Analysis of the Most Significant Operational Parameter that Determines the Productivity of Indian Manufacturing Organizations

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Abstract

Manufacturing aims to contribute 25 percent to the share of India's GDP by 2020. India plans to be a technology driven manufacturing hub with many multi- national companies starting to set up the infrastructure for manufacturing. The Government of India has forwarded a supporting hand by implementing various initiatives. In the year of 2019 the government has permitted foreign direct investments of 100 percent in the sector of contract manufacturing. The Pradhan Mantri Kaushal Vikas Yojna has facilitated industry oriented skill development to lakhs of prospective employees. Many hi-tech electronics and communication, luxury brands have started their operations in India after the availability of the skilled labor. Industrial corridors, smart cities and integrated supply chains are now trying to achieve excellence to place India on global manufacturing arena. Catering to the global market would help India in its exports. Customer orientation is the key functional aspect of any business. Customers primarily expect five things from the product like quality, faster delivery, effective cost, variety and experience with supplier during the lead time. The manufacturing organization has to strive at its best to ensure customer satisfaction. The research aims to understand the most crucial operational parameter from the entrepreneurs perspective that helps them determine the productivity of their manufacturing organization.

Keywords: Operational Parameter, Manufacturing, Productivity, Entrepreneurs And Quality.

Introduction

The second industrial revolution embarked between 1870 and 1914 led to life changing innovations like steel, power, moving assemble lines, telephone, internal combustion engines etc. The revolution connected the world and made it a smaller place. The second industrial revolution was predominantly restricted to the western world. With a scattered agricultural economy, manufacturing soon picked up the pace and became a major economic contributor in terms of employment, production and catered to the customer needs (Mokyr, Joel, 1998).The economic situation then led to development of products and services that became a vital need of the customer. The demand started to increase exponentially but the supply remained constant. This situation gave the manufacturers a higher access to the market dynamics. The manufacturers were often said to control the supply.

This left the customers in a situation where they had no choice but to accept what was put forth by the manufacturers be it in terms of quality, quantity, variety, cost, speed of delivery and experience (More, Charles, 2002). There was an unspoken resentment that lied within customers but with no availability of options the situation continued to exist the way it was. Seeing the lucrative scope of the market, competitors started creeping in and dilution of profits began. Slowly and steadily supply started increasing to cater to the ever growing needs of the customers. The situation altered soon, supply was now available in excess whereas the demand for products started to remain as a constant. Organizations now started to improve their productivity in order to survive the business and earn profits. The reins of the market were now in the hands of the customer who could be demanding and decided the fate of the manufacturers. The western world was getting a taste of customer driven market economies (Mokyr, Joel, 1977).

The era of 1940's saw another wave of customer orientation that was evolving in the eastern world. After the World War-II, Japan was smashed down economically. The Hiroshima and Nagasaki bombings had destroyed the entire manufacturing hub in Japan. But the country refused to agree its defeat and took a united decision to rise up from this down trodden situation. The nation united to a philosophy that if economic situations were to be improved then employment opportunities had to be improved. Understanding the skill set possessed by the population , manufacturing seemed to be the choice of the country. In order to improve the financial state of the country it was obvious that targeting the global markets and increasing the exports was the way out to move away from the economic crisis. To move to the global markets was not an easy task as the global markets were already flooded with products from the western and Chinese market. Something extra and unique had to be provided to the customer. One thing had to be kept in the mind that there was no financial aid that would be available to provide this something extra to the customers. (Fujita, Masahisa and Tabuchi, Takatoshi, 1997).With significant leadership the country decided to move ahead. They knew they had to deliver more with less resources as compared to the western market. Necessity being the inventor the manufacturing sector started understanding the lacunas of the western market. They soon learnt that the western market provided a very limited variety to the customer that created resentment among the customer. The customers believed this to be conflicting with their personal identity. The cost for which certain products were offered seemed to be costly. Customers were subjected to unpredictable waiting periods. The Japanese manufacturers decided to target these lacunas and converted them into their unique selling points. Improving productivity now became the chase strategy. (Yamashina, Hajime, 2000). The research aims to understand the most significant operational parameter that determines the productivity of the manufacturing organizations.

Literature Review

Productivity all together had a new definition. Productivity was defined as delivering the best quality product in the shortest lead time at the most effective cost without compromising the variety that was to be offered. Resources were limited and wasting them was a blunder. Doing more with less was the new definition of productivity. The Toyota Production System formally introduced a production methodology that took the world by aghast. Till date the Toyota Production system proves to be the most effective production system. Productivity improvement through their techniques like identification and elimination of non- value added activities, Quick Changeovers, Quality Checks at source, Total Productive Maintenance, Kaizen, Value stream mapping, single piece flow, Just in Time etc are now adopted by all the successful organizations in the world. The world now looks up to Japan as the most productive country in terms of its manufacturing strength. (Drucker, Peter F, 1995)

Being productive demands organizations to constantly be vigilant. Productivity is an accumulative judgement derived from the performance of various operational parameters. Focusing on the customer oriented approach productivity can be derived from the following few operational parameters:

- Lead Time
- Quality
- Production Quantity
- On Time In Full Delivery
- Inventory
- Overall Equipment Effectiveness

Let us study the impact of each of these operational parameters on the productivity of manufacturing organizations.

Lead Time:

Online order registration portals have opened up global markets for organizations. Customers can easily compare the best of the deals to avail the best offering. Lead time can be described as the time required to complete a series of operations that includes order registration, actual production and then the final delivery to the customer.

When the order is actually received by the customer, satisfying his/her expectations, the duration is termed as lead time. Online portals with an inventory based model have lured customers with lightning fast deliveries. This has put pressure on the manufacturing organizations to shorten their lead times as fast as possible. Lead time provides a competitive edge over the competition but may involve the use of additional resources to speed up the delivery. Resources such as additional workforce, better equipment, training, technology may help organizations deliver in shorter lead time. Lead time tests the operational performance of the organization as there are many activities that impact the Lead time. Planning and scheduling often determine the timings when an order will start processing and when the order will be complete for delivery. Lead time has three components interlaced one after the other-the first component being the inbound logistics, the second component being the production and the third component being the outbound logistics. Production as a component can be addressed by the organization and improvements related to shortening of the lead time can be actionable. Inbound and Outbound logistics are often outsourced and proves to be a difficult area in which the organization can do anything significant. Lead time is heavily dependent on the material flow in the organization. When there are a lot of orders pending with the organization the situation gives rise to accumulation of moving work in progress. The moving work in progress cumulatively increases the lead time of the new orders registered in the system. Quality as an operational parameter also impacts the lead time of the organization. High rate of defects leads to higher rework which puts a stress on the resources as well the time consumed for production increases. (Kuhlang, 2011) (Helo, 2004)

Quality:

When long term association with a customer is foreseen quality is the most uncompromisable factor. Quality is often represented as adherence to standards, specifications, precision, durability, performance etc. Organizations often take into consideration the aspect of quality as external quality delivered in the form of finished goods to the customers. But the game changer is actually the parameter of internal quality. Quality is often considered as an investment oriented parameter. It is a myth that quality can be incorporated into the product only if huge investment in terms of cost are involved. In fact it is a common myth that the more the number of internal checks the more the quality incorporated into the product. The Japanese manufacturing busted this myth by simply delivering quality at six sigma standards without extravagant expenditure on technology and an increase in the levels of quality check. The simple philosophy they followed was, that, what matters the most when it comes to quality is the stage at which it is checked. If the quality is checked after the production is over, the number of defects occurring at the end of the process are going to be tremendous. On the other hand if quality checks are introduced in the beginning itself the defects recognized in the final stage are few. Early detection leads to prevention is the underlying philosophy. When quality is checked at the initial stage itself , rework being the main cost center of the organization is averted and tremendous cost savings can occur. Taking elimination of rework as a cost improvement opportunity too, Pokayoke a mistake proofing technique comes in handy. Quality as an operational parameter helps organizations achieve customer satisfaction and create lasting business relationships. Another reason why quality as an operational parameter is crucial is because it helps in eliminating non value added costs involved in manufacturing by eliminating the concept of rework that burdens the resources. (Park, Sung H, 2003) (Deming, W Edwards, 1981)

Production Quantity:

The operational parameter that stands very close to any entrepreneurs heart is the production quantity. It gives a quick indication on a daily basis about the state of the organization. Production quantity is the final defect free output that has been obtained and can be measured on an hourly, daily, weekly, monthly, annual basis. Production quantity is dependent on innumerous factors. The availability of quality input material is vital. If quality material is compromised then a lot of productive time is wasted in doing the internal check of input, once the input with inferior quality has been identified a new subprocess of rejecting the material and awaiting the new material consumes a lot of time and reduces the production quantity. The involvement of the top management in the production planning and scheduling needs to be executed by skilled operators to deliver the best output. Any breakdown in the machine and equipment will lead to reduced availability of the production time. Contribution of maintenance to production quantities is significant. An interesting measure of production quantity is, when only the quantities produced against an order are considered in the quantity. To explain this further, inter batch changeovers are sometimes quite time consuming. To avoid the loss of production time organizations produce in big batch sizes irrespective of orders. This situation technically increases the production quantity as a whole but creates inventory that has no demand as of now. Production quantity can often be a misleading figure. Organizations that are made to stock may have daily targets of production quantities but,

creating an inventory without the demand may lead to investment of working capital that could cut through the profits. Defects may sometimes too be included in the count of production quantity and can mislead the entire production system. Production quantities driven by a registered order and defect eliminated count are the true count of measuring the production quantity and hence should be considered as a significant operational parameter. (Wu, YS, 1969) (De Vries, 2014)

On Time in Full Delivery:

Operational Parameters are usually studied in isolation but with advance developments in the supply chain a new operational parameter was introduced which was a combination of Lead time and the Production Quantity. On time in Full Delivery binds together production and service in a single factor. On time in full delivery is usually expressed in percentages. All the orders that are fulfilled in a particular time period are analyzed. Two deciding criteria that are considered in every order is that was the order completed in totality in terms of the units demanded by the customer. Has the order been received by the customer in the duration that was demanded by him/her. If both the criteria are satisfied only then would we say that the order was completed in On time and in full. The On time in full status of all the orders are analyzed and a percentage is calculated that, out of all the orders fulfilled in a particular time how many have been delivered as per the On time in full criteria. Supply chains today analyze the On time in full percentage to understand the integrated flow of material and information throughout the organization. On time in full parameter helps us diagnose that if the there exists a problem in the production aspect or the delivery aspect of the organization and effective measures can be taken to improve the on time in full parameter. On time in full directly impacts the customer satisfaction. Whenever organizations handle their own logistics it is almost like the organization runs a supply chain. On time in full delivery acts as a parameter that tracks the velocity of the supply chain and the production capacity. With an inventory accumulation in the organization still if the organization is not able to achieve a good on time in full delivery rate gives it is a clear indication that the production is not going as per the order management but is being continued on the preference of convenience over delivery. When the organization aims to look at operational performance of supply chain as a whole on time in full delivery is very important. (Ahmad, 2002) (Temponi, 1995)

Inventory:

Financial health of the organization remarkably depends on the management of the inventory. Different types of businesses manage inventories in a different ways. Businesses that follow the made to order model possess very little inventory whereas the made to stock business model welcomes huge possessions of inventory. If we look into manufacturing of seasonal goods inventory is accumulated for a restricted period of time and then for the rest of the period there is no inventory. Traditional management approach believes inventory to be asset. The modern management approach contradicts this belief and believes inventory to be a liability. The theory of constraint philosophy of Goldratt also believes inventory to be liability when it is lying with organization itself. Inventory can be converted from liability to asset only when the actual sales of the inventory generates cash to the organization. (Watson, Kevin J and Blackstone, John H and Gardiner, Stanley C, 2007) The Toyota production system consists inventory as one of the seven fundamental wastes that organizations should look forward to eliminate. The Just in Time manufacturing philosophy considers inventory as a blunder and the possession of inventory when not needed increases the operational expense of the organization and sweeps away the profit. Inventory occupies space and requires handling safety of material which again burdens the organization. The inventory is classified into three categories , one is the inventory of the raw material, second is the inventory of the work in progress and the third inventory is that of the finished goods. Inventory possessed in the form of raw material is still less harmful. When the inventory is in the form of raw material it has yet not undergone through any of the process and no additional value added cost is involved. Inventory in the form of Work in progress is the next dangerous inventory as working capital has been invested into it but yet returns are to be awaited. The most dangerous form of inventory is that of the finished goods because it has consumed all the aworking capital, needs investment in the form of handling and holding. There are several myths that organizations hold when it comes to storing excess inventory. One of them is the hope that some urgent customer order can be fulfilled with the possession of inventory. Sometimes the availability of labor throughout the year is a problem and pressurizes organizations to build inventory. Seasonal availability of material, luring supplier deals, wrong forecasts, incorrect speculations from sales, maintenance shutdowns, machine breakdowns, planning and scheduling create a havoc in managing the inventory. (Lieberman, Marvin B and Asaba, Shigeru, 1997) (Koumanakos, 2008)

Overall Equipment Effectiveness:

Overall equipment effectiveness is an important parameter for manufacturing organizations that are equipment

intensive. The health status of the machines in an organization directly impacts the organizations production, maintenance, costs, defect. Overall equipment effectiveness encompasses three factors

- Availability
- Performance
- Quality

The ideal time available for manufacturing by an organization can be expressed as the number of working hours. But in reality these working hours are interrupted with changeovers and unplanned interruptions like power failure, unavailability of raw material, breakdown etc. When these losses are subtracted from the ideal working hours we are left with the actual availability of time. This availability of time is further subjected to interruptions like reduced speed of operations may be due to complexity of products or some minor stoppages. When the preceding interruptions are eliminated from the available time we are left with the actual operating time where an equipment can actually deliver value added output. But this operating time is further interrupted with production of defects that consume the value added operating time. Finally the time when the machines producing defect free products is known as the fully productive time of the machine. Overall equipment effectiveness calculates the ratio of the fully productive time to the ideal working time. An OEE of above 85 percent can be considered as a gauge to determine the health of the organization. If OEE is above 85% the organization is good in terms of its operational performance. OEE is thus considered as an important operational parameter by many manufacturers. (Andersson, 2015) (Muchiri, Peter and Pintelon, Liliane, 2008)

Research Methodology

The research aims to understand the most crucial operational parameter that determines the"Productivity" for manufacturing organizations taking into consideration the entrepreneurs perspective. The primary research involved an exploratory approach by designing a questionnaire whose respondents were the entrepreneurs of the manufacturing organizations. The respondents were expected to rank the operational parameters on the basis of their business acumen and experience. Rank 1 was to be allocated to the most significant parameter and rank 6 was to be allocated to the least significant parameter. The operational parameters structured in the questionnaire were derived from an extensive secondary research from literature like research papers, articles, news feed. There were 6 operational parameters that were taken into the construct. The research aimed to understand which amongst the 6 operational parameters is the most significant parameter for a manufacturing organization. The 6 operational parameters that were taken into consideration were as follows:

- Lead Time
- Quality
- Production Quantity
- On Time In Full Delivery
- Inventory
- Overall Equipment Effectiveness

The Primary survey was confined to the geographical area in the district of Mumbai. The population size in manufacturing is 1580 approximately through which a sample size of 100 respondents was obtained using statistical methods. The sampling techniques used in the primary research were purposive sampling and quota sampling. The research scholar being a professional consultant could contact the entrepreneurs through the client based portfolio. Analysis of the data was carried out using the statistical software of IBM SPSS. Google forms were the medium to circulate and collect responses from the respondents. As the questionnaire had only one question which involved ranking hence reliability and validity was ensured by asking and correcting the questionnaire during the pilot survey. An advanced multivariate statistical technique known as Friedman's Rank test was applied to the coded data that rendered the most significant operational parameter that impacted the productivity.

Research Objectives:

- To study the operational parameters that determines the productivity of a manufacturing organization in India.
- To identify the most significant operational parameters that determines productivity of a Small Medium Enterprise from the entrepreneurs perspective.

The question that contains the ranking and the operational parameters can be represented as :

Operational Parameter	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6
[Lead time]						
[Quality]						
[Production Quantity]						
[On time - In Full Delivery]						
[Inventory]						
[OEE - Overall Equipment Effectiveness]						

The Entrepreneurs were requested to allocate a rank to every operational parameter and it was made sure that only one parameter could be allocated to a particular rank.

Research Aim:

To analyze the most significant operational parameters that determines the productivity of a manufacturing organization.

Hypothesis:

H0 : All the operational parameters determining the productivity are equally significant from an entrepreneurs perspective

H1 : All the operational parameters determining the effectiveness are not equally significant from the entrepreneurs perspective

Data Collection and analysis :

The responses gathered from the 100 respondents were coded in excel and then the statistical software of IBM SPSS was used for further analysis. The advance multivariate statistical technique of Friedman's Rank Test was used for testing the hypothesis. Friedman's rank Test is a non- parametric test which is an extension of paired data concept.

Results and Interpretation:

NPAR TESTS

/ F R I E D M A N = L E A D T I M E Q U A L I T Y PRODUCTIONQUANTITY OTIF INVENTORY OEE.

Friedman Test

Parameter	**Mean Rank**
Leadtime	4.41
Quality	5.92
Productionquantity	3.84
Otif	3.17
Inventory	2.55
Oee	1.11

Test Statistics[a]	
N	100
Chi-Square	386.389
df	5
Asymp. Sig.	.000
a. Friedman Test	

The score distributio n of individual parameters is as follows with 6 being the highest achieved score and 1 being the least achieved score :

Score	Lead time	Quality	Production quantity	On time in full delivery	OEE	Inventory
6	6	94	0	0	0	0
5	54	4	42	0	0	0
4	15	2	1	56	25	1
3	25	0	56	6	13	0
2	6	0	1	37	54	8
1	54	0	0	1	8	91

The percentage wise contribution of an operational parameter to a score is as follows:

Score	Lead time	Quality	Production quantity	On time in full delivery	OEE	Inventory
6	6%	94%	0%	0%	0%	0%
5	54%	4%	42%	0%	0%	0%
4	15%	2%	1%	56%	25%	1%
3	25%	0%	56%	6%	13%	0%
2	6%	0%	1%	37%	54%	8%

Friedman's test is a non-parametric test which is used for testing the differences between the various groups that are taken into consideration. Mean ranks for each of the groups is considered and the group with the highest mean rank is the most significant group. With a sample size of 100 it is observed that the Chi – Square values are significantly positive. The differences in the rank have been evaluated statistically at a significance level below 0.000% which is extremely good. This means that the probability of committing type 1 error is below 0.000%.

As level of significance is below 5.000%, we can safely reject H0. H0 the null hypothesis states that all the operational parameters are significantly equal. As we safely reject the null hypothesis we can conclude that all the operational parameters are not significantly equal.

Conclusion

With the results obtained from the Friedman's test it is clear that all the operational parameters are not equally significant. When productivity is determined from an Entrepreneurs perspective, the most significant operational parameter that determines the productivity is "Quality". Quality is often referred to as the adherence to standards, specifications, precision, durability, performance etc. and creates long lasting business relationships with the customer. As per the research, entrepreneurs observe quality to be the most significant operational parameter that determines the productivity of their organization.

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