

A Review Paper on Modern Developments in Production and Operations Management

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Abstract

The paper discusses what generally is happening in the area of Production and Operations Management by highlighting the importance and role of Global focus, CAD/CAM, Just-In-Time, Product life cycle, Customized Production and Green Production. Analysis is done on how all these trends play an indispensable role in making processes more efficient, with the sole aim of reducing waste, increasing production rate, product quality, standard of living, cost-cutting and making the process faster by maximum utilization of man, material, and machine. These rapid developments have lead to increase in wages of employees, creating a global market for selling the products, improved designing and quality of the products, opportunities for introducing new innovations in product design, customization and last making our environment clean and green with the introduction of green production.

I. INTRODUCTION

Life would be much easier if the world would stand still, but of course it doesn't. As the world evolves, so must the disciplines whose mission includes helping managers deal with it. Production and operations management is the process, which combines and transforms various resources used in the production and operations subsystem of the organization into value added product and services in a controlled manner as per the policies of the organization. Therefore, it is that part of an organization, which is concerned with the transformation of a range of inputs into the required (products/services) having the requisite quality level. The set of interrelated management activities, which are involved in manufacturing certain products, is called as Production management. If the same concept is extended to services management, then the corresponding set of management activities is called as Operations management.

Operations Management is no exception, Robert Hayes discerns some changes in the business world deriving mainly from opportunities presented by the digital technologies, and explains what these mean to the management profession and hence how operation management must change so as to support managers in a changing world.

Historical Evolution of Production and Operations Management

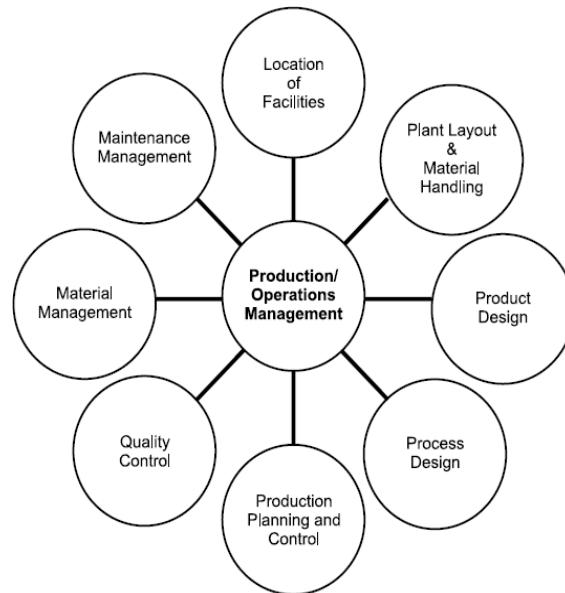
For over two century's operations and production management has been recognized as an important factor in a country's economic growth. The traditional view of manufacturing management began in eighteenth century when Adam Smith recognized the economic benefits of specialization of labour. He recommended breaking of jobs down into subtasks and recognizes workers to specialized tasks in which they would become highly skilled and efficient. In the early twentieth century, F.W. Taylor implemented Smith's theories and developed scientific management. From then till 1930, many techniques were developed prevailing the traditional view. Production management becomes the acceptable term from 1930s to 1950s. As F.W. Taylor's works become more widely known, managers developed techniques that focused on economic efficiency in manufacturing. Workers were studied in great detail to eliminate wasteful efforts and achieve greater efficiency. At the same time, psychologists, socialists and other social scientists began to study people and human behavior in the working environment.

In addition, economists, mathematicians, and computer socialists contributed newer, more sophisticated analytical approaches. With the 1970s emerge two distinct changes in our views. The most obvious of these,

reflected in the new name Operations management was a shift in the service and manufacturing sectors of the economy. As service sector became more prominent, the change from „production“ to „operations“ emphasized the broadening of our field to service organizations. The second, more suitable change was the beginning of an emphasis on synthesis, rather than just analysis, in management practices.

Scope of production and operation management ^[31]

Due to the dynamic change in the business environment, the scope of production and operation management has increased. Following are the activities which are included under production and operations management functions.



Activities under Production and Operations Management

- **Facility Location** - Selecting appropriate location for the production.
- **Plant layouts and material handling** - Deciding upon the machines, equipment and necessary devices which could lead to effectual and desired production in the most economic way. Preparation of plan layout for the establishment of machines in the required sequence. Storage of material and handling it in most effective way to avoid the wastage and delivery at the work centers as and when required.
- **Product design** - Designing the product and conceive the idea about its production.
- **Process design** - Determination of the production process which is most relevant and efficient in the given state of affairs.
- **Production and planning control** - Planning the production and its various aspects how, when and where producing a particular product or its assembly will be done.
- **Quality control** - Controlling the production and ensuring the quality by setting the check points and taking the periodic measurements of the current performance.
- **Materials management** - Managing the inventories of raw material, semi-finished and finished goods in a way that neither excessive money may block in this non-productive operation nor the required material.
- **Maintenance management** - Analysis the deviations and formulating the corrective measures to stay in track with planned quality, time-schedule and predetermined cost schedule.

Modern developments in production and operation management

The modern history of production and operations management was initiated in the 1950s by the extensive development of operations research tools such as waiting line theories, decision theories, mathematical programming, scheduling techniques and other theories. From the Industrial Revolution in 1769 up to the recent Internet Revolution, Operations Management has seen trends, which designed and redesigned the processes in order to make them more efficient, and businesses more profitable. Now with the fast expansion of technology, product lifecycles have become short and almost every product gets replaced by a new product in shorter time spans.

Due to this reason, companies are forced to introduce rapid development of new products with

encouraging innovation. This has provided a new challenge and requires redesigning of operations making the process faster. The trend has now been changing towards customized production of goods, whenever and wherever needed. This has led to change in the way operations were redesigned earlier leading to better and more efficient processes

The operations management is the process of managing activities that produces goods and services in order to create value to the customer. With recent development the operations management has changed drastically and major changes in operations management are summarized below:

- **Global Focus**
- **Computer-aided Design and Manufacturing (CAD/CAM)**
- **Just In Time Production**
- **Supply Chain Partnerships**
- **Shrinking product life cycle**
- **Customized Production**
- **Employee Empowerment**
- **Green Production**

GLOBAL FOCUS ^{[1][2][3]}

The geographical limitation of the market has expanded from focusing on local markets to focus on global markets. This has occurred due to the rapid development in communication, globalization and increased mobility of resources among countries. As a result countries focus on producing goods and services at a global scale rather than limiting themselves to geographical boundaries. The People's Republic of China (PRC) is the world's second largest economy by nominal GDP and by purchasing power parity after the United States. China is also the largest exporter and second largest importer of goods in the world. On a per capita income basis, China ranked 90th by nominal GDP and 91st by GDP (PPP) in 2011, according to the International Monetary Fund (IMF). As the Chinese economy is internationalized, so does the standardized economic forecast officially launched in China by Purchasing Managers Index in 2005.

China has become increasingly integrated into the world economy. It has become a major player in many commodity markets and global product chains as it seeks raw materials to sustain its rapid economic growth; to supply its growing export industries; and ultimately to achieve its goal for establishing a peaceful, comfortable and healthy society. While China's involvement in international product chains logically implies some degree of responsibility for ensuring environmental integrity across the product chains within which it operates, it similarly implies a shared responsibility with other actors along the respective product chains (including foreign suppliers of Chinese raw materials and foreign consumers of Chinese finished products).

Computer-aided Design and Manufacturing (CAD/CAM) ^[24]

Computer-aided operations meant that all the designing and manufacturing of the product would be done with the help of computers making the operations way more efficient (Groover, 1997). These systems immensely helped in new product development and redesigning the processes. Computer Aided Design (CAD) involves the use of computer hardware and graphics software to generate design drawings. Modern CAD equipment enables the designer to quickly produce very accurate and realistic images of products to be manufactured.

Computer Aided Manufacturing (CAM) is a system of automatically producing finished products by using computer controlled production machines.

CAD and CAM work together in that the digital model generated in CAD is inputted to the CAM software package. The CAM software needs to know the physical shape of the product (CAD model) before it can compose a proper set of fabrication instructions to a production machine.

In 1996, GM initiated a program to substantially reduce its Vehicle Development Process (VDP) time from 42 months to 24 months. In the same year, GM entered into an agreement with Unigraphics Solutions to use its CAD/CAM software Unigraphics. In 1999, GM signed a three-year agreement with the company as a follow up to the 1996 agreement. The agreement included the endorsement of Unigraphics' Internet-centric PDM application, iMAN. The new US \$ 139 million software and services contract was believed to be the world's largest collaborative engineering network.

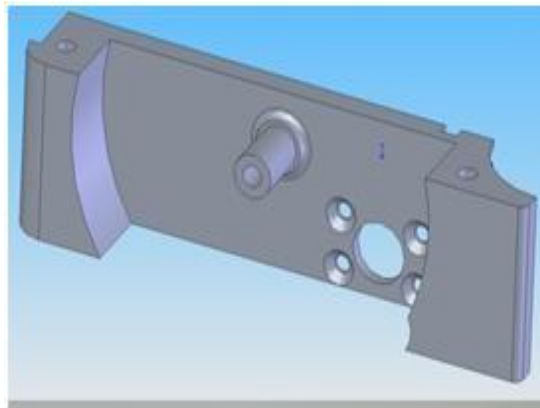
GM claimed to have saved hundreds of millions of dollars with the CAD/CAM/CAE systems.

The new systems allowed the company to launch innovative new cars and trucks in the market faster. The company successfully reduced its VDP time to 24 months. GM aimed at reducing the VDP time to 18 months. The company reported a 13 % improvement in engineering productivity in 1997 and expected an

additional 30% improvement by 2000. According to Jay Wetzel, the CAD/CAM/CAE tools enabled the company to save costs by reducing the number of physical validation builds. Cost savings were estimated at 30% during development and 10% during validation.



CNC Machine ^[26]



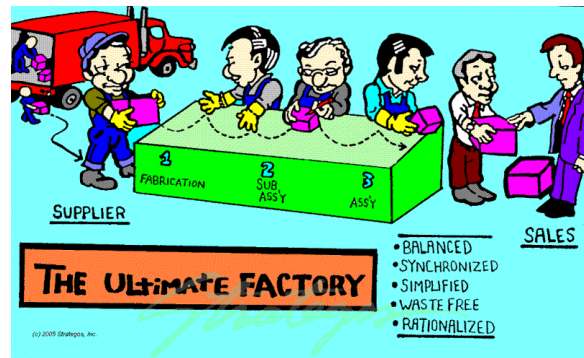
CAD Model



CNC Machined part

Just In Time Production ^{[4 to 13][28]}

In past production was carried out in a mass production method where there were batches of goods produced and sold at mass scale generating economies of scale. In the modern operations management era batch production focus has shifted towards Just In Time production where goods and services are produced upon the receipt of order with customizations. It has reduced the inventory cost drastically.



Just-in-time system^[28]

It is also assumed that JIT is sometimes said to have been invented by Henry Ford because of his one-at-a-time assembly line, circa 1913. This is an incorrect conclusion since Ford's system could handle no variety and was designed for large volumes and large **batch sizes** of the same parts. But actually it was invented by Taiichi Ohno of Toyota shortly after World War II. Ohno's system was designed to handle large or small volumes of a variety of parts. Many people are intimidated by JIT because of its association with Japan. If these people take a broader look at JIT, they will see that it is nothing more than good, common sense manufacturing.

Ohno and his associates came to America to study our manufacturing processes. They determined that our system was much like the system that Japanese companies were using, but Japanese companies could not afford waste in their systems due to the devastation to their economy caused by World War II. While in America, Ohno learned much about America's culture. One of his discoveries has transformed the world's perspective on manufacturing.

JIT implicitly assumes that input parts quality remains constant over time. If not, firms may hoard high-quality inputs. As with price volatility, a solution is to work with selected suppliers to help them improve their processes to reduce variation and costs. Longer term price agreements can then be negotiated and agreed-on quality standards made the responsibility of the supplier. Fixing up of standards for volatility of quality according to the quality circle.

A company called Green Gear Cycling Inc. in Eugene, Oregon uses the JIT system. While installing the JIT system the company was able to store the inventory that it was going to use at the moment forcing inventory to go down and they were able to keep the reordering quantities small, by only ordering what they needed. With the JIT system Green Gear is able to complete the construction of a bicycle in less than one day. Once the bicycles are completed they are shipped immediately to one more satisfied customer.

Several other known companies using Just-in-Time are Round Rock, Dell Computer Corp. and Cisco Systems Inc. According to a company spokesman of Dell, Vanancio Figueroa the process is known as "pull to order." "The system contributes to increasing the accuracy of doing business, both from a customer and supplier standpoint." (Figueroa) After getting an order, Dell informs suppliers about the parts that are going to be needed, and the parts are delivered within an hour and a half. When the parts are received in the Dell factories the manufacturing process begins. "With our pull-to-order system, we've been able to eliminate warehouses in our factories and have improved factory output by double by adding production lines where warehouses used to be," says Figueroa. Figueroa also mentions that Dell will save \$15 million dollars in the six months and \$150 million dollars in three years.

With Dell's exceptional JIT system they are usually able to meet consumer demands in less than a week.

Benefits of JIT

1. Reduced setup time.

Cutting setup time allows the company to reduce or eliminate inventory for "changeover" time. The tool used here is SMED (single-minute exchange of dies).

2. The flow of goods from warehouse to shelves improves.

Small or individual piece lot sizes reduce lot delay inventories, which simplifies inventory flow and its management.

3. Employees with multiple skills are used more efficiently.

Having employees trained to work on different parts of the process allows companies to move workers where they are needed.

4. Production scheduling and work hour consistency synchronized with demand.

If there is no demand for a product at the time, it is not made. This saves the company money, either by not having to pay workers overtime or by having them focus on other work or participate in training.

5. Increased emphasis on supplier relationships.

A company without inventory does not want a supply system problem that creates a part shortage. This makes supplier relationships extremely important.

6. **Supplies come in at regular intervals throughout the production day.**

Supply is synchronized with production demand and the optimal amount of inventory is on hand at any time. When parts move directly from the truck to the point of assembly, the need for storage facilities is reduced.

Supply Chain Partnerships^{[14-18][25]}

In past the purchasing activities were carried out based on the lowest bid where organizations chose the supplier who provides the lowest bid for a particular order. This was more short term focused and quality and reliability was ignored. In modern days the low bid purchasing has shifted to supply chain partnerships where companies consider suppliers as a part of their value chain and build long lasting relationships with suppliers rather than focusing on short term gains with low prices.

Historically, most businesses have based the quality of their supplier relationships on transactional metrics such as price, availability, level of service, or the perceived value of the supplier to the business. Using this approach at a simplistic level, enterprises typically place their suppliers into one of two categories:

1. **Tactical Relationships** are commodity-oriented associations that are based on the supplier's ability to provide the lowest price or best availability of commonly used goods and/or services. These relationships are typically short term in nature, and depending on market dynamics, any "tactical" supplier can be replaced when market conditions (such as new customer requirements) warrant such a change.

2. **Strategic Relationships**, on the other hand, are defined as high-value, long-term relationships that require an investment of time, training, and resources, and as a result, increase the overall worth of that relationship to the business. Unlike with tactical relationships, the *value of personal interactions* is an important metric in a strategic supplier relationship.

By applying strategic supplier development solutions that will monitor and measure the effectiveness of these relationships, enterprises can achieve four beneficial results:

1. **Increased Performance** – With strategic supplier development solutions, enterprises can use detailed information that allows them to reach into supply chain operations and gain a better understanding of the specific areas where output performance can be improved. Through this analysis, relationship experiences can be leveraged into an increased level of enterprise/supplier trust that can translate into process improvements and increased performance.

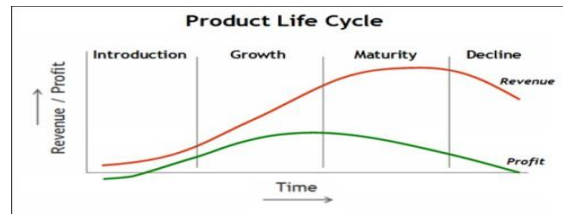
2. **Reduced Risk and Turnover** – Reducing the amount of turnover associated with strategic suppliers is essential to maintaining enterprise growth and long-term profitability. Negative or deteriorating supplier relationships can lead to greater friction, distrust, and poor resource performance. An effective strategic supplier relationship management solution allows an enterprise to detect specific problem areas, thus making it easier to implement changes, improve the working relationship, and reduce the factors that contribute to greater employee/supplier turnover.

3. **Improved Operational Efficiencies** – Strategic supplier relationship solutions allow the enterprise to build bridges between internal and supplier organizations that maximize operational efficiencies. These solutions realign processes and resources based on trust. By allowing client and supplier participants to provide commentary, feedback, and scorecard rankings that realign supply chain resources, enterprises can extract greater cost-effectiveness from their strategic supplier relationships, thereby directly contributing to improved corporate profitability.

4. **Better Access to Exceptional Suppliers** – By using strategic supplier management solutions that enable in-depth evaluations and scoring of strategic supplier relationships, enterprises can find, improve, retain, or if need be, eliminate specific resources, ensuring that the best-qualified strategic suppliers will continue to meet their business needs today, and well into the future.

Shrinking product life cycle^{[15][27]}

In past the product life cycle was lengthy and when a product was introduced it stayed in the market for a long time. But with the rapid expansion of technology the product life cycle has become short where every product is replaced by a new product very fast. Due to this reason companies are not able to have lengthy product development processes and the forced to introduce rapid development of new product while encouraging innovation. Proprietary branded product companies are facing increasing competition from generic manufacturers who are able to produce products at a similar or identical quality levels in very quick time frames. Gone are the days of cheap nasty rip-offs. It appears on many levels Quality is now a commodity. Just look the modern car: cheaper cars now offer pretty much all the same safety and quality features of their more highly priced competitors: airbags, air conditioning, accessories, GPS, etc.



Product life cycle^[27]

Shrinking product lifecycles make it increasingly important for businesses to get innovative offerings into the customers' hands, quickly. With continuous product innovation and further market fragmentation, customers have more choices and leverage than ever before.

A great example of modern retailer is the worldwide retail clothing chain phenomenon, ZARA. They have listened to their customers, read the market extremely well and as a result offer great design at affordable prices, with 16 range cycles a year and good service; and what's even better is you can dress a whole family at ZARA in good looking, smart clothes for a reasonable price.

Customized Production ^[20-22]

In past there was mass production where production was made in large scale with standardized production to gain economies of scale. But with increased flexibility and competition now companies are forced to customize their products based on customer requirement and techniques such as mass customization is used in doing so. **Mass customization**, in marketing, manufacturing, call centres and management, is the use of flexible computer-aided manufacturing systems to produce custom output. Those systems combine the low unit costs of mass production processes with the flexibility of individual customization.

Mass customization is the new frontier in business competition for both manufacturing and service industries. At its core is a tremendous increase in variety and customization without a corresponding increase in costs. At its limit, it is the mass production of individually customized goods and services. At its best, it provides strategic advantage and economic value. The concept of mass customization is attributed to Stan Davis in Future Perfect and was defined by Tseng & Jiao (2001, p. 685) as "producing goods and services to meet individual customer's needs with near mass production efficiency". Kaplan & Haenlein (2006) concurred, calling it "a strategy that creates value by some form of company-customer interaction at the fabrication and assembly stage of the operations level to create customized products with production cost and monetary price similar to those of mass-produced products". Similarly, mass customization involves balancing operational drivers by defining it as "the capability to manufacture a relatively high volume of product options for a relatively large market (or collection of niche markets) that demands customization, without tradeoffs in cost, delivery and quality".

Dell Computer has changed the competitive landscape by:

- Offering customized products directly to customers on demand without premiums in either price or lead time
- Minimizing inventory to unthinkable levels
- Being agile quickly responding to the market/technology changes
- Eliminating the cost and risk of finished goods inventory
- Successfully executing a mass customization strategy quarter after quarter, year after year.

Michael Dell adopted mass customization for far more pragmatic reasons. From his humble college dorm room, he could only afford to build products on demand. He didn't have the resources (capital, work space, infrastructure, etc.) to build finished goods inventory and put it on a shelf in the hope that someone would come along and buy what he had built. He could only afford to produce real customer orders. Michael Dell was forced into this business strategy due to tangible constraints, not because he recognized the larger potential of this business strategy.

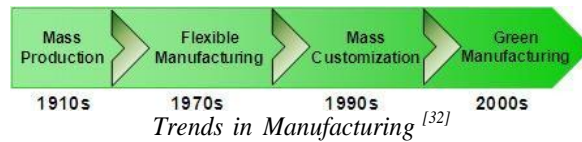
Employee Empowerment ^[29]

In past employees were treated as just another input to the production process where they were treated like machines. There was specialization and workers concerns were ignored. With the development of Human Resource Management now firms focus on employee empowerment where they treat employees as resources that bring competitive edge to the firm. In this concept the workers concerns are heard and organizations make arrangements for their welfare and mental/physical fitness. Employee empowerment is a strategy and philosophy that enables employees to make decisions about their jobs. Employee empowerment helps employees own their work and take responsibility for their results. Employee empowerment helps employees serve customers at the level of the organization where the customer interface exists.

Advantages of Employee Empowerment

- It leads to greater job satisfaction, motivation, increased productivity and reduces the costs.
- It also leads to creativity and innovation since the employees have the authority to act on their own.
- There is increased efficiency in employees because of increased ownership in their work.
- Lesser need of supervision and delegation.
- Focus on quality from the level of manufacturing till actual delivery and service of goods.
- Employees when empowered become more entrepreneurial and start taking more risks. Greater the risk, greater are the chances to succeed.

Green Production [23][30][32]



Green Production is a part of green business strategies that are based on the principle of environmental sustainability. It focuses on profitability through environmentally friendly operating processes. These processes may constitute a key basis for competitive advantage in the coming decades. It is not just instituting pollution controls or recycling programs when manufacturing goods but it is about minimizing the harmful impact of the manufacturing processes on the environment at every stage. In past the production was focused on obtaining resources at lowest possible cost and manufacturing at the lowest cost ignoring the damage made to the environment.



Due to the initiatives by environment pressure groups companies are moving towards green production and green marketing where they carry out business activities without damaging the environment by not destroying natural resources, taking care of forests and wild life and so on. According to Hart and P. Shirvastav, Green production focuses on three fundamental goals

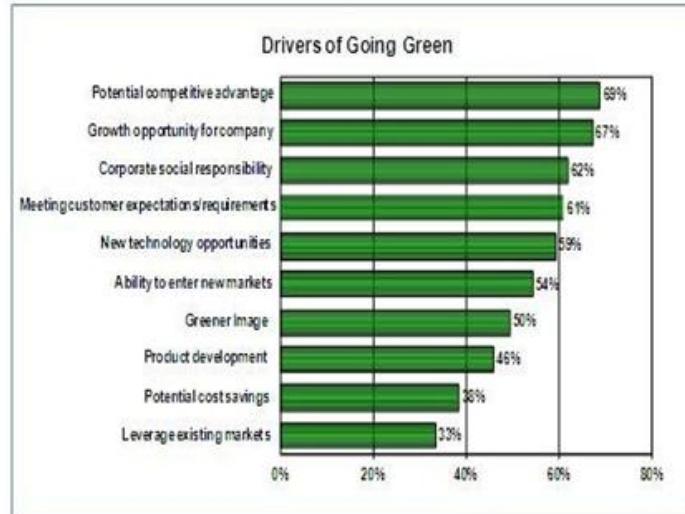
- Minimize emissions, effluents, and accidents
- Minimize the use of virgin materials and non-renewable forms of energy
- Minimize the life-cycle cost (cradle to grave) of products or services.

Drivers of Green Production

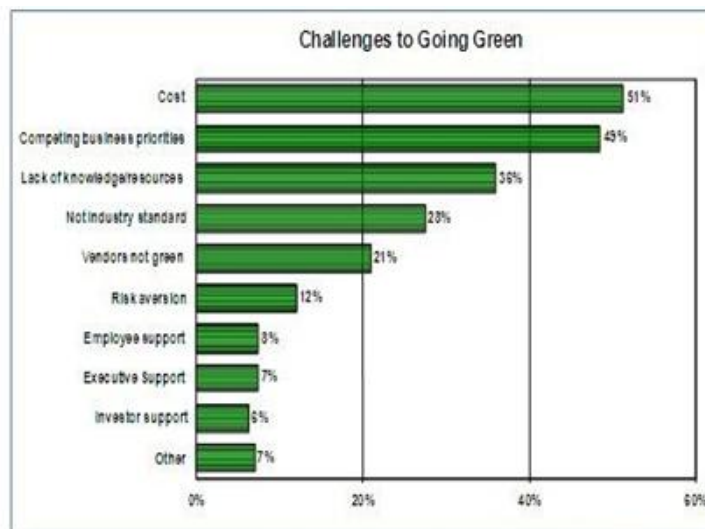
More and more companies have started adopting Green Production as an integral part of their Operations. Factors driving such initiatives are

- Increasing energy and input costs
- Growing consumer awareness about Green Products
- Regulatory pressures
- Need to differentiate from competitors by enhancing competitive advantage

The chart below shows result of survey conducted by BCG in collaboration with CII. The survey aimed at finding drivers for green production.



Source: Frost & Sullivan



Source: Frost & Sullivan

II. CONCLUSION

With the help of these trends following things are achieved:

1. Increased Production rate
2. Reduced production time
3. Improved quality
4. Reduced scraps
5. Reduced unit rate of the products.
6. Improved the skill of the worker
7. Increased living standards.
8. Less labour
9. Green and pollution free environment
10. Maximum utilization of machines
11. Maximum inventory control
12. Risk free environment.

From this we conclude that several achievements are achieved after these developments. In past production is limited, wages were limited, resources were limited, and main customer satisfaction was limited. But now the rapid growth in the production and operation management field proved that developments are occurred in every field like in product selling to green environment. These trends helps in increasing skills of workers, creating global market for selling, good infrastructure creation, competition in market, new products for customers with reasonable rates. In last this help in protecting our resources for future.

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