Six Sigma
Prof. Jitesh J Thakkar
Department of Industrial and Systems Engineering
Indian Institute of Technology, Kharagpur

Lecture – 09
Cost of Quality

Hello friends. I welcome you to the lecture 9 on Cost of Quality as a part of our Six Sigma Course. And we have continuously emphasize that if top management in people need to be sensitized for quality, then quality must be measured in terms of cost, what you are really losing by not opting for the better and higher quality standards. So, this part we will try to see in this lecture 9.

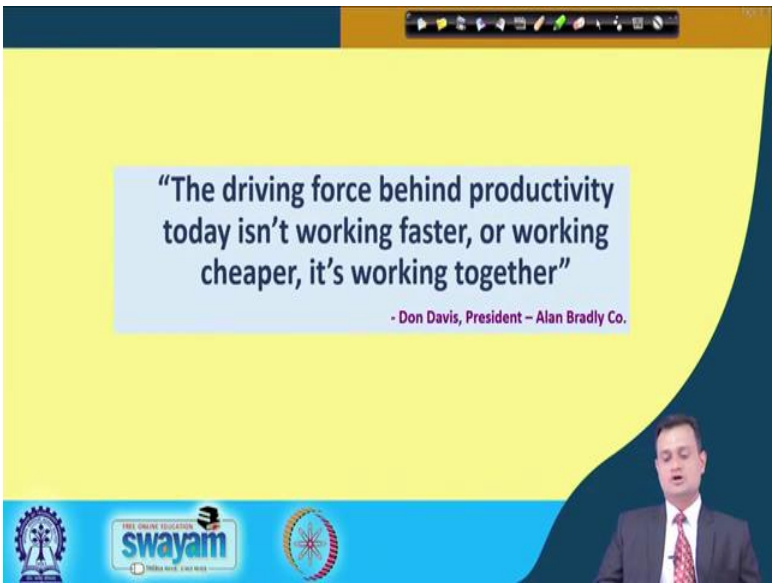
(Refer Slide Time: 00:55)

Before that let us just try to have a small recap, we have basically talked about pillars of TQM in last lecture. We have seen the quality management, philosophies, and principles extended by various quality gurus. Quality enablers and what is the prerequisite for implementing continuous improvement program like Six Sigma. And what is the difference between leadership and management, and how leadership at every level in the organization can play a great influential role in building the quality culture.

(Refer Slide Time: 01:39)

So, with this let us try to continue in our journey and this lecture will basically focus on quality cost, cost of poor quality, typical poor quality cost and link between quality and the profit. So, these issues will help you to appreciate that any organization service or manufacturing by not putting their efforts for achieving the better quality, how much they are losing and what is the rupee or dollar cost associated with this.

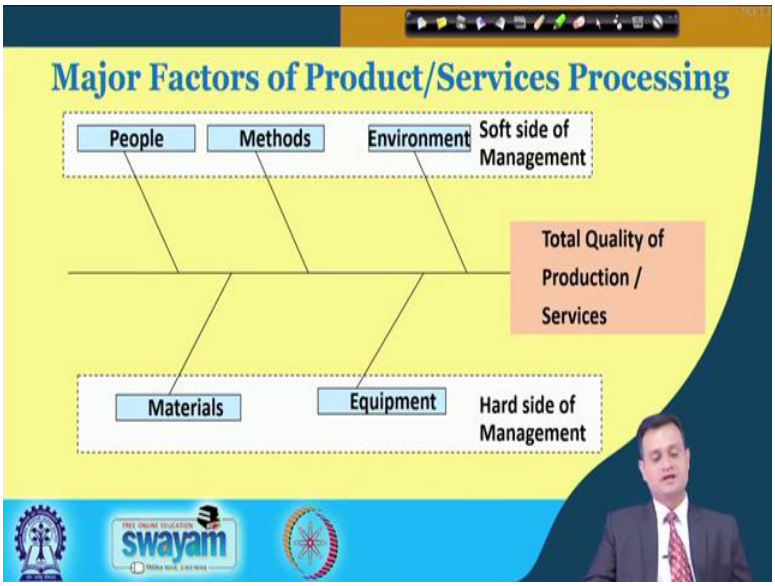
(Refer Slide Time: 02:17)



So, to begin with I would like to refer a very good quote given by Don Davis, president of Alan Bradly company, he said that the driving force behind productivity today is not

working faster, or working cheaper, it is working together. So, this is the spirit we have seen as a part of TQM and quality is the responsibility of everyone, it must empower the people, motivate the people to participate in a team based work and achieve for the higher quality standards.

(Refer Slide Time: 02:56)



Now, let us see that major factors of product and services processing and this factors could be divided into two broad categories, number one soft side of the management and another is hard side of the management. So, when you talk about total quality of product or services, you can see that environment people and methods. This maybe put together as a soft side of the management and equipment, material this is hard side of management. So, it is important for an organization to integrate these two in order to realize the benefit of quality in terms of cost and see that perpetual sustainable quality improvement can be implemented in the organization.

(Refer Slide Time: 03:52)

So, commitments for the organization to consistently produce conforming products. The moment you produce defect, defective product, non-conforming product you are basically adding the rework or scrap and this leads to hidden factory and the cost. So, we want to achieve a desired standard, product or service, which meets the customer requirement and satisfaction and for that I want to produce the confirming products.

(Refer Slide Time: 04:28)

Quality is basically the conformance to requirements; not just goodness. I may be producing fantastic product, but this product does not meet the necessary requirements of

the customer or market, then it is not conformance to requirements. The requirements are often measurable and the system of causing quality is prevention and not the appraisal. I would like to emphasize heavily on this third point that the system of causing quality is prevention; and not the appraisal. So, if you spend 1 rupee, 1 dollar on prevention, then your appraisal cost including your inspection, correction cost can drastically be brought down.

(Refer Slide Time: 05:23)

So, with these let us try to see the broader categorization of quality cost. There is cost of conformance and that is cost of non-conformance.

So, typically I would like to put prevention cost and the appraisal cost as a part of cost of conformance and cost of non-conformance, it is internal failure cost as well as external failure cost. So, in the first case, I am trying my best to see that I can meet the stipulated requirements, I can confirm to those requirements. And in my pursuit of doing so, I will have to accept prevention cost and appraisal cost.

Second is cost of non-conformance. My product is non-conforming either in terms of performance or requirements, then I will have to accept the internal failure cost this may be related to rework or scrap; and there would be external failure cost. So, my product is not satisfactorily performing or meeting the customer requirement when it is handed over to the customer.

(Refer Slide Time: 06:36)

So, we will see the detailed classifications and that the various cost we as a company will have do incur for cost of conformance as well as for cost of non-conformance. There could be other quality cost difficult to quantify. Many a times you cannot realize how the quality not meeting the customer requirement and market is slowly and gradually damaging the company. This may be resulted or reflected in this shrinking market share, but such realization may be slow and gradually you will see that many based organizations they are thrown out from the market and their sustenance was at the stake.

So, loss of customer goodwill, low company profile, reduction in market share, low work-place employee morale, these are some of the hidden intangible factors that you may not immediately realized, but gradually it will have a long term impact on the organization and your over all sustenance or profitability of the company will be at stake.

(Refer Slide Time: 08:03)

So, just see this that quality cost there is a typical distribution it may vary from company to company, but in general prevention if you really spend wisely, then 5 percent of the total. So, for companies who measure this cost for the first time appraisal, 25 percent of the total and failure maybe internal or external 70 percent of the total. So, in totality this is a typical distribution of your quality cost and in order to produce the confirming products are the products which can meet the customer requirement, I may a spend my money on this different components.

(Refer Slide Time: 08:52)

Now, COPQ – Cost Of Poor Quality. Just see, that it is the expense of doing things wrong. So, here the concept is that you measure what will happen, if I will not do that thing rightly. It means if I am not meeting the customer specifications, requirements and quality standard what exactly damage I am accepting and if you really measure this, you can better sensitize the top management as well as the people for achieving the better quality standards.

So, service units 30 to 40 percent of turnover that is the cost of poor quality and if you see the manufacturing unit, then 20 to 30 percent of the turnover. This is something where if you convert it into monetary term, you can really say get sensitize that what exactly you are losing and spending little money on training, prevention maybe as a continuous improvement program would be much rewarding.

(Refer Slide Time: 10:06)

So, typical poor quality cost if you see, then there could be various types of cost within a category of prevention appraisal and so on. So, if you just see the prevention cost, then job-related training for employees. Fine, we are enhancing their skills and through that they are becoming more competent in executing their task. So, it is a prevention cost. Their mistake level, error level will go down.

Customer inter interfere interface to understand expectations. Very important, organization and the customer should not behave as separate entity. Let there be proper marriage, let there be proper collaboration between customer and the organization, and

these interface can help the company to appreciate; what to produce, what to provide, and what not. Technical manuals that provides the guiding lines guidelines to the people in executing the task, so that they stick to certain standards, operating procedures and do not make the mistakes.

Early approval of product specifications. So, many time I say you undertake the production and still you are not final from the client point of view, R & D point of view about the specifications; and this is quite dangerous. So, early approval of the product specifications from R & D, manufacturing as well as the most important is customer can help you to realize better product and services. Computer aided design and also the simulation that can save lot of cost, before actually you go for the real life production and quality planning.

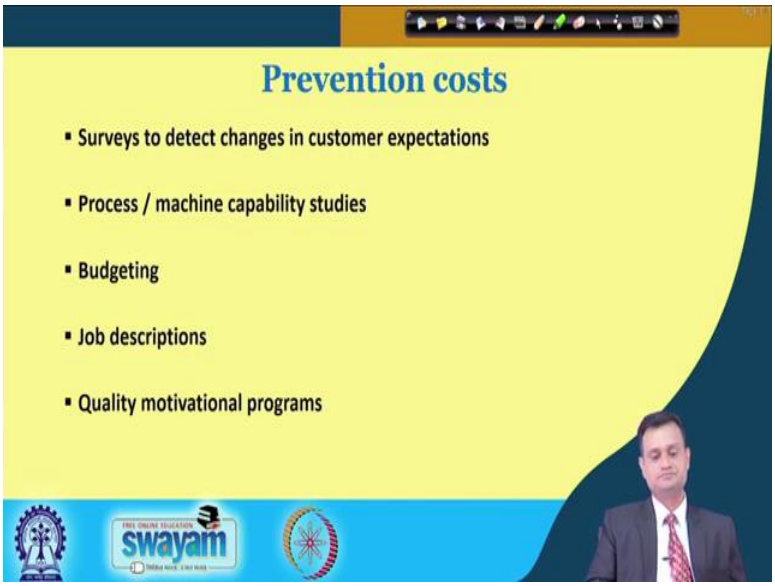
(Refer Slide Time: 11:56)

Another component that we may appreciate as a part of prevention cost is the most important, preventive maintenance an equipment. So, we always talk about the philosophy, Total Productive Maintenance – TPM and TPM emphasizes on empowerment of the people for doing the maintenance of their own equipment and becoming more proactive, in keeping the instruments, equipments, up to the mark with better efficiency to carry out the production.

Quality systems, procedures and standards. Your quality manuals, it must be up to date and must be properly communicated to the people, so that they stick to the company

wide accepted standards. Pilot production runs; reviews – design process, specifications, packaging, selection right man, right job. So, as I mention in lean 8th waste is waste of unutilized human competence or potential, and we should try to minimize this component also.

(Refer Slide Time: 13:11)



Prevention cost you can see, there are many many areas where if you just spend little bit, you would avoid inviting many troubles later on. So, service to detect changes in customer expectations. See customers, they are exposed to lot many products, they are exposed to lot many varieties, brands and it is extremely difficult to expect that my customer will stick to the same expectation.

So, in the dynamic environment time to time, you should keep a track on changing customer expectations, and see that how you can modify your existing product and features to meet the new customer expectations. Process machine capability indices in studies, we will see these in detail.

So, many a times with aging factor wear and tear and use of the equipments machineries, maybe there process capability has gone down or the process capability because of some parameters disturb, it has got little bit lower and this study helps you, also to take necessary action on equipments and machines to keep them up to the mark. Budgeting job description and making people comfortable for their task quality motivational programs and continuously seeking the commitment of the people.

(Refer Slide Time: 14:47)

So, this was a detailed say a list of various types of initiatives that you can take as a part of prevention. Now, let us see the appraisal cost. I am receiving the material, there could be incoming inspection. So, remember inspection is not bad, but inspection is a wasteful activity which does not add really any value to my product.

So, there could be incoming inspection, there is in process inspection, there is final inspection, there could be process control activities like control chart and another's. And calibration of equipment evaluate quality. So, there are various appraisal cost that also add to my COPQ domain and if I spend little bit more on prevention, then appraisal cost can even be minimized.

(Refer Slide Time: 15:43)

So, product audits, quality system audits, training of quality assurance personnel, life testing, burn – In, stress analysis, operating expenditure review, invoice reviewing, personal appraisal then safety and so on. So, mainly you will see that here in majority of the component inspection is the central part and either I have little less confidence in my system or I want to be double sure, then I keep on adding inspection, and this really does not add much value to my products and processes.

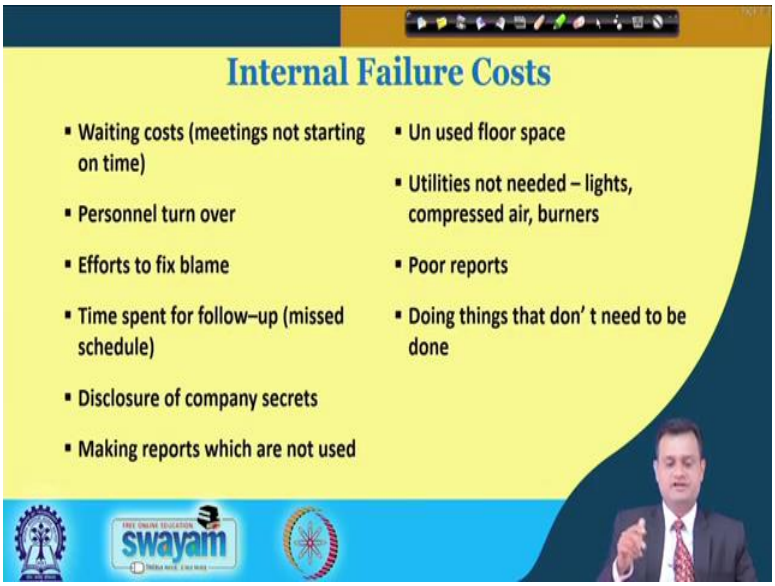
(Refer Slide Time: 16:27)

There could be say non-conforming quality cost and that is internal failure cost. So, rejection of parts in process sudden break down your machine, downtime is higher, oil spillage, parts dropping on shop floor, rework, scrap all this. So, as I mentioned in the previous class that there is the hidden factory. And these hidden factory needs to be addressed adequately, this is all part of your hidden factory internal failure cost.

(Refer Slide Time: 16:59)

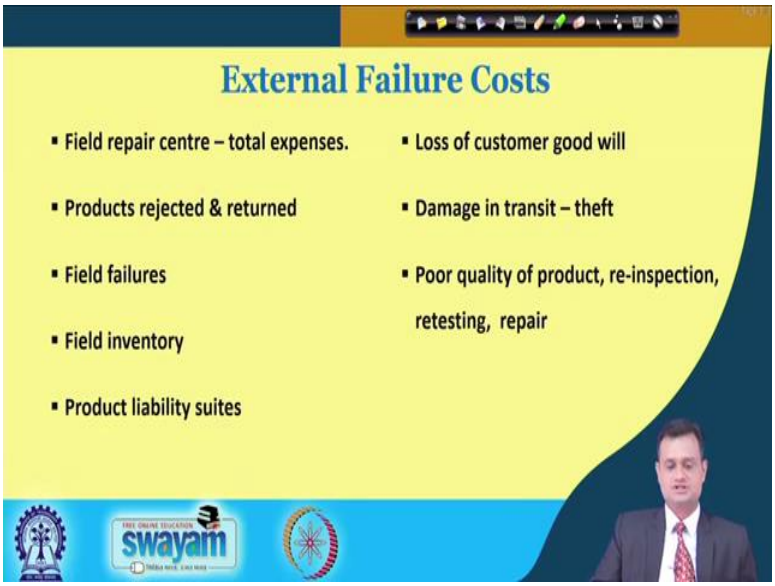
You can see re-inspection activity. I am increasing the level of inspection, because I am not very much confident about my processes and hence the outcome. Troubleshooting, wrongly produce product, excess inventory, salvaging, billing error, line stopping due to parts shortage, redoing, retyping, and lot many.

(Refer Slide Time: 17:27)



So, all these are part of hidden factory and there could be many more waiting cost, personnel turnover, you are losing the human asset. So, you really need to figure out that what is that de-motivating and many a times it is not only the money, but the kind of motivation, challenge people they get in handling their assignment is one of the very important factor, and this needs to be analyzed. So, losing human asset is a big loss, because you are trained human for a long of time and then if they move to other organization, it is not just a loss of one person, it is a loss of 10 years of experience. So, time spend for follow-up missed schedules, disclosure of company secrets, this is also dangerous when this is disclose to your competitors and market. Making reports which are not used so lot of duplicating work and adding too many layers in administration, poor reports and doing thing that do not need to be done. So, many a times we do lot many thing in the factory that is actually not required, maybe too much material handling, may be too much processing and all these puts together and adds to my COPQ under internal failure cost.

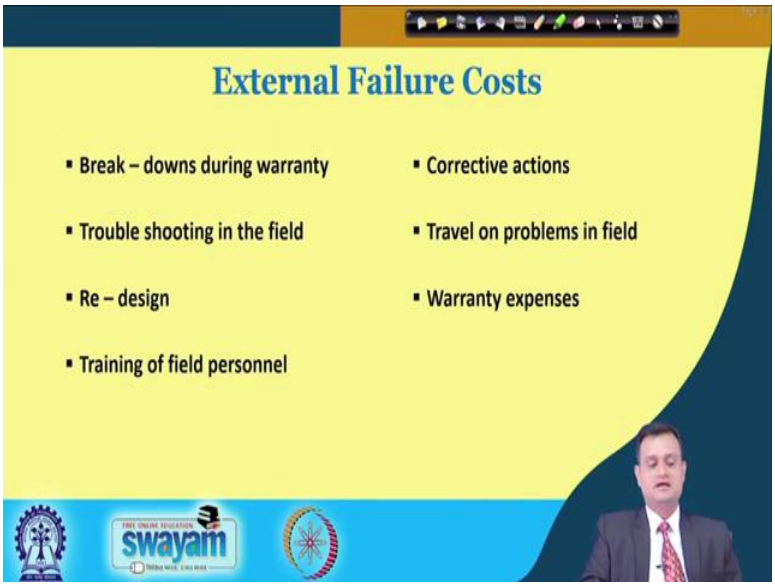
(Refer Slide Time: 18:53)



If you see the various components of external failure cost, then you have delivered the product to the customer. Now, after that product is creating the problem and there is a field repair centre and total expenses. So, you will have to visit the customer site, correct the equipment and this is field visit related cost, correction cost. Products rejected and returned, customer is not at all happy, he is just returning the products or rejecting it, and you are bound to accept as a part of your contract with the customer.

Field failures, you are not able to rectify and correct the problem; and there could be say failure of the machine and subsequently failure of the service. Field inventory, product liability suites, legal issues, loss of customer good will, damage in transit or theft; your packaging is poor or maybe the road condition and transport is not adequate. So, there could be a damaged in transit. Poor quality of product re-inspection, retesting and repair.

(Refer Slide Time: 20:08)



There could be break-downs during warranty, troubleshooting in the field, re-design, training of the field personal, because they are not able to handle the customer complaints, corrective action, travel on problems in field and warranty expenses. You can see that there are many many areas where company they might be spending money, but it is actually not adding any value to the product or service and to the customer.

(Refer Slide Time: 20:40)

So, typically if you see the example, just of one particular process. Let us say purchasing and I want to understand the various cost of quality involved in terms of cost of

conformance as well as in terms of cost of non-conformance. If you see the cost of conformance, proper specification drawings to vendor, if you can do this fine, they associated administrative cost will lead to conformance to requirements and it will help me to improve upon my quality.

Vendor evaluation review and approval. So, you are installing this as a regular process, and this helps your company to get better material as well as helps the vendor to improve upon their competency. Higher inventory due to difficulty in procurement fine, this is not a positive indicator, but sometimes if the lead time variation is very high at the supplier end, then you may try to build little bit higher inventory.

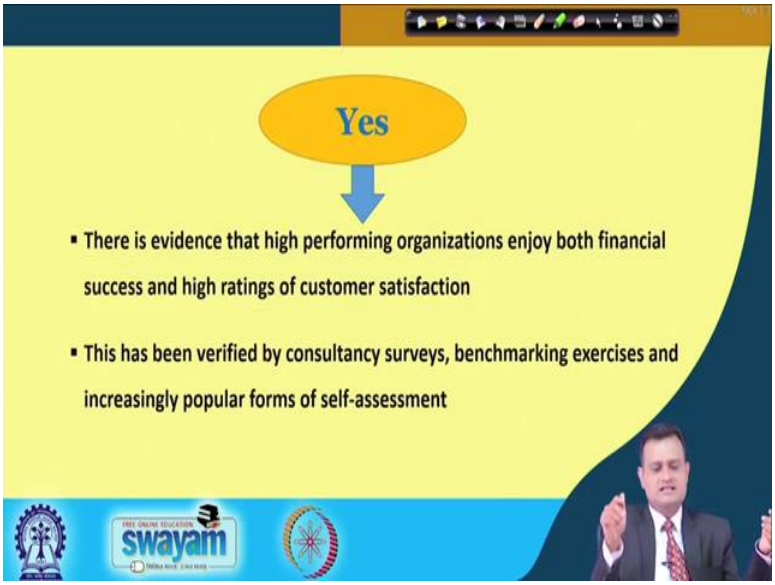
Incoming inspection, many a times say we go for acceptances of sampling or if we know that my supplier is highly reliable based upon the track record, and the process capability is very high at supplier end. Then we may accept the certificate provided by supplier, and that could be good enough. Educating vendors to put quality system in place; Training, programs and vendor meet.

(Refer Slide Time: 22:17)

We can see the list of cost of non-conformance. Purchase order not proper, rewrite amendments, there could be incoming material rejected, sorting – rework, re-inspection. You can see that here whatever I am doing, it is mainly rework, it is mainly adding inspection, adding say a duplicating kind of effort. Material return cost, premium on freight, visits to supplier to solve the problems or conflicts.

So, the question here is that. Are Quality and Profit Linked? What is your view? Are Quality and Profit linked? Or without bothering much about quality, I can still reap the better profits. So, we have talked and seen in detail, the various cost associated with the quality and I need to really see that how much I can spend little bit on prevention, so that other cost component can be minimized.

(Refer Slide Time: 23:33)



So, let us see the answer is yes. There is an evidence that high performing organizations, benchmark organizations, world class organizations they enjoy both financial success and high rating of the customer satisfaction. So, these two go together when you have greater customer satisfaction and loyalty, automatically you are business success improves. This has been verified by many consulting service, benchmarking exercises, and increasingly popular forms of self-assessment.

(Refer Slide Time: 24:12)

Let us try to see as an example, some study conducted by a well known consulting firm Ernst and Young and what they discovered, when 500 businesses in Canada, USA, Germany and Japan were analyzed. So, there are three parameters they have considered; number one quality performance is low, quality performance is medium, and quality performance is high.

Now, if you see the impact of this various quality performance on set of parameters, then let us say return on asset is less than 2 percent. Value added per employee is less than 47000 if you are quality performance is low. And customer satisfaction index obviously is low. If you go to medium, then return on asset increases 2 to 7 percent; value added for employee it goes higher 47000 dollar to 74000 dollar, and customer satisfaction index is medium.

And if you see the quality performance high, meeting the conformance requirements, customer requirements with less rework, scrub, hidden factory, then return on asset is 7 percent. Companies are investing heavily in machineries, infrastructure, equipment, human resource all these assets and you really want to have better utilization of the resources and hence the greater return on assets.

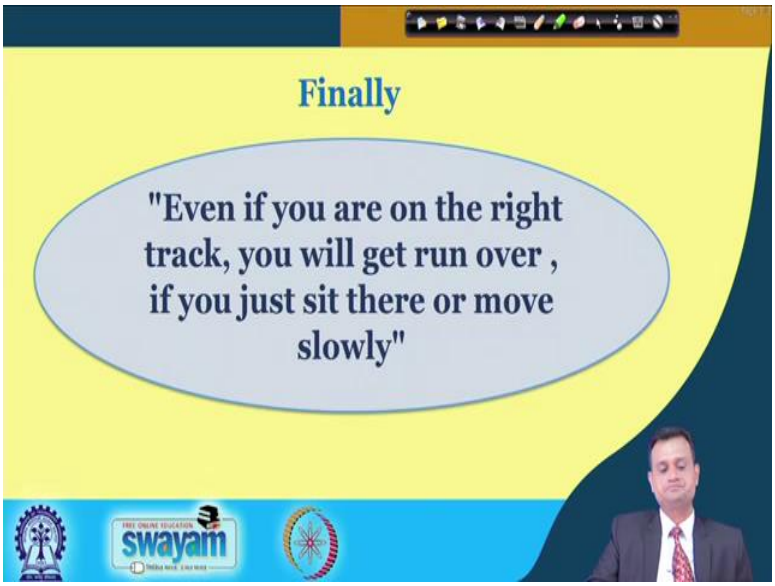
So, return on asset is more than 7 percent, sometimes it goes higher than 10 percent; and value added per employee is greater than 74000 dollar, and customer satisfaction index is highest. So, this clearly demonstrates yes there is a link between quality and the

performance of the organization. And we cannot ignore the importance of COPQ - Cost of Poor Quality, and this helps the company to really get sensitized over their quality performance.

(Refer Slide Time: 26:32)

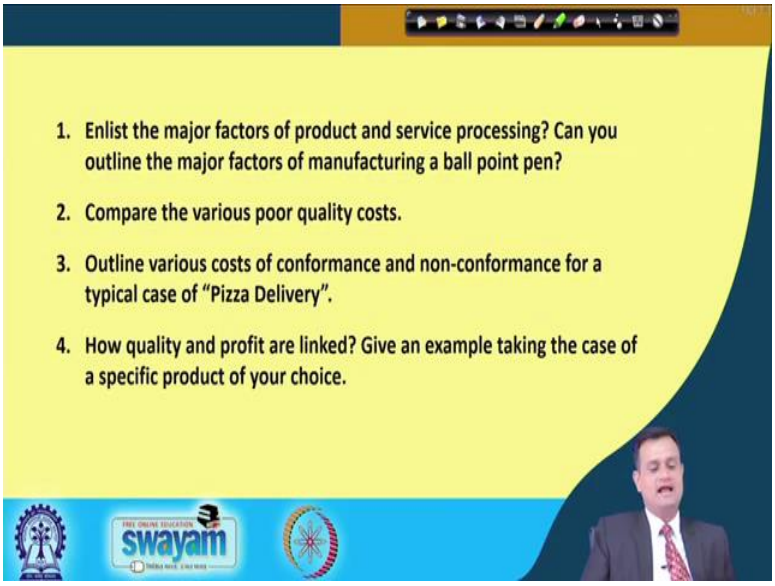
So, what is the action plan? So, the action plan is determination and commitment of the management. Quality first must be communicated to all employees, no compromise. Quality management in 3 phases, quality planning like budgeting in finance, quality control keep within budget and quality improvement make results better than forecast in budget and keep the process ongoing continual.

(Refer Slide Time: 27:06)



So, finally even if you are on the right track, you will get run over if you just sit there or more slowly. So, please understand that quality is a continuous journey and the majors like cost of poor quality always helps us to be on the right track and with the right pace in our pursuit of improving quality and meeting our internal as well as external benchmarks. So, before I close, I want you do think over couple of issues, I am floating here few questions for your internal consumption and thinking.

(Refer Slide Time: 27:46)



So, enlist the major factors of product and service processing? Can you outline the major factors of manufacturing a ballpoint pen? Just a product, address both hard and soft issues and you can make use of cause and effect diagram. Compare the various poor quality costs. And just try to emphasize it is importance in terms of COPQ. Outline various cost of conformance and non-conformance for a typical case of pizza delivery? So, restaurant wants to deliver a pizza.

Now, we have seen the example for purchasing. Now, for this particular process can you identify the various cost of conformance and non-conformance. How quality and profit are linked? Give an example, taking the case of the specific product of your choice. So, please give a thought over couple of questions and that will help you to have quick revision of the concepts we have learnt, in this particular lecture.

(Refer Slide Time: 28:59)

These are the references that you can refer for deeper understanding and exploring the greater details.

(Refer Slide Time: 29:08)

Finally, as the conclusion we can say that organization must commit to consistently produce conforming products and hence be sensitize on the cost of quality. COPQ is a management tool, it is a critical measure. Eliminating non-conformities leads to enormous financial results. And focus on comparative data and measurement is extremely vital, because unless you look at the benchmark, best practices, what is the cost of quality of your competitor, what is the hidden factory cost at your competitor place, and what you are add you cannot really set the program for the improvement.

So, thank you very much for your interest in learning the concept of cost of poor quality. Appreciate this I would advise you visit an industry; consider a particular process manufacturing or service and first you make a checklist of various elements of cost of poor quality as a part of cost of conformance as well as cost of non-conformance. And just try to quantify it in terms of say monetary value. And then discuss with the specific functional manager, and see that if you spend little on prevention, how many of this cost can really be minimized or avoided. So, wish you all the best, be with me.