The Guidebook to Toyota's 13 Pillars System

Toyota Production System Concepts

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Table of Contents

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Introduction

Toyota Motor Corporation created a production system that aims to achieve high-quality products, minimize expenses, and shorten the time it takes to make them by reducing waste. TPS consists of two main components, just-in-time and jidoka, and is usually represented by the "house" image shown on the right. To make TPS better and keep it working well, we follow a process called PDCA or the scientific method. We do this by repeatedly doing standardized work and making small improvements called kaizen.

The development of TPS is attributed to Taiichi Ohno, who was in charge of production at Toyota after World War II. Ohno started implementing TPS at Toyota in the 1950s and 1960s, beginning with machining operations. He then expanded its use to other areas within the company and shared it with other suppliers during the 1960s and 1970s. Outside of Japan, spreading started in a serious way when Toyota and General Motors created a partnership called NUMMI in California in 1984.

The ideas of just-in-time (JIT) and jidoka were developed before the war. Sakichi Toyoda, who started the Toyota group of companies, came up with the idea of jidoka a long time ago. He did this by adding a device to his automatic looms that would make the loom stop if a thread broke. This made things a lot better in terms of quality and allowed people to focus on more important work instead of just watching machines for quality. Over time, this simple idea became a part of every machine, every production line, and every Toyota operation.

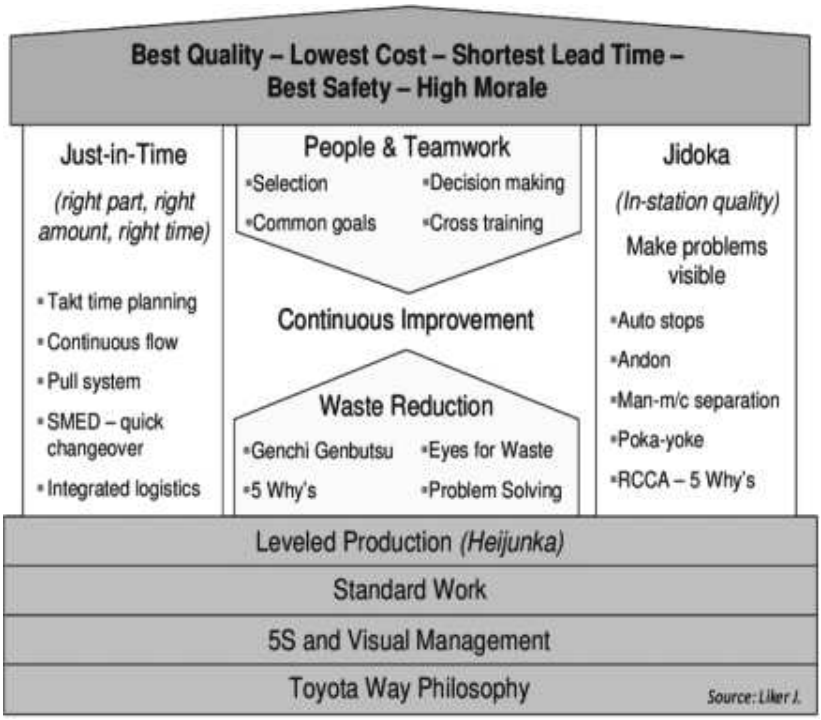
Kiichiro Toyoda, the son of Sakichi and the person who started the Toyota car company, came up with the idea of JIT (Just-in-Time) in the 1930s. He ordered that Toyota should not have too much extra inventory and that Toyota will try to work together with suppliers to have a consistent production level. Ohno led the

development of JIT, a special system to manage production and control overproduction.

TPS became well-known when The Machine That Changed the World was published in 1990. This book was the result of five years of research led by the Massachusetts Institute of Technology. The scientists at MIT discovered that TPS was much better and faster than traditional mass production. It was such a big change that they called it lean production to show how different it was.

Returning to the past

Like mentioned, Sakichi Toyoda devised the automatic loom technology in 1926. He is regarded as the "Father of the Japanese Industrial Revolution" and has been dubbed the "King of Inventors." Sakichi established his own values, which later became the guiding principles of Toyota Motor Company (give to society, get your hands dirty, respect for people, put the customer first, etc.). One of his most influential innovations, the loom that could stop itself when there was a problem, exemplified his built-in quality. He referred to this as jidoka. Kiichiro Toyoda founded the automobile manufacturer Toyoda. Kiichiro is a mechanical engineer and the inventor of the "just-in-time" JIT idea. Later, Taiichi Ohno created a new manufacturing system that transformed just-in-time manufacturing from a concept to a practical system. The Ohno technique was based on continuous kaizen. Ohno is the proprietor of takt time and idea cellular manufacture. The two main pillars of Toyota Production System TPS are Kiichiro Toyoda's just-in-time and Sakichi Toyoda's jidoka.


Best Quality – Lowest Cost – Shortest Lead Time –
Best Safety – High Morale
Just-in-Time
(right part, right amount, right time)
Takt time planning
Continuous flow
Pull system
SMED – quick changeover
Integrated logistics
People & Teamwork
Selection
Decision making
Common goals
Cross training
Continuous Improvement
Waste Reduction
Genchi Genbutsu
Eyes for Waste
5 Why's
Problem Solving
Jidoka
(In-station quality)
Make problems visible
Auto stops
Andon
Man-m/c separation
Poka-yoke
RCCA – 5 Why's
Leveled Production (Heijunka)
Standard Work
5S and Visual Management
Toyota Way Philosophy
Source: Liker J.

Just-in-time JIT

People called Toyota Production System an inventory reduction program when they first heard of it. "Just in time" is one of the main pillars in the TPS. "Just in time" ideally means "one-piece flow." Inventory is the greatest waste in the process, and it hides many problems, such as quality problems, breakdown times, waiting waste, and more. Let's get back to history. Prior to the 1970 oil crisis, very few people in the world know what Toyota was up to. The fact that it emerged stronger than ever while many of its competitors were quite battered made people take notice. People went to Japan to find out how Toyota had done this. What people found was that Toyota was doing something called "just in time." In the West, this was interpreted as an inventory reduction program. As a result, it became known as the "just-in-time inventory" program. Nobody really believed inventory could be taken out of the whole value stream. Therefore, "just in time" came to mean "go beat the heck out of your suppliers." The big three auto companies (Ford, General Motors, and Chrysler) had lots of power over their suppliers, and they became pretty expert at this tactic—to their eventual detriment. James P. Womack came forward with Lean Thinking in 1996 and helped many to see the whole value chain. He showed how waste clogs the system and how continuous improvement was needed to link all parts of the chain to customer demand. He explained his findings in plain English, but once again people didn't hear. Lean might be an element of the larger strategy, but it is most likely to be relegated to plant and manufacturing work. As a result, one company after another has tried lean and failed.

Is JIT zero inventory?

Many people believe that just-in-time inventory equals zero inventory. The ideal situation is one-piece flow, which can only be achieved through the use of a manufacturing cell. The inventory buffer exists, but it is rarely used. The Andon system includes a

buffer. There is a safeguard in place to protect your customer. There is a buffer to prevent the entire manufacturing line from being shut down to rectify a problem. There is a buffer in place to prevent the breakdown of a vital manufacturing process.

So, what is Just-in-Time?

Just-in-time production is a manufacturing system that produces and delivers only what is required, only when it is required, and only in the amount required. The Toyota Production System is built on two pillars: JIT and jidoka. JIT is based on heijunka and consists of three operating elements: the pull system, takt time, and continuous flow.

Jidoka

Yet many companies focus on the mechanisms of implementation—one-piece flow, pull production, takt time, standard work, kanban—without linking those mechanisms back to the pillars that hold up the entire system. JIT is fairly well understood, but jidoka is key to making the entire system stick. A lot of failed implementations can be traced back to not building this second pillar.

Jidoka is one of the main pillars of the TPS. The TPS is presented as a house with two pillars. One pillar represents just-in-time (JIT), and the other pillar the concept of Jidoka. Take away any of the pillars holding up the roof, and the entire system will collapse. Take out quality, and there is no TPS. Jidoka is a principle of building quality for customers—not inspecting quality. Building quality mean making it right the first time. If you are making defective products or using unacceptable quality standards and filtering these defects out through an inspection system, there is no building quality—and no Jidoka. You are just catching the mistakes made in the manufacturing process. This cost a lot of money and resources and puts the business at risk.

About this book

This book is a part of the series "Toyota Production System Concepts" I wrote over 50 books. I have written 22 digital books in this series about the Toyota Production System, and they are available in stores worldwide. Some people talk about how Toyota is run and who is in charge; focusing on the Toyota's management and leadership structure while others talk about the tools and ways, they use to make things more efficient. It's important for everyone to understand and use these tools properly for it to work well.

Early on, Taiichi Ohno, codeveloper of the Toyota Production System, refused to document or write the system down for fear people would focus narrowly on the tools and theories. When he finally wrote it down, he presented it as a house (see figure 1.1) because a house is a good example of a system. Take away the supporting structures, and the roof and entire system will collapse. One of Ohno's students said Toyota made a mistake calling it the "Toyota Production System." Instead, Toyota should have called it the "Thinking Production System" because the real point was to make people think, and people are the value of any system. People created, adapted, and improved the TPS and its tools, and people are still improving them every day.

This book is explaining the main pillars of the TPS. But remember, all the textbooks, resources, and workshops are table stakes compared to learning through actual practice. Always remember to apply the PDCA cycle slowly at every step and remove obstacles as they are found. It is preferable not to apply a large improvement all at once. The obstacles and resistance to such change would be huge, and the entire program could fail quickly and cause disappointment for the working team.

The use of lean tools

In numerous associations, lean usage is frequently trademark by discontinuity, confinement, and disconnection. The usage of lean in an association requires social change, which, thus, requests leadership characteristics and the capacity to roll out maintainable improvement. An improvement culture is a piece of this behavior change

The inability to connect the top administration objectives with day-by-day management at the operational level is a significant reason for lean disappointment at the endeavor wide. Means, associations that are utilizing lean strategy to improve business activities won't have the option to accomplish their business destinations and improve the whole association without the best possible connection. The effect of lean is regularly too diffuse when hurrying off in various ways, seeking after various thoughts of the most significant issues to tackle without arriving in a desperate predicament line and soon the lean activity will look like simply wild activity without course. Simultaneously, when organizations have the goals to peruse without every day critical thinking to accomplish the objectives they won't succeed.

Associations are regularly portrayed by the bureaucracy of the executives rehearses. Anyway, these kinds of practices require change as associations advance, as improvement is accompanied by expanded strain to institutionalize work division, administrative undertakings, and frameworks. A significant piece of such change is the presentation of a strategic administration framework, for example the identification of strategy deployment system and usage.

As of late, there has been an expansion in the utilization of lean standards and strategies – the idea of improving value-added work and eliminating waste. A few references recommend this has been a constructive encounter, authors have contended that lean possibly accomplish the ideal outcomes if its utilization improves the critical thinking capacities of individuals in the whole foundations, and that

leadership is basic in achieving and continuing lean outcomes. Hoshin Kanri is a way of thinking that permit senior pioneers, directors and representatives to concentrate energies on the key needs. *I have written two separate books about hoshin Kanri.* The utilization of Hoshin Kanri, which connects the most significant level, "true north" goals of security, quality, consumer loyalty, and monetary stewardship to explicit activities, help keep senior pioneers concentrated on needs, information, and results, and it's an extraordinary strategy. Associations that are attempting to utilize lean approach to improve their organizations without shared vision or clear purposes that adjust individuals, plans, techniques, and endeavors with procedures to accomplish their business targets are not profoundly fruitful associations.

Concentrating just on the tools; applying value stream mapping and the other lean toolboxes won't make great associations more prominent. In the event that you have well-prepared individuals equipped for taking on difficulties, you simply need to let them center around your needs and use their vitality for business endurance and genuine improvement. A few organizations have shared visions yet no abilities. They have no genuine pioneers fit for taking on the test, creating individuals, and engaging them to improve the procedure. Individuals frequently ask which starts things out: creating vision, clear purpose, and alignment utilizing Hoshin Kanri or improving individuals' abilities to help every day critical thinking and continuous improvement? It bodes well to create individuals first and afterward reveal the Hoshin Kanri. Liker and Convis (2012) at first referenced the pioneer advancement stages regarding Hoshin Kanri approach, and Liker and Trachilis (2015) abridged them as pursues: (a) focusing on self-advancement, (b) figuring out how to lead at the gemba, (c) learning by educating and creating others, and (d) learning by doing and executing genuine tasks utilizing the continuous improvement theory.

Chapter.1

Jidoka

First pillar we are going to explain here is jidoka and the other principles sets around it such as Poka Yoka and Andon. The idea of the jidoka principle started in 1902 when Sakichi Toyoda created a clever device that could sense when a thread was broken and turn off a machine called an automatic loom. This invention made it possible for one person to manage and control up to twelve looms at the same time, ensuring that everything was done perfectly. However, the system goes even beyond that.

To make sure things are made well, the machines should be made to find mistakes and stop making things when there's a problem. Then, an employee can fix the problem before it affects more things.

One of Taiichi Ohno's well-known sayings is "make the factory help the business just as the human body helps a person. " This means that when your body needs more blood, your heart automatically pumps more, without you having to tell it to. It does it automatically on its own. Jidoka means that processes and systems should be made in a way that when mistakes happen, people take action right away to help. So, if there are errors in your systems at midnight on a Saturday, how do you handle them. Are the errors quickly noticed and fixed right away or do you wait until Monday to address them. Jidoka would make sure that any problems are immediately seen and it would push you to make sure that the people responsible for fixing the problem have the ability and power to do so.

Toyota uses special cords or ropes called andon cords or pull cords. These cords have the power to stop the entire assembly line. Each team member can stop the line whenever they notice anything that doesn't meet the expected standards. According to Toyota Way, "jidoka means using machines that can think like humans to stop themselves when there is a problem.

"Building Culture of Stopping the Production Line

I first learned about Jidoka when I worked for a manufacturing company in Egypt. They wanted to use Jidoka to make their products better and safer. In this factory, if you didn't work at full capacity for the entire shift, you had to give a reason to the different departments. We prioritize quantity over quality and regular maintenance. By developing a habit of addressing and solving problems, you are motivating employees to not keep their issues hidden. These issues can significantly impact profits and efficiency. You need to think ahead and make plans to be productive for a long time.

The old way of thinking about productivity was to make lots of parts using as much resources and machines as possible, so that each part would be cheaper to produce. This approach believes that when more products are made, the cost per unit becomes lower. If any problem comes up, we can deal with it later because we have a lot of extra supplies that will keep things running smoothly even if there are issues. Problems are not logical or reasonable. In large-scale production, quality is checked again through inspection. Also, if you are making 500 parts and there is a problem with how they are made, all of those parts may end up being faulty. The losses will be very big. There are also hidden problems, and it will be very difficult to find out where the mistake is coming from. So, the main reasons will stay unknown.

With lean, production is done one step at a time. If one step stops, everything else stops and there is a feeling of needing to hurry. Now everyone knows that we have some problems that need to be solved. We need to work on finding a permanent solution to these

problems, or else there will be too many instances of work being halted.

How does Jidoka stop quality issues from happening?

Jidoka's main aim is to avoid any problems with quality from going into the next step or reaching the customer, which can be really bad. This is one of the great advantages of lean, which works hard to reduce the number of items produced at once. At the same time, Toyota wants to make sure they continue making cars without any interruptions or risks to the production process. That's why they made a system called "Minimizing Line Stoppage Time" which uses techniques to solve problems and prevent mistakes. Dr Liker explained how the problem-solving cycle is connected to the Jidoka culture in his book called Toyota Way Field.

1. Identifying problems: standardization is important for ensuring quality. It is hard to tell if there is a problem or not without a standard. If there are no rules, people will do things in their own way, which can lead to problems with the quality of work. Standard work is a way to compare things. If the person in charge notices a problem, they should fix it right away. If there is a problem that cannot be solved, the person in charge must ask for assistance.

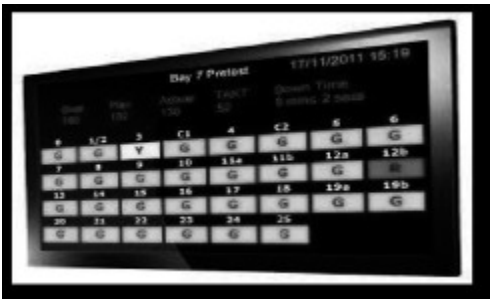
2. Escalation: The concept of artificial intelligence (AI) is advancing rapidly. AI refers to a technology that allows machines to perform tasks that normally require human intelligence, such as visual perception, speech recognition, and decision-making. This technology has the potential to greatly impact various industries, including healthcare, finance, and transportation. However, there are concerns about the ethical implications of AI and how it could affect job opportunities for humans. Despite these concerns, AI continues to develop and has the potential to revolutionize many aspects of our lives. Increasing problems: If the situation is getting worse or the problem is not small, the employee should ask for help. When you pull the cord, it signals that you need help. The

andon instrument used by Toyota sends signals fast to the assigned support people, like Toyota team leaders and group leaders. This usually includes a loud noise and a light that shows where something is.

3. Estimate: the leader needs to fix the issue in a certain amount of time. If he couldn't do this, he needs to tell someone higher up. Afterwards, the leaders need to find solutions to these problems and make sure they don't happen again. The management's job is to make sure that the things needed for work are given to everyone in a clear way.

4. Control: The person in charge needs to address the root cause of problems. Go through the line and solve the problems forever. If we can't figure out what is causing the problem, the leaders need to decide to start over again.

5. Eliminating root causes: once the problem is under control and work is back on track, the team needs to figure out where the differences are coming from. They will use a method called PDCA to find the best solution to prevent the problem from happening again and causing another halt in production.



Jidoka is a Principle That Focuses on Making High-Quality Products without Sacrificing the Production speed.

Unfortunately, and like many other companies there is a wrong misunderstand about the concept and how it operates. As Liker illustrated in The Toyota Way when Toyota competitors started to use the andon system, they made the same mistake of assuming the line-stop system was hardwired to each and every production line. So, when the button is pushed, the entire assembly line like comes to a screeching halt. At Toyota, the principle of andon is worked remarkably different. When an operator in a workstation pushes an andon button, that workstation will light up in yellow typically like the traffic light, but the line will continue moving. The team leader has until the product moves into the next workstation zone to respond, before the andon turns red and the line segment automatically stop. As Liker explained, in Toyota this likely is to be a matter of 15-30 seconds on an assembly line making cars at one minute. In that time the team leader might immediately fix the problem or note it can be fixed while the car is moving into other workstations and push the button again, canceling out the line stoppage. Or the team leader might conclude the line should stop.

In that system, that are many considerations and tips presented in The Toyota Way:

1. The team leader has to be trained as well on a standardization procedure on how to respond to andon calls.

2. The assembly line should be divided into segments with small buffers of products in between (in Toyota this buffer is typically 7-10 cars). Because of the buffer, when a line segment stops, the next line can keep working for about 10 minutes using the buffer and before the entire plant is shut down and rarely does it do shutdown.

3. The purpose of andon is to build in quality, not to lose production. Toyota achieved the purpose of andon without taking needless risks of lost production.

4. Some manufacturers assign a worker to watch the machine for error. This is a waste of the human precise time! Operator that is watching the machine for error is a pure waste and you have to develop a method (like Toyota andon) so problems are surfaced automatically when they occur.

The Two Distinct Interpretations of the Jidoka Principle

The first concept is to separate man from machine. It was normal in the original parent company for a single young woman to operate many machines since they were automated. So, when Mr. Ohno came to the automotive company after WW II and saw one man operating one machine tool, he thought that it was strange and inefficient.

He embarked upon a path of breaking down the notion of one man one machine in the engine shops. Instead of "monitoring" machines the operator was to walk between two machine tools and keep them both up and running. Then three machines and four machines and so on.

The second concept of Jidoka is of course the concept of building in 100% quality every time at the process and not inspecting it in later downstream.

This means you have to have a highly capable process and know how to maintain all the key variables in the process so that a good part is made every time. If a problem occurs the machine should stop right away.

The main purpose of Jidoka principle is to discover quality problems at earlier stages, find the root causes and eliminate the problem from recurring again in the future. By doing so you are saving both your customer and your business. If a defected product is passed to customer so this is a problem and because customers are what keep you in business, you have to build quality for them. This is one of the main lean goals. The goal is to prevent a quality issue that is reducing productivity every day and killing your capacity, decreasing value, increasing costs and reducing safety. Lean encourages you to make it right from first time and this is why

surfacing problems is important and can't be done without a single-piece-flow system. Inspecting defects before they pass to the customer is not really the main goal of lean. But having a system that allow information to flow, problems to surface so they can be fixed immediately is the goal. Root causes should be identified and eliminated through kaizen. With lean, there is no or very little inventory buffer, so when process A stops process B will stop too. This allow problems to be noticed quickly and eliminated. There will be no more underlying costs and hidden wastes.

You can't compromise quality. Quality problems are one of the greatest wastes in the process. Quality is what adds value for your customer and keeps you in business and defective products that reach the customer can lead to complete business loss.

Examining Quality Defects to Remove the Causes

Basically, it is easy to keep track of the number of faulty products produced using just a piece of paper. It is difficult to know what caused the defects. Understanding the reason behind the quality problem can be difficult and it may take a lot of effort. This is why doing one task at a time improves the quality of work. When you see problems early, you can fix them right away before they become big and expensive.

Identifying issues with quality is a crucial task for managers. When practitioners have problems, they often use a complicated method called Six Sigma to figure out what is causing the differences. However, frequently just going and observing (called gemba) can help easily identify the true cause. Watching the operator do their job, checking if it meets the standards, and getting the technical team involved can help solve many issues. Comparing the machine or process with another one that makes the same part with fewer mistakes can make the analysis even faster and simpler.

At Toyota, managers don't use many complicated statistical tools for quality. In simpler terms, they usually use methods like going to see for themselves, using techniques to prevent mistakes, using a simple analysis tool called Pareto, and problem-solving methods like asking "why" five times. This information can be found in a popular book called The Toyota Way.

Methods used to make things better – other quality improvement techniques

There are many tools to help achieve quality goals in every part of the process. There are lots of tools that can help you avoid quality issues before they happen and help you make a product without any mistakes. Poka Yoka, a Japanese term also known as

mistake-proofing, is a helpful tool for stopping human errors. I have used it many times myself when evaluating the causes and effects of failures. This tool can make things better in many different types of businesses like services, making things, and designing things. Inventory control is a method that is typically connected to any device that prevents mistakes.

There are many real-world applications where mistake-proofing is used in product design. Here are some examples to make sure things are done correctly: limit switches to check that a part is in the right place or fixture before it is worked on; part features that only allow assembly in the correct way; special connectors to prevent mistakenly connecting wire harnesses or cables incorrectly; part symmetry that prevents wrong insertion.

Sadly, some companies mistakenly believe that investing in technology will prevent mistakes. Technology can only help people and systems avoid mistakes if there is a good management system in place and people are trained to solve problems and respond quickly to problems.

To figure out why a product doesn't work and what needs to be done to prevent it from happening again, you can use a technique called failure mode and effect analysis.

Failure mode effect analysis (FMEA) is a way to evaluate how likely something is to fail, how bad the failure would be, and how easy it would be to recognize the failure. If we have more ways to find and anticipate problems, the chances of something going wrong with the product are reduced. FMEA is a useful tool for improving quality if used correctly. I wrote an article for the Industrial Management magazine called "Analyzing Failure to Prevent Problems. " A lot of organizations only use FMEA when they are making something, but FMEA can also be used when they are fixing something or taking care of it.

Lean is not a set of tools used in manufacturing to reduce expenses and increase profits. Lean is a way to make customers happy by giving them higher quality things while also charging them less. Creating a product that solves the problems your customers face when using it is a valid goal for lean engineering. Lean is about coming up with new and creative ideas. If you can make a product without any flaws or include good quality in the design, it will make customers happy and increase their trust.

Cost of Quality – Why Quality is Important?

Cost of Poor Quality: Internal Failure Costs

Internal failure costs are costs that are caused by products or services not conforming to requirements or customer/user needs and are found before delivery of products and services to external customers. They would have otherwise led to the customer not being satisfied. Deficiencies are caused both by errors in products and inefficiencies in processes. Examples include the costs for:

- Rework.
- Delays.
- Re-designing.
- Shortages.
- Failure analysis.
- Re-testing.
- Downgrading.
- Downtime.
- Lack of flexibility and adaptability.

Cost of Poor Quality: External Failure Costs

External failure costs are costs that are caused by deficiencies found after delivery of products and services to external customers, which lead to customer dissatisfaction. Examples include the costs for:

- Complaints.
- Repairing goods and redoing services.
- Warranties.
- Customers' bad will.
- Losses due to sales reductions.

- Environmental costs.
- It takes 1-3 years to re compensate a leaving customer!

Cost of Good Quality: Prevention Costs

Prevention costs are costs of all activities that are designed to prevent poor quality from arising in products or services. Examples include the costs for:

- Quality planning.
- Supplier evaluation.
- New product review.
- Error proofing.
- Capability evaluations.
- Quality improvement team meetings.
- Quality improvement projects.
- Quality education and training.

Cost of Good Quality: Appraisal Costs

Appraisal costs are costs that occur because of the need to control products and services to ensure a high-quality level in all stages, conformance to quality standards and performance requirements. Examples include the costs for:

- Checking and testing purchased goods and services.
- In-process and final inspection/test.
- Field testing.
- Product, process or service audits.
- Calibration of measuring and test equipment.

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