control. In parallel, studies by R A Fisher on experimental design; the beginning of control charts at western Electric in USA
- Late 1930s Quality standards and approaches are introduced in France and Japan.

Beginning of SQC, reliability and maintenance engineering

- 1942 Seminal work by Deming at the ministry of war in USA on quality control and sampling Working group setup by Juran and Dodge on SQC in US army Concepts of acceptance sampling devised
- 1944 Daodge and Deming carried out seminal research on acceptance sampling
- 1945 Founding of the Japan standard association
- 1946 Founding of the ASQC 1950 Visit of Deming in Japan at the invitation of K Ishikawa
- 1951 Quality assurance increasingly accepted
- 1954 TQC in Japan ; Book published 1956 1957 Founding of European organization for the control of quality
- After 1960s 1961 The Martin Co in USA introduces the zero defects approach while developing and producing Pershing Missiles. Quality motivation is starting in the US and integrated programmes begun
  1962 Quality circles are started in Japan

Features of TQM

- Performance.
- Features.
- Reliability.
- Conformance.
- Durability.
- Serviceability.
- Aesthetics.
- Perceived quality

Eight building blocks of TQM;

To be successful implementing TQM, an organization must concentrate on the eight key elements:

1. Ethics
2. Integrity
3. Trust
4. Training
5. Teamwork

6. Leadership
7. Recognition
8. Communication

Total Quality Management (TQM) – 16 Commonly Adopted Tools

TQM can be put to practice by adopting TQM methods. Adopting the right method is important as success of TQM largely depends upon selection of the method, its suitability for quality management problems and effective implementation by effective leaders.

Some of the commonly adopted tools are discussed below:

1. Benchmarking:

The purpose of benchmarking is to fill gaps in firms' performance by taking an independent look at it, comparing it with others and adopting the best practice being followed by competitors in all areas of operations. Benchmarking helps organisations move from introspective to externally focused areas of business operations.

2. Deming Wheel:

Aiming at full satisfaction of consumers, Deming, a famous TQM theorist, suggested a concept to satisfy the customer requirements by developing a cycle called PDCA cycle. It refers to Plan, Do, Check and Action and helps in developing a new product based on requirements of the customers.

3. ISO-9000:

It aims at providing an effective management system to firms and their customers so that tasks are standardized, that is, carried out in the same way irrespective of who does them. It aims at providing consistent quality to customers.

4. Just-in-Time:

When firms want to keep minimum stocks to avoid unproductive costs, this method aims at delivering the raw materials and components to the production line just-in-time when they are needed. This system is also known as 'zero inventory' and 'stockless production'.

5. Quality Circles:

These are small groups of people consisting of about 3 to 12 people who do similar work and meet voluntarily for about an hour every week to identify their problems and search forsolutions. Once the problems are solved, they identify further problems and, thus, self-regulate their work. This method of TQM develops the quality of products and also the individuals.

6. Critical Path Analysis:

At the project design stage and later on at all subsequent major project reviews, critical path analysis is a project planning technique that separates the work on a project into discrete elements, specifies the time and costs associated with competition of each element, allows key elements that affect the overall project to be identified and determines the path that is

most critical in terms of usage of time and cost. It is the path that takes the longest to complete the project and directs management's attention towards that path so that project does not take longer than the critical path for its completion.

The benefit of this method, underlies the fact that it allows the effects of different courses of action to be determined at the planning stage thereby allowing the best overall approach to be decided about the completion of the project.

7. Failure Mode and Effect Analysis (FMEA):

This method helps in designing fool proof products and processes by detecting problems at early stage in a structured manner. It provides a structure for analysing the problems, identifies their possible causes and examines the product or service to look for possible causes of deviation. FMEA, thus, allows for planning the failures and their prevention.

8. Force-Field Analysis:

As a means to implement change and allow organisation development, force field analysis allows a team of individuals to identify forces that help and those that hinder in reducing the gap between where the firm is and where it wants to be. It helps managers identify the forces which have maximum impact on implementation of change and, therefore, concentrate their efforts in those areas.

9. Brainstorming:

When managers want to find the cause or solution of any problem, they use the method of brainstorming where they try to generate as many ideas as possible by encouraging all organizational members to contribute to the solution. This method breaks barriers between the departments and the levels of hierarchy and encourages everyone to develop collaborative behaviour which strengthens their groups skills.

10. **Nominal Group Technique**:

At the end of the brainstorming session when the leader has a lot of ideas with him, he brings together these ideas, concise them and reaches a conclusion to solve the problem. The nominal group technique is "a way of generating ideas from a group and identifying the level of support within the group for those ideas". The group remains committed to the final outcome and accepts the decision and control exercised by the group leader.

11. Suggestion Schemes:

Suggestion schemes aim to generate new ideas for moving to continuous improvement through incremental changes. It provides substance to the quality improvement plan and generates ideas to keep it going.

12. C-Charts:

The control charts are graphic representations where managers set standards of expected normal variation due to chance causes which are acceptable within the range of upper quality level and the lower quality level.

Any variation outside the acceptable limits is investigated for its causes and attempts are made to correct those deviations, whether they are with respect to wear and tear of the machine, poor quality of materials, obsolescence of machines or disharmony in superior-subordinate interaction etc.

13. Histograms:

At the early stages of problem-solving, when the team tries to find the progress of work, it displays continuous data collected by check sheets so that patterns of regularity or non-regularity can be displayed. Histograms are visual representation of data that highlight the problem areas which pinpoint to the team the need for corrective action or analysis of data.

14. P-Charts:

Similar to C-charts, P-charts help in identifying the percentage of defective items in a sample of variable size which varies by more than 25 per cent of the mean sample size.

15. Pie Charts:

It is a pectoral representation of data where relative size, in terms of percentage, of each individual part is shown to the total.

16. Tally Charts:

While defining a problem or implementing a solution, when the team needs to collect data to find out what is happening or to monitor the new situation, it collects data and presents it in the form of tally bars. These bars depict the value of defects or failures and help the team identify the causes of failure and search for ways to remove them. Tally bars is a simple method of data collection and interpretation which can be applied in office and work areas. It helps people of all areas to deal with problems related to quality improvement.

Benchmarking

Benchmarking is the competitive edge that allows organizations to adapt, grow, and thrive through change. Benchmarking is the process of measuring key business metrics and practices and comparing them—within business areas or against a competitor, industry peers, or other companies around the world—to understand how and where the organization needs to change in order to improve performance. There are four main types of benchmarking: internal, external, performance, and practice.

1. Performance benchmarking involves gathering and comparing quantitative data (i.e., measures or key performance indicators). Performance benchmarking is usually the first step organizations take to identify performance gaps.

What you need: Standard measures and/or KPIs and a means of extracting, collecting, and analysing that data. What you get: Data that informs decision making. This form of benchmarking is usually the first step organizations take to identify performance gaps.

2. Practice benchmarking involves gathering and comparing qualitative information about how an activity is conducted through people, processes, and technology.

What you need: A standard approach to gather and compare qualitative information such as process mapping.

What you get: Insight into where and how performance gaps occur and best practices that the organization can apply to other areas.

3. Internal benchmarking compares metrics (performance benchmarking) and/or practices (practice benchmarking) from different units, product lines, departments, programs, geographies, etc., within the organization.

What you need: At least two areas within the organization that have shared metrics and/or practices.

What you get: Internal benchmarking is a good starting point to understand the current standard of business performance. Sustained internal benchmarking applies mainly to large organizations where certain areas of the business are more efficient than others.

4. External benchmarking compares metrics and/or practices of one organization to one or many others.

What you need: For custom benchmarking, you need one or more organizations to agree to participate. You may also need a third party to facilitate data collection. This approach can be highly valuable but often requires significant time and effort. That's why organizations engage with groups like APQC, which offers more than 3,300 measures you can use to compare

performance to organizations worldwide and in nearly every industry.

- Gain an independent perspective about how well you perform compared to other companies
- Drill down into performance gaps to identify areas for improvement
- Develop a standardized set of processes and metrics
- Enable a mindset and culture of continuous improvement
- Set performance expectations
- Monitor company performance and manage change

Elements of Benchmarking / Benchmarking Process

- Identifying the need for benchmarking and planning
- Clearly understanding existing business processes
- Identify best processes
- Compare own processes and performance with that of others
- Prepare a report and implement the steps necessary to close the performance gap
- Evaluation

Reasons benchmarking is important for business

1. Increase effectiveness and efficiency

Performing regular benchmarks contributes to a company's overall effectiveness and efficiency by allowing an organization to identify any potential areas of improvement internally. This is true for sales and manufacturing businesses as well as service-oriented companies. Components that benchmarking can help an organization improve upon include sales, marketing, support and advertising.

By looking at the most effective and efficient companies within your business's industry or niche, you'll have the opportunity to analyze they are more efficient and effective and use this information to support your company's improvements.

Questions to ask to ensure you assess other companies' efficiency and effectiveness in a successful way include:

What is the efficiency like within your industry or niche?

What makes the most efficient and effective companies that way?

What can you take from their business models and incorporate them into your own business?

2. Set clear business goals

Performing regular benchmarks will allow you to set clearer business goals for your organization. Understanding why the competition is succeeding will give you important insight that will allow you to create measurable goals by defining success, develop innovative strategies to make an impact and effectively monitor your progress towards each goal over time. As you monitor your progress, be sure to make adjustments when necessary to accommodate changes in the market or changes within your organization

3. Provide new opportunity for discovery

Another reason why benchmarking in business is important is because it gives you a way to discover new opportunities for increased growth and success. This is especially important if your organization is stuck or not moving forward in the way you want it to. Performingbenchmarks allows you to identify the areas to improve upon to get your company on par with the growth and success of other organizations within your industry or niche. By assessing what other companies are doing to be successful, you can develop a plan to boost performance and take advantage of new opportunities.

4. Increase business sales performance

Strong sales greatly increase a company's overall success, but not having the appropriate insight to understand your sales performance can create a barrier for your organization. Benchmarking provides an opportunity to assess your sales figures and compare them to that of the most successful organizations in your niche or industry. For example, you could examine how much another company is selling, how many people they have on their sales team, how many sales teams they have and where they are located and whether your competitors are working with other major organizations in the form of partnerships.

There are several reasons why a company may have higher sales performance than your

organization. Common factors to look into include how they are marketing and advertising their products, any perks they are offering their customers for repeat business and where they are selling their products and services. You should also look at the organization's internal situation. Assessing why a sales team performs well will help you determine what changes you can make internally for increased performance.

5. Motivate employees

Regular benchmarking in business also provides a great opportunity to rejuvenate employees and increase their overall motivation and contribution to the organization. The best benchmarking to increase employee motivation is benchmark tests that evaluate the competition's individual departments. You then compare these results to the departments within your own organization and set goals to match the competition.

When setting goals for employees, it's important to ensure they are attainable, realistic and measurable. This ensures that everyone understands the expectations you have for them and that each employee knows the goal or goals they are working towards. You should also implement recognition or reward programs to ensure employees are recognized for their efforts and stay motivated

6. Better understand the competition

An obvious reason why benchmarking in business is important is that it allows you to better understand your competition as a whole. Understanding the competition's methods of operation and what's contributing to their overall success allows you to expand your current operations and increase overall productivity and performance.

7. Improve quality of product

You can also use benchmarking to assess your current product quality and improve upon it. For example, you could purchase another, more successful company's product, analyze what makes it different from yours and come up with ways to outperform that product.

8 steps in the benchmarking process

- Select a subject to benchmark. ...
- Decide which organizations or companies you want to benchmark. ...
- Document your current processes. ...
- Collect and analyze data. ...

- Measure your performance against the data you've collected. ...
- Create a plan. ...
- Implement the changes. ...
- Repeat the process.

Quality function deployment

QFD Process

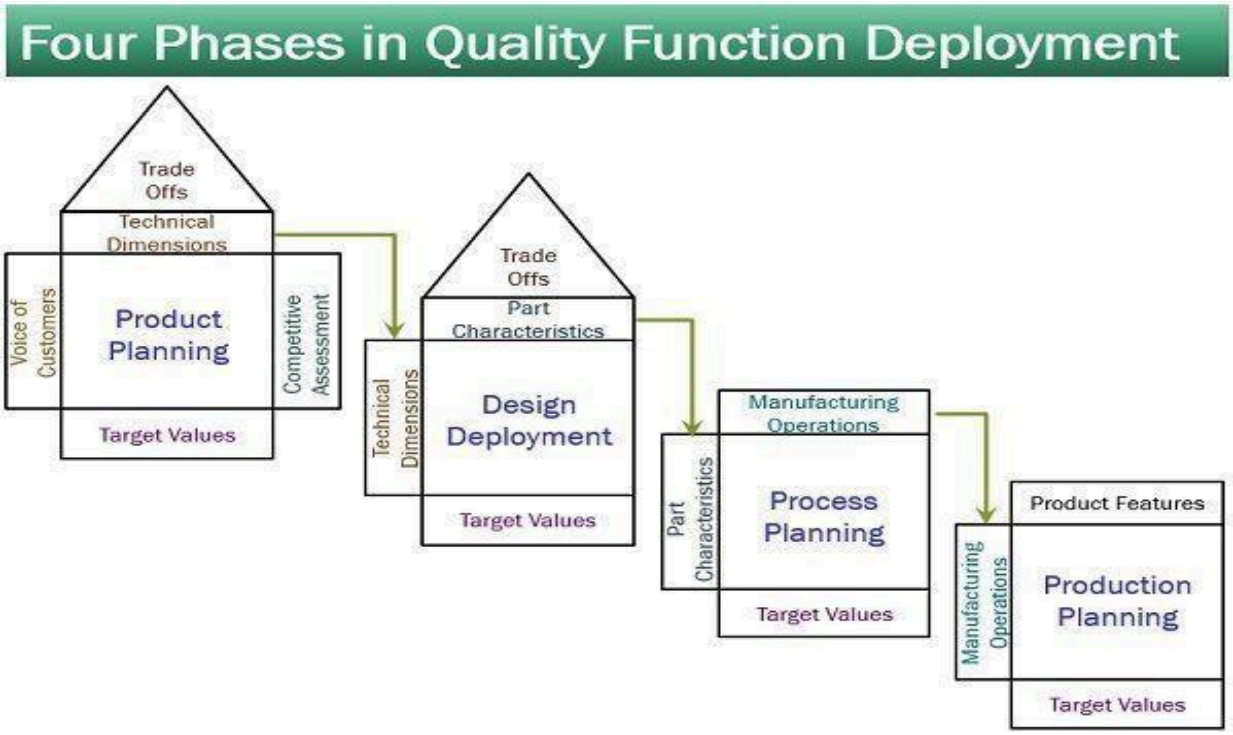
Introduction to Quality Function Deployment (QFD)

The average consumer today has a multitude of options available to select from for similar products and services. Most consumers make their selection based upon a general perception of quality or value. Consumers typically want “the most bang for their buck”. In order to remain competitive, organizations must determine what is driving the consumer’s perception of value or quality in a product or service. They must define which characteristics of the products such as reliability, styling or performance form the customer’s perception of quality and value. Many successful organizations gather and integrate the Voice of the Customer (VOC) into the design and manufacture of their products. They actively design quality and customer perceived value into their products and services. These companies are utilizing a structured process to define their customer’s wants and needs and transforming them into specific product designs and process plans to produce products that satisfy the customer’s needs. The process or tool they are using is called Quality Function Deployment (QFD).

What is Quality Function Deployment (QFD)

Quality Function Deployment (QFD) is a process and set of tools used to effectively define customer requirements and convert them into detailed engineering specifications and plans to produce the products that fulfil those requirements. QFD is used to translate customer requirements (or VOC) into measureable design targets and drive them from the assembly level down through the sub-assembly, component and production process levels. QFD methodology provides a defined set of matrices utilized to facilitate this progression.

A quality function deployment emphasizes on product and process design. It involves the following four phases



Definition: Quality function deployment is a systematic approach of specifying the customer needs and desires, rating them in terms of priority and designing the quality products and process to serve these requirements, through proper planning.

QFD is a process of bridging the gap between where we stand and what we aim at, by providing target values and competitive analysis.

This tool is widely applied in case of:

Application of Quality Function Deployment

Derivative products which are familiar but launched in a new
market Products which are casual but have been introduced with a
twist;
Next-generation products which have a new concept and started in an established market.

However, QFD is not applicable in case of products which have a new concept and introduced in a new market (i.e., first of its kind products). This is because of insufficient information or consumer data.

QFD Process

A quality function deployment emphasizes on product and process design. It involves the following four phases: Four Phases in QFD

Phase 1: Product Planning

The initial step of QFD exercise involves product planning. It is a process of analyzing the customer requirements and comparing these with the product's technical specifications to ensure quality optimization while designing a product. It involves the creation of the house of quality for a particular product.

House of Quality

House of quality is a matrix which is the basis of product planning, and its diagram looks like a house. It is a realistic approach which analyses the consumer desires and matches it with the technical attributes of a product, to optimally fulfil these requirements by utilizing the resources available with the organization.

This matrix determines the following parameters:

- Customer needs or requirements;
- Product design to suit these needs and wants;
- The priority of each item and its importance while designing a product and process;
- Competitive assessment and analysis of each element;
- Establishing benchmarks and target values for each component

Phase 2: Design Deployment

At this stage, the product design is developed by identifying the suitable assemblies or systems, sub-systems and components.Following are the various levels analyzed at this phase:

System Level: It includes the analysis of technical requirements for a product, prioritization of these specifications and their impact over a particular system or assembly.

Sub-system Level: The complex systems are then distributed into sub-systems to list, rank and study the critical components.

Component Level: The characteristic are then figured out in terms of purchased components,

thus provides as a source of information to the suppliers.

Phase 3: Process Planning

Now comes the process development stage of QFD. This phase evaluates the correlation between the various processes or steps and the technical and functional specification of the product. It helps to identify the process which meets the part requirements in the best possible manner.

Following functions are performed in this stage:

Analyze the crucial processes; Identify the process flow;
Find out the need for production equipment; Develop the framework for a critical process Phase 4: Production Planning
It is the last phase of quality function deployment. At this stage, the product's quality control throughout the production process is determined.

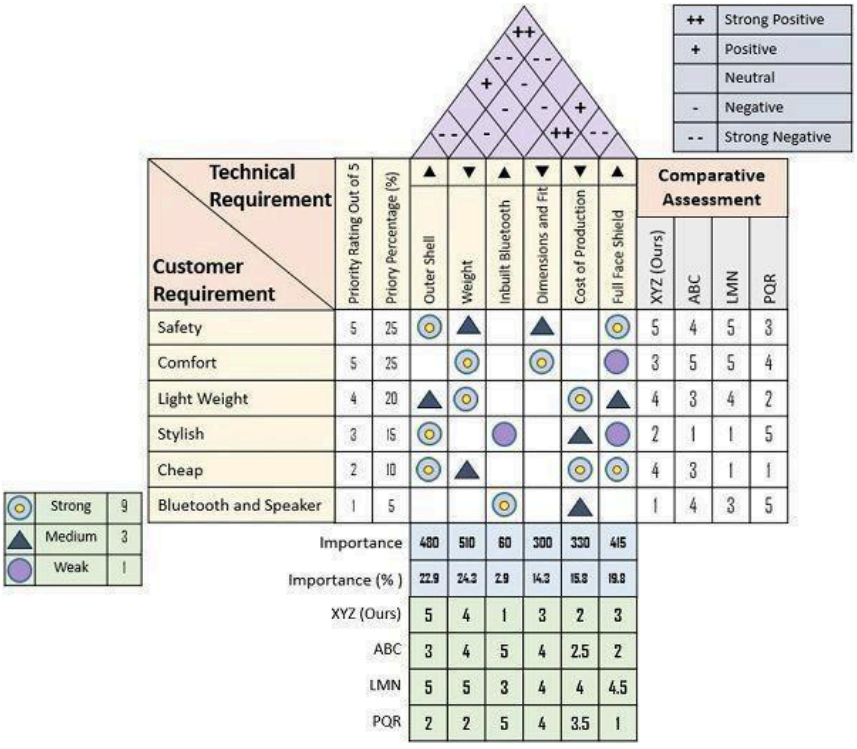
In other words, quality targets are decided during production planning. The various related activities carried out are as follows:

Examine the crucial technical and process characteristics; Identify methods of process control;Analysis and testing of the process and associated parameters

House of Quality Example

To have a clear understanding of the house of quality, let us study the given an example:

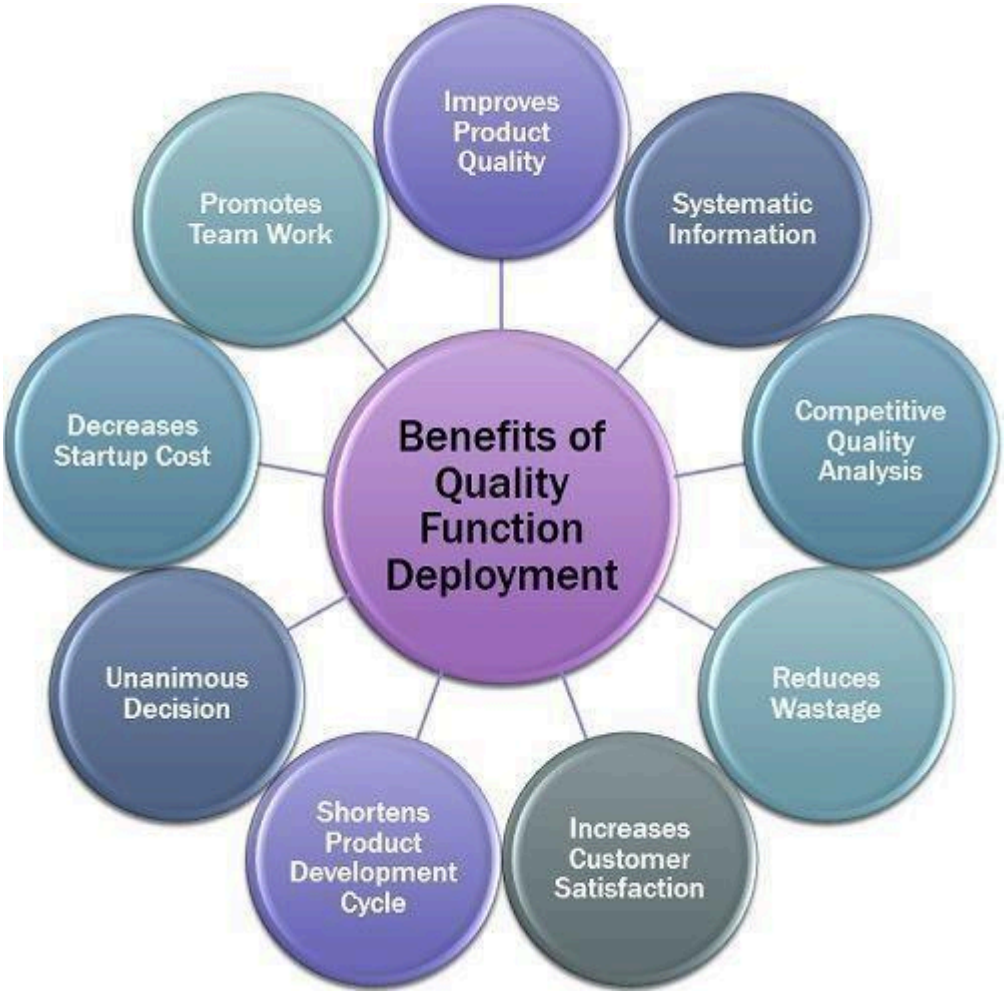
XYZ Company is the manufacturer of helmets. It conducted the quality function deployment to review the customer requirements, technical attributes, target values, competitiveness and measures for enhancing the product and process quality



++	Strong Positive
+	Positive
	Neutral
-	Negative
--	Strong Negative

Technical Requirement / Customer Requirement	Priority Rating Out of 5	Priory Percentage (%)	▲ Outer Shell	▼ Weight	▲ Inbuilt Bluetooth	▼ Dimensions and Fit	▼ Cost of Production	▲ Full Face Shield	Comparative Assessment: XYZ (Ours)	ABC	LMN	PQR
Safety	5	25	◎	▲		▲		◎	5	4	5	3
Comfort	5	25		◎		◎		●	3	5	5	4
Light Weight	4	20	▲	◎			◎	▲	4	3	4	2
Stylish	3	15	◎		●		▲	●	2	1	1	5
Cheap	2	10	◎	▲			◎	◎	4	3	1	1
Bluetooth and Speaker	1	5			◎		▲		1	4	3	5
Importance			480	510	60	300	330	415				
Importance (%)			22.9	24.3	2.9	14.3	15.8	19.8				
XYZ (Ours)			5	4	1	3	2	3				
ABC			3	4	5	4	2.5	2				
LMN			5	5	3	4	4	4.5				
PQR			2	2	5	4	3.5	1				

◎ Strong	9
▲ Medium	3
● Weak	1



What is Quality Loss?

The quality loss function as defined by Taguchi is the loss imparted to the society by the product from the time the product is designed to the time it is shipped to the customer. In fact, he defined quality as the conformity around a target value with a lower standard deviation in the outputs. It is a graphical representation of a variety of non-perfect parts that can each lead to losses, and these losses can be measured in rupee value. These losses basically originate from:

- Cost to produce,
- Failure to function,
- Maintenance and repair cost,

- Loss of brand name leading to customer dissatisfaction,

- Cost of redesign and rework

The Taguchi loss function is graphical depiction of loss developed by the Japanese business statistician Genichi Taguchi to describe a phenomenon affecting the value of products produced by a company

Through his concept of the quality loss function, Taguchi explained that from the customer's point of view this drop of quality is not sudden. The customer experiences a loss of quality the moment product specification deviates from the 'target value'. This 'loss' is depicted by a quality loss function and it follows a parabolic curve mathematically given by $L = k(y–m)2$, where m is the theoretical 'target value' or 'mean value' and y is the actual size of the product, k is a constant and L is the loss. This means that if the difference between 'actual size' and 'target value' i.e. (y–m) is large, loss would be more, irrespective of tolerance specifications. In Taguchi's view tolerance specifications are given by engineers and not by customers; what the customer experiences is 'loss'. This equation is true for a single product;Quality Circles

What is the role of quality circles in TQM?

A quality circle is a participatory management technique that enlists the help of employees in solving problems related to their own jobs. Circles are formed of employees working together in an operation who meet at intervals to discuss problems of quality and to devise solutions for improvements

The most well-known example would be Toyota, which helped to pioneer the concept decades ago. These circles continue to meet on a regular basis to identify potential problems and get them resolved as efficiently as possible

How can quality circles improve productivity?

By solving the problems and also making desirable improvements, quality circles contribute in increasing the quality, productivity and safety of the operations. More importantly the workers develop a positive and problem solving attitude by participating in the QC activities and derive more job satisfaction

What is Total in Total Productive Maintenance TPM?

- Total Productive Maintenance (TPM) started as a method of physical asset management focused on maintaining and improving manufacturing machinery, in order to reduce the operating cost to an organization.
- It can be considered as the medical science of machines. Total Productive Maintenance (TPM) is a maintenance program which involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction.
- TPM brings maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process. The goal is to hold emergency and unscheduled maintenance to a minimum.

TPM was introduced to achieve the following objectives. The important ones are listed below.

· Avoid wastage in a quickly changing economic environment.

· Producing goods without reducing product quality.

· Reduce cost.

· Produce a low batch quantity at the earliest possible time.

· Goods send to the customers must be non-defective.

Similarities and differences between TQM and TPM:

The TPM program closely resembles the popular Total Quality Management (TQM) program. Many of the tools such as employee empowerment, benchmarking, documentation, etc. used in TQM are used to implement and optimize TPM.

Following are the similarities between the two.

1. Total commitment to the program by upper level management is required in both programmes

2. Employees must be empowered to initiate corrective action, and

3. A long range outlook must be accepted as TPM may take a year or more to implement and is an on-going process.

Module-6 Quality Systems

ISO

The International Organization for Standardization is an international standard-setting body composed of representatives from various national standards organizations.

Founded on 23 February 1947, the organization develops and publishes worldwide technical, industrial and commercial standards. It is headquartered in Geneva, Switzerland and works in 166 countries.

Use of the standards aids in the creation of products and services that are safe, reliable, and of good quality

The ISO plays an important role in facilitating world trade by providing common standards among different countries. These standards are intended to ensure that products and services are safe, reliable, and of good quality. For the end-user and consumer, these standards ensure that certified products conform to the minimum standards set internationally. The ISO has been credited with setting more than twenty thousand standards, ranging from manufactured products and technology to food safety, agriculture, and healthcare standards

ISO FAMILY

ISO 9000 is a set of international standards, established by the International Organization for

Standardization, as the basis for quality management systems and quality assurance.

ISO 14000 is a series of environmental management standards developed and published by the International Organization for Standardization (ISO) for organizations. ... ISO 14001 specifies the requirements of an environmental management system (EMS) for small to large organizations.

ISO 21001:2018

Educational organizations — Management systems for educational organizations — Requirements with guidance for use

ISO 9000 history and revisions: ISO 9000:2000, 2008, and 2015

ISO 9000 was first published in 1987 by the International Organization for Standardization (ISO), a specialized international agency for standardization composed of the national standards bodies of more than 160 countries. The standards underwent revisions in 2000 and 2008. The most recent versions of the standard, ISO 9000:2015 and ISO 9001:2015, were published in September 2015.

The ISO 9000 family of standards listed below has been developed to assist organizations, of all types and sizes, to implement and operate effective quality management systems.

— ISO 9000 describes fundamentals of quality management systems and specifies the terminology for quality management systems.

— ISO 9001 specifies requirements for a quality management system where an organization needs to demonstrate its ability to provide products that fulfil customer and applicable regulatory requirements and aims to enhance customer satisfaction.

— ISO 9004 provides guidelines that consider both the effectiveness and efficiency of the quality management system. The aim of this standard is improvement of the performance of the organization and satisfaction of customers and other interested parties.

— ISO 19011 provides guidance on auditing quality and environmental management systems
'ISO 14000' is a global term for a set of standards that has been written in response to this need for environmental protection systems, in the same way that ISO 9000 standards were written to satisfy the need for quality assurance systems to control the goods produced and services supplied by companies. In fact, there is a very strong parallel between ISO 14000 standards and ISO 9000 standards, which will be discussed more fully later. Within the ISO 14000 series of standards, the fundamental standard that prescribes good practice in environmental management is

ISO 140011

*. ISO 14001 specifies the various requirements that have to be satisfied in setting up an effective EMS, such that the risks of pollution incidents and other forms of environmental damage through the operations and activities of a company are minimised

The ISO 14001 standard prescribes that a company shall establish an environmental policy that identifies all potential environmental effects arising out of its operations, and implements procedures designed to minimise these effects within the bounds of what can reasonably be achieved at an acceptable economic cost. As well as requiring the implementation of such an environmental management policy, ISO 14001 also prescribes that there must be a commitment to review the operation of the policy regularly and seek continual improvement in its performance in reducing environmental damage

ISO 21001, Educational Organization Management Systems, is a published international standard by the International Organization for Standardization, and released on May 1, 2018.[1] It is intended provide a common management tool for organizations providing educational products and services capable of meeting learner and other beneficiary needs and expectations and it focuses on the specific interaction between an educational organization, the learner, and other relevant interested parties.

ISO 21001 specifies requirements for an Educational Organization Managements System (EOMS) when such an organization

- needs to demonstrate its ability to support the acquisition and development of competence through teaching, learning or research;
- aims to enhance satisfaction of learners, other beneficiaries and staff through the effective application of its EOMS, including processes for improvement of the system and assurance of conformity to the requirements of learners and other beneficiaries

All requirements of ISO 21001 are generic and intended to be applicable to any organization that uses a curriculum to support the development of competence through teaching, learning or research, regardless of the type, size or method of delivery. ISO 21001 can be applied to educational organizations within larger organizations whose core business are not education, such as professional training departments, but does not apply to organizations that only produce or manufacture educational products.

Six Sigma

It is a method that provides organizations tools to improve the capability of their business processes. This increase in performance and decrease in process variation helps lead to defect

reduction and improvement in profits, employee morale, and quality of products or service

A six sigma process is one in which 99.99966% of all opportunities to produce some feature of a part are statistically expected to be free of defects.

Features of Six Sigma

- Improving Processes.
- Lowering Defects.
- Reducing process variability.
- Reducing costs.
- Increasing customer satisfaction.
- Increased profits.

The goal of Six Sigma is to reduce variation for optimal quality control. The discipline known as Lean Six Sigma (LSS) blends these two approaches. Refinements to the production process are essential to managing and reducing the 8 wastes analyzed by the Lean method

The DMAIC model is a roadmap for Six Sigma, used to improve the quality of results that company processes produce. The letters DMAIC are short for:

- ***Define,***
- **Measure,**
- ***Analyse,***
- **Improve**
- **Control.**

Eight Steps to a Successful Lean Six Sigma Implementation

Step 1: Create a Burning Platform. ...

Step 2: Put Resources in Place. ...

Step 3: Teach the Methodology. ...

Step 4: Prioritize Activities. ...

Step 5: Establish Ownership. ...

Step 6: Take the Right Measurements. ...

Step 7: Govern the Program. ...

Step 8: Recognize Contributions

Supply Chain and Operations:

In its simplest form a supply chain is the activities required by the organisation to deliver goods or services to the consumer. A supply chain is a focus on the core activities within our organisation required to convert raw materials or component parts through to finished products or services

A supply chain is comprised of all the businesses and individual contributors involved in creating a product, from raw materials to finished merchandise. Examples of supply chain

activities include farming, refining, design, manufacturing, packaging, and transportation

Supply Chain "KEIRETSU"

Keiretsu is a Japanese term referring to a business network made up of different companies, including manufacturers, supply chain partners, distributors, and occasionally financiers. ...
Translated literally, keiretsu means "headless combine.

Technical Supply Chain Competencies

1. Capacity Planning

Assuring that needed resources (e.g., manufacturing capacity, distribution centre capacity, transportation vehicles, etc.) will be available at the right time and place to meet logistics and supply chain needs. In other words, capacity planning focuses on determining the appropriate production levels that the company is capable of completing.

This also includes capacity planning with suppliers, at all manufacturing cells and also critical

machine/equipment; this also includes overall Equipment Effectiveness (OEE) and Sales Inventory & Operations Planning (SIOP

2. Demand Management

The demand management is the process of determining what customer will purchase and when, in other words predicting demand. The good demand management uses qualitative and quantitative methods to use customer data to reduce uncertainty, predict short-term
incoming demand for use as input into the Sales, Inventory, & Operations Planning (SIOP) process.

The competency includes the use of high analytical techniques; excel spread sheets and maybe software to generate baseline statistical forecasts. In my view demand management is one of the most important Supply Chain competencies.

3. Order Processing

Out of all supply chain competencies, Order Processing is the most underrated competency. Order processing entails the system that an organisation has for getting orders from customers, checking the status of orders, communicating with customers about them, and actually filling the order and making it available for customers. In some business, it also includes processes until invoicing.

4. Master Production Scheduling

The Master Production Scheduling is a statement of the anticipated manufacturing schedule for selected items by quantity per planning period (Fogarty and Hoffman 1983; Higgins and Tierney 1990). It is a response to the forecast demand described by the production plan, and the actual demand in terms of received customers' orders.

This supply chain competency also includes evaluation of plant capacity effectively, attaining the strategic objectives of the business as reflected in the production plan.

5.

6. Inventory Management & Optimization

Inventory management is a practice to manage inventory as working capital. The key objective of inventory management is to increase corporate profitability through improved inventory activities such as demand planning, inventory optimization, safety stock management, excess and obsolete inventory management or right inventory levels to meet customer services expectation with a minimum possible inventory

7. Materials Replenishment Planning

SAP has defined this competency very well as, “the main function of material requirements planning is to guarantee material availability, that is, it is used to procure or produce the requirement quantities on time both for internal purposes and for sales and distribution. This process involves the monitoring of stocks and, in particular, the automatic creation of procurement proposals for purchasing and production.

In doing so, material requirements planning tries to strike the best balance possible between

- Optimizing the service level and
- Minimizing costs and capital lockup

8. Logistics, Warehousing and Distribution

One of the key supply chain competences is to management physical flow of the goods, which mean the knowledge and skills necessary to effectively manage logistics communication, warehouse and storage management, material handling and distribution of goods (including reverse logistics).

9. Knowledge of Continuous Improvement Processes or Methods

As the name suggests knowledge of the processes or methods that seek to improve performance, which assumes more and smaller incremental improvement steps. In general learning and implementing the best known of these are the aforementioned: lean manufacturing (JIT), Six Sigma, Lean Six Sigma, and Agile.

Bu learning these philosophies it is not the rate of improvement which is important, it is the momentum of improvement in the area you want to improve.

Relationship of Operations and Supply Chain;

Operations and Supply Chain

In smaller organizations, there can be overlap between operations and supply chain management. One person or department can manage or play a role in both supply chain and operations. In part this is because Supply Chain Management has become more complex over time and the demand for highly trained professionals has emerged. Previously, the roles in SCM were handled by Operation’s professionals. Both positions require leadership, goal setting, organization, finance,

and decision making. Managers in both areas oversee people, parts, and supplies. They both require the ability to communicate across departments internally and externally, to lead people and teams, and to manage human capital

But how do they differ?

“Overall, supply chain is sourcing and moving both the raw materials and the finished product. Operations management is the part in the middle where the product is created from the raw materials. Supply chain is how you get it and get it to customers. Operations is how you make it,” stated Lee Buddress, an Associate Professor of Supply and Logistics Management at Portland State University.

Relationship of Purchasing and Supply Chain

Procurement is the process of getting the goods and materials your company needs, while supply chain management is the process of transforming those goods into products and distributing them to customers as efficiently as possible

Generally speaking, quality is the capacity of a product or service to meet or exceed customer requirements or expectations. There are seven dimensions of quality that are

important to consumers and businesses from the perspective of operations and supply chain management.

Service Quality and Supply Chain

How do you determine the quality of a service? Did the waitress serving you dinner provide a quality dining experience? How about whether your landscaper provided your lawn with a quality cut? Generally speaking, quality is the capacity of a product or service to meet or exceed customer requirements or expectations.

The customer's view of quality has these characteristics:

- Receiving the right product for their use
- Being satisfied that their needs have been met.
- Meeting their expectations
- Being treated with integrity, courtesy and respect