CHAPTER 6 – Quality & Productivity

Introduction

Someone once said that beauty is in the eye of the beholder; and so, it is with quality. In a world that is becoming more-and-more reliant on disparate markets to produce the goods and services that we all want, the ability to deliver quality has never been more important. In this chapter we will take a close look at how quality is defined, some of the more significant trail blazers in the quality movement and explain the use of some of the tools that have been developed in order to ensure quality. No discussion about quality would be complete without looking at such programs as Total Quality Management (TQM), Lean, Total Productive Maintenance (TPM) and Six Sigma. We will discuss some of the more recent findings associated with Strategic Human Resource Management (SHRM); more specifically, what SHRM is and how it relates to TQM. Before concluding the chapter, we will take a brief look at Quality Management Systems (QMS) as it relates to International Organization for Standardization (ISO) 9000.

Definitions

The American Society for Quality (ASQ) defines **quality** in two ways: *1) the characteristics of a product or service that bear on its ability to satisfy stated or implied needs; 2) a product or service free of deficiencies.*

While the above two definitions are useful, it is universally recognized that there is a subjective component to defining quality. At the end-of-the-day companies are providing goods and services to customers and it is those customers who ultimately decide what quality is or is not. The customer is the ultimate arbiter of what is a quality product or service.

Before moving forward, there are two additional phrases and their definitions that we should add to our vocabulary. ASQ defines **quality control** (QC) as: "*the operational techniques and activities used to fulfill requirements for quality*". On the other hand, **quality assurance** (QA) is defined as: "*all the planned and systematic activities implemented within the quality system that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality".*

Armed with a rudimentary understanding of what quality is and, in general terms, how it might be achieved, the rest of the chapter focuses on very specific ways that quality can be attained.

Quality Experts

Now days it is often discussed how a small portion of the population owns a vast majority of the world's wealth. This phenomenon was first noticed by the economist **Wilfredo Pareto** (1848-1923) who discovered what is now called the Pareto Distribution. Pareto widened his view and applied his observations to materials management. Today, what is known as the Pareto Chart (see **Diagram 6.1 – Sample Pareto Chart**), helps management prioritize defects; starting with the cause of the greatest number of defects and moving toward the cause of the least number of defeats, while at the same time showing their cumulative effect. The chart provides a visualization of the Pareto principle (also known as the 80/20 rule) where 80 percent of the defects are generated by as few as 20 percent of the causes.

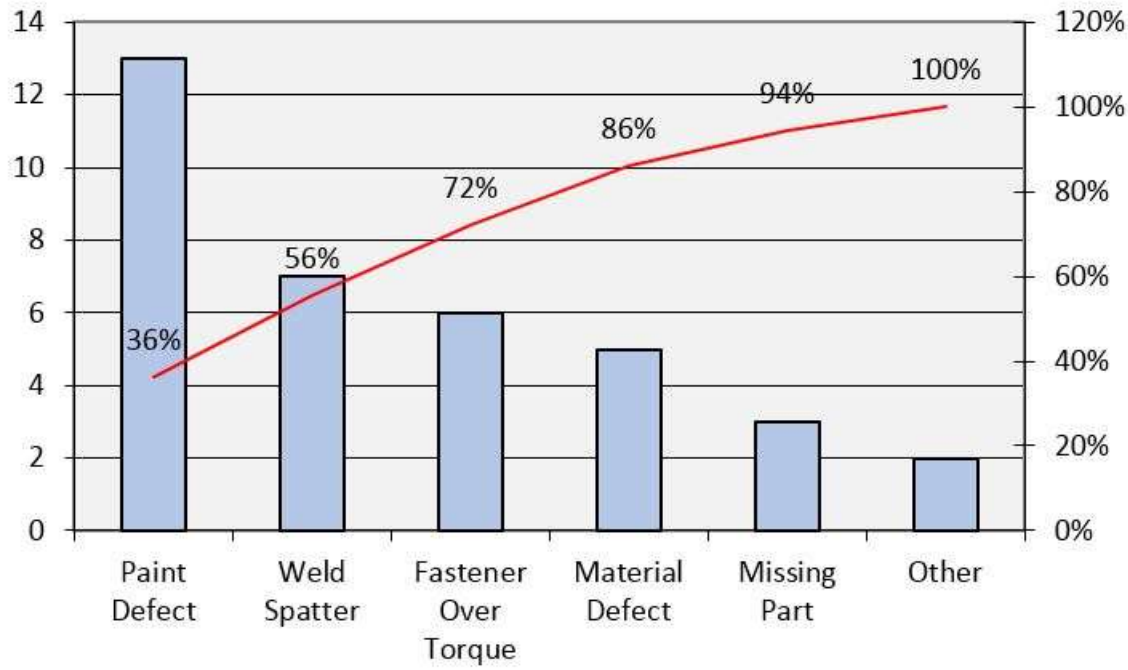

Diagram 6.1 – Sample Pareto Chart

It was during the Second World War that the Allied forces developed a number of statistical techniques in an attempt to better control the quality of their armaments. **Walter A. Shewhart** 1891-1967) was the first to develop what are now known as a **control chart** or **run chart (**see **Diagram 6.2 – Sample Control Chart**). An example of a simple control chart (assuming a normal distribution) is based on the idea of an upper control limit (UCL) of three standard deviations (3σ), a mean (μ) and a lower control limit (LCL) of a negative three standard deviations (-3σ). If for example, a bolt is being manufactured where its mean length is 25 mm and a standard deviation of 0.05 mm. Using the above control chart, we would expect the bolt length to vary between 25.15 mm and 24.85 mm. Any observations outside these two limits would indicate a process that is not in state of statistical control and remedial action should be taken.

After the Second World War the Americans began to help Japan rebuild. In 1950 **W. Edwards Deming** (1900-1990), a former co-worker of Shewhart's, was invited to Japan to give a number of lectures on quality control. His contribution in helping Japan rebuild its economy were immeasurable; he became known as the Father of Japanese Quality. In addition to lecturing on the use of control charts, he also promoted the use of the PDCA (Plan-Do-Check-Act) cycle.

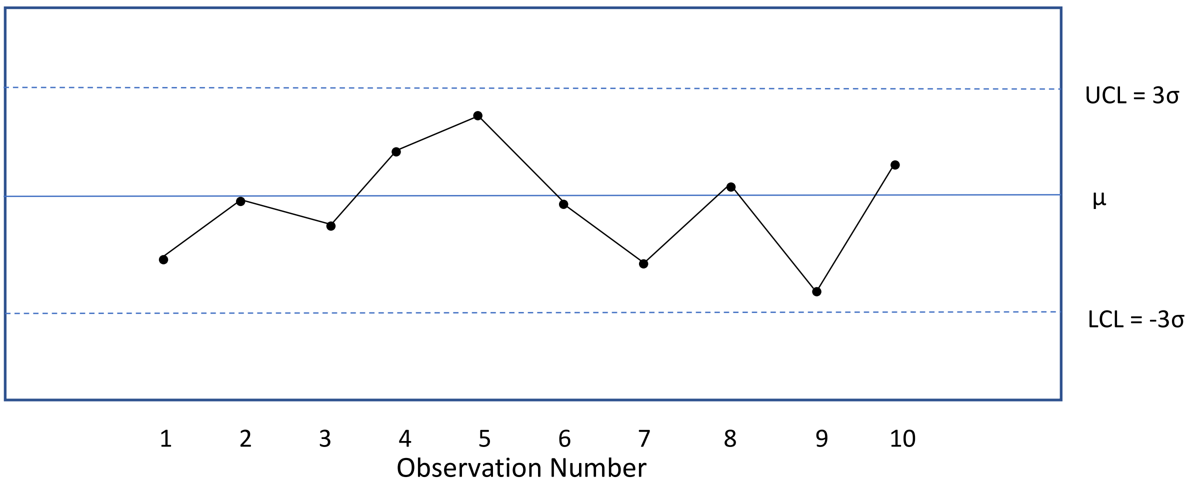

Diagram 6.2 – Sample Control Chart

After returning to the United States, he continued to work on his philosophy of quality, which is best expressed by Deming's 14 Points (see below).

1. Constancy of purpose – improve products and service
2. Adopt the philosophy – take on change management
3. Do not rely on mass inspection – build quality into products and service
4. Don't award business on price – build loyalty and trust with single suppliers
5. Constant Improvement
6. Training
7. Leadership – supervision should help workers and machines do a better job
8. Drive out fear
9. Break down barriers – teamwork
10. Eliminate slogans and exhortations – the work force does not control system issues
11. Eliminate quotes – use leadership instead
12. Pride of workmanship – quality before numbers
13. Education – self-improvement
14. Plan of action – transformation is everyone`s job

Another famous expert on quality who contributed to the rebuilding of Japan after World War II was an engineer by the name of **Kaoru Ishikawa** (1915-1989). Ishikawa is perhaps best known for his development of the Ishikawa or cause-and-effect diagram (also known as the fishbone diagram – see **Diagram 6.3 – Sample Ishikawa Diagram**). The Ishikawa diagram sets out an effect (defect or issue); in the sample provided, poor software sales. The analyst then looks at diagraming the various major causes of the effect; here causes include, people, promotion, price and product. Under each cause is listed one or more contributing factors. One of the many benefits of using the Ishikawa diagram is its focus on the whole system affecting the effect.

Ishikawa is perhaps most famous for the adoption around the world of his development of the quality circle. Quality circles are made-up of workers who have similar jobs, who meet regularly (on company time) to identify and resolve work related quality issues. The group is led by a supervisor or manager who is trained in the use of quality improvement tools and techniques.

Joseph Juran (1904-2008) started his electrical engineering career at Western Electric in 1926. Juran was invited to Japan in the 1950's at the same time that Deming was working in Japan. While Deming's focus at the time was on the use of statistical process control, Juran was focused on management's influence on quality. Juran believed that resistance to change was the main cause of poor quality. Solve the human issues and quality improves. Juran was also interested in the cost of poor quality and, as a result, developed what is now known as the Juran Trilogy. His trilogy addressed three managerial functions: quality planning, quality control and quality improvement. He proposed that higher costs could be recouped by higher margins on quality goods and services.

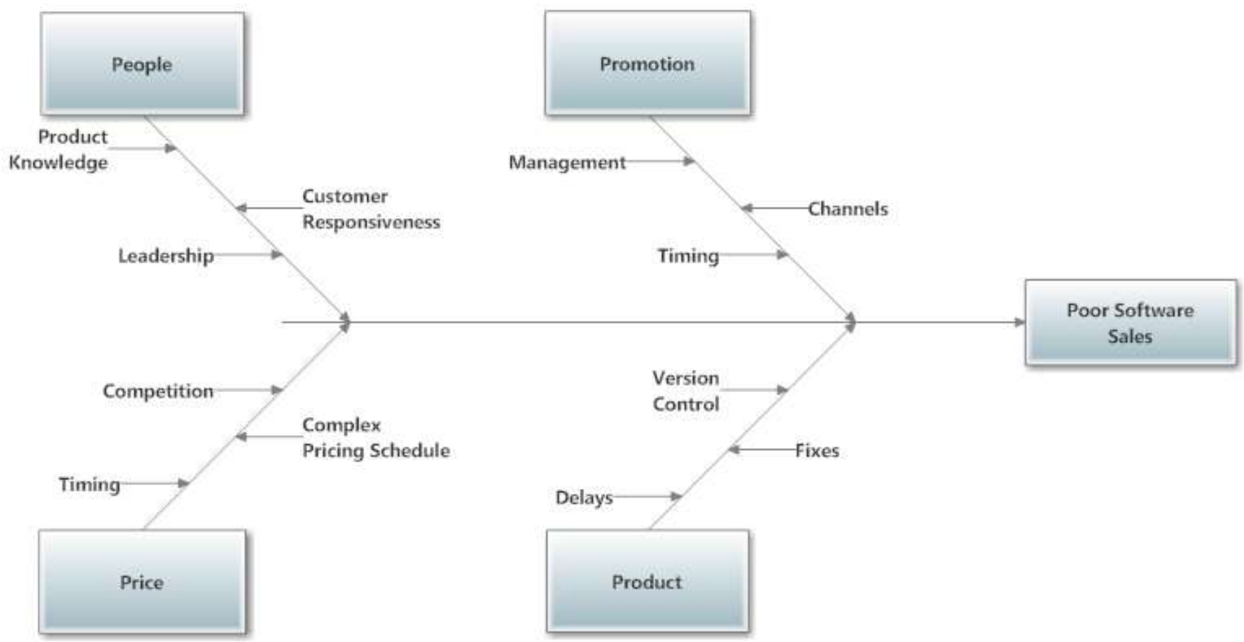

Diagram 6.3 – Sample Ishikawa Diagram

The quality expert (in 1951) that was first to coin the phrase **Total Quality Control** (**TQC**), was Armand Feigenbaum (1920-2014). Feignbaum defined TQC as follows.

Total Quality Control as an effective system for integrating the quality development, quality maintenance and quality improvement efforts of the various groups in an organization so as to enable the production and service at the most economical levels which allow full customer satisfaction.

Later, in America and around the world, TQC became known as **Total Quality Management** (**TQM**).

Philip Crosby (1927- 2001), was part of the Martin Missile program in the 1950's. He not only proffered his own 14 points for quality management, but is credited with being the first to promote the concept of **zero defects**. He was also the first to suggest that quality is less costly than, in Crosby's terms, "nonconformance".

Total Quality Management (TQM)

As Japan improved the quality of its products, the United States took notice and what was called Total Quality Control in Japan was changed to Total Quality Management (TMQ). Over the years numerous organizations from around the world have provided various definitions of TQM.

Definition

- American Society for Quality

TQM can be summarized as a management system for customer-focused organizations that involves all employees in continual improvement. It uses strategy, data and effective communication to integrate the quality discipline into culture and activities of the organization.

- Chartered Institute of Procurement and Supply (CIPS)

TQM drives continuous improvement within all aspects of an organization by adopting a product quality approach aiming to thoroughly transform the organization through progressive changes in attitude, practices, structures and use of systems. TQM is a culture and as such involves everyone in the organization and covers every function.

- JUSE (Japanese Union of Scientists and Engineers) International Seminar on TQM - 2009

TQM is a set of systematic activities carried out by the entire organization to effectively and efficiently achieve company objectives so as to provide products and services with a level of quality that satisfies customers, at the appropriate time and price.

The takeaways from the above definitions include, TQM requires:

1. Focus on customer satisfaction;
2. Continuous improvement;
3. Applying a systematic approach that includes data, planning and communication; and
4. Involvement by everyone in organization.

Tools

As has been noted above, one of the corner stones of TQM is the emphasis on quantifying and visualizing the quality effort. We have already seen three out of the first seven (original) quality tools used when implementing a quality program (**Pareto Diagram**, **Ishikawa Diagram**, **Control Chart**). The remaining four tools are as follows.

- **Check Sheet** – Structured collection of data that facilitates easy analysis.
- **Histogram** – Displays frequency of differing items or observations.
- **Scatter Diagram** – Plots paired values to facilitate pattern recognition.
- **Flow Charts –** A detailed visual representation of the steps that define a process.

Lean

Over the decades, since the inception of Deming's 14 points, TQM has evolved into a number of different quality systems. One example of this is the creation of the quality system known as **Lean**. Lean found its way into the quality landscape in the 1980s when Toyota added Lean to its **Toyota Production System** (**TPS**). Lean focuses on continuous improvement, systematic workflows and, for the first time, the use of the phrase "worker empowerment". In short, Lean is all about leaning out the manufacturing of a product, promoting doing things right the first time, eliminating waste and streamlining problem solving.

Some of the tools used in the Lean approach include:

- **5S –** The workplace should be organized based on "Sort", "Set in Order", "Shine", "Standardize", "Sustain"
- **Poka Yoke** – Eliminating errors
- **A3 –** Structured problem solving, includes desired outcome determination and root cause analysis.

The seven wastes (in Japanese **– muda**) highlighted in the Toyota Production System are as follows.

- Defects
- Additional Processing
- Waiting
- Unnecessary Transportation and Handling
- Extra Inventory
- Unnecessary Motion
- Additional Production

One of the corner stones in Lean and TPS is **Just-In-Time** (**JIT**). JIT means having just the right amount of inventory (both production materials and final product) helping to eliminate waste and aiding in quick response times to change.

Today Lean has found application in such initiatives as Lean Manufacturing, Lean Management and Lean Six Sigma (see below).

Total Productive Maintenance (TPM)

As Toyota developed its Total Production System (see the **Lean** section above) it discovered that in order to get the full benefit from Lean manufacturing it would also have to apply Lean to its equipment maintenance program. In the early 1970's Toyota was maintaining its equipment using what it called **Total Productive Maintenance** (**TPM**).

TPM is based on what the Japanese called the eight pillars.

1. Continuous Improvement (kaizen), even if improvements are small.
2. Planned maintenance, not waiting for equipment to breakdown.
3. Minimize new production equipment start-up time.
4. Provide training so that employees can work autonomously.
5. Equipment to be maintained by the operator.
6. Equipment maintained to a level that ensures zero defects and zero downtime.
7. TPM office that works efficiently to eliminate losses.
8. Safety, Health and Environment (SHE), zero accidents and environmental preservation.

From the eight pillars are derived a number of initiatives, including:

- Concept of Zero
- Eliminating Six Major Losses
- Overall Equipment Effectiveness (OEE)
- Root Cause Analysis

Concept of Zero

TPM provides a systemic approach to maintaining areas and machines. This is accomplished, in part, by working to achieve the following.

- Zero Defects
- Zero Waste
- Zero Downtime
- Zero Accidents
- Zero Pollution

Eliminating Major Losses

Eliminating the following six major losses can help to attain the Concept of Zero.

1. Equipment Failure
2. Setup and Adjustments
3. Idling and Minor Stops
4. Reducing Speed
5. Process Defects
6. Reduced Yield

Overall Equipment Effectiveness (**OEE**)

Insights gained from working on reducing the six major losses result in a better understanding of the factors that are used to calculate overall equipment effectiveness; these OEE factors are:

- Availability – expected equipment runtime
- Performance – how close to the equipment's design rate
- Quality – making the product right the first time (First Pass Yield)

Each OEE factor has a calculated numeric value; OEE = Availability x Performance x Quality. A low OEE can be explained by closely examining one or more of the OEE factors and ultimately applying one or more root cause problem solving tools (see below).

Root Cause Tools

Problem solving tools used to determine a root cause.

- 5 Whys

  When using this tool, a question starting with the word "Why" is asked and an answer is given. The next "Why" question is asked using the answer from the previous question; this loop is continued until a root cause is determined.

- 8D

  The 8D tool has eight steps.

  1. Develop action plan for team approach.
  2. Describe the problem.
  3. Implement and verify interim remedial actions.
  4. Determine and verify root cause(s) using one or more tools (e.g. 5 Whys).
  5. Choose and verify effectiveness of corrective action.
  6. Implement corrective action.
  7. Prevent recurrence.
  8. Recognition for teamwork well done.

- Failure Mode and Effects Analysis (FMEA)

  There are 10 steps to completing Failure Modes and Effects Analysis.

  1. Review the problem process, listing each component of the process.
  2. Brainstorm the possible failure modes and create a list.
  3. List possible effect(s) of each failure.
  4. List possible cause(s) of each failure.
  5. List what systems are in place to detect each failure or cause.
  6. Assign a severity ranking (1-10) for each effect.
  7. Assign a severity ranking (1-10) for each failure or cause.
  8. Assign a ranking (1-10) to detecting the failure, cause or effect based on likelihood of detection.
  9. Calculate the Risk Potential Number (RPN) by multiplying the three rankings for each failure mode and effect.
  10. Develop an action plan.

- Pareto Diagram

  (See **Quality Experts** section above)

- Ishikawa Diagram

  (See **Quality Experts** section above)

From a process operations point of view, TPM starts with the simple act of cleaning both equipment and the process area. In TPM terms, cleaning is inspecting, giving the operator the opportunity to observe, record and tag any abnormalities. This type of maintenance catches problems sooner rather than later, allowing for planned repairs and shorter repair times.

Operators are also responsible for lubrication of the equipment. Up to 70 percent of mechanical failures are due to improper lubrication.

Six Sigma

Relying on much of the work previously accomplished in the area of quality, Motorola developed (1981) an in-house process centric quality project called **Six Sigma**. Motorola quickly saw the benefits associated with their Six Sigma program and by the late 1980's expanded Six Sigma to include other important business functions.

Six Sigma is named after the Greek letter σ (sigma), which is used to represent a single standard deviation from the mean for a normal distribution. Without getting too detailed, six sigma (6σ), in the Six Sigma system, indicates that the process is in statistical control between -6σ and +6σ (remember the discussion about Control Charts above). In other words, to achieve a Six Sigma quality level there can only be 3.4 defects per million opportunities for nonconformance.

Six Sigma sees all work as a type of process and as such applies an approach to quality improvement called **DMAIC**; **DMAIC** as defined by the ASQ.

Define the problem, the scope, the key customers and customer requirements.

Measure process performance based on the current understanding of both process and customer requirements.

Analyze the process identifying root causes of variation and poor performance.

Improve the process by eliminating root causes.

Control systems should be installed improving current and long-term performance.

Six Sigma takes advantage of numerous analytical tools; a list of some of these tools, without details, is as follows.

- Pareto Diagram
- Ishikawa Diagram
- Process Mapping
- Gage R&R
- FMEA
- Hypothesis Testing
- Analysis of Variance
- Linear Regression
- Design of Experiments
- Flow Chart

The training system of Six Sigma is based on the martial arts system of awarding belts. Some of the requirements for each belt are shown below.

- ***White Belt*** *- Problem solving teamwork; understands the basics of Six Sigma.*
- ***Yellow Belt*** *- Project team member; gains experience with methodologies and DMAIC.*
- ***Green Belt*** *- Three years of work experience; data collection and analysis; leads Green Belt project teams.*
- ***Black Belt*** *- Completion of two Six Sigma projects; trains and coaches project teams.*
- ***Master Black Belt*** *– Five years of work experience; completion of 10 Six Sigma projects; trains and coaches Green Belts and Black Belts.*

Lean Six Sigma

Lean Six Sigma combines the Six Sigma reduction of variation with Lean waste reduction. Lean accomplishes its goals through continuous improvement (kaizen), management processes (e.g. 5S, JIT) and visual controls. Six Sigma promotes the use of DMAIC and use of advanced statistical methods such as hypothesis testing and design of experiments (DOE).

Quality Management Systems (QMS)

The International Organization for Standardization (ISO) published its first quality management systems (QMS) standard, ISO 9000, in 1987. Approximately 30 years later, ISO 9000 is a set of international standards on quality management and quality assurance that assists any company with systematically documenting their quality system. As of the writing of this chapter, the latest updated releases are ISO 9000:2015 (QMS – Fundaments and Vocabulary) and ISO 9001:2015 (QMS – Requirements). These two new standards promote the use of seven quality management principles.

1. Customer Focus
2. Leadership
3. Engagement of People
4. Process Approach
5. Improvement
6. Evidence-based Decisions
7. Relationship Management

A closer review of each of the principles listed above quickly leads to the observation that many of the concepts that we have already discussed are part of QMS. Just to provide a few examples: continuous improvement, data collection and analysis, employee empowerment and meeting customer standards.

Strategic Human Resource Management (SHRM)

The genesis of Strategic Human Resource Management (SHRM) started in the early 1980s when new and different approaches to Human Resource Management (HRM) were being developed.

The first approach was called the **Instrumental** approach; it is also known as the hard approach to HRM. It promotes the idea that HRM is driven by corporate head office, resulting in the formulation of such metrics as profit per employee, value-add per employee and costs per employee. Employees are seen as widgets, passive resources to be used by management to gain a competitive advantage.

The **Humanistic**, or soft approach, was a second type of approach to HRM. In some ways it was a response to the Instrumental approach. This second approach was closely associated with the Harvard School of HRM. Competitive advantage is attained by working with people rather than merely taking advantage of them. Under this approach the HR function focuses on the following core principles.

Competence – creates a culture of learning and development where employees want to take on new tasks.

Commitment – employees are open to management's ideas regarding the organization of work.

Congruence – employee goals and companies' goals are the same. In addition, HRM polices are aligned with how the company operates.

Cost Effectiveness – HRM polices are subject to cost-benefit analysis.

In addition to the above approaches to HRM, there was also a school of thought that emphasizes best practices that can be used in any organization to connect HRM practices with organizational performance. It is this emphasis on performance that is different from the two previously discussed HRM approaches. The best practices approach enhances both performance and productivity and is based on the application of **high performance work practices** (**HPWP**), **high commitment work practices** (**HCWP**), **high involvement work practices** (**HIWP**).

Since, approximately 2006, it started to be suggested by personnel and industrial-organizational psychologists that melding the strategic goals of an organization with the promotion of employee empowerment, teamwork and extensive training, could lead to significant performance benefits; this type of approach to human resource management is called **Strategic Human Resource Management** (**SHRM**).

The psychologists with expertise in this area have developed the following definitions for the three SHRM practices mentioned above.

Empowerment – individuals and teams have the responsibility of making operational decisions.

Extensive Training – frequently and consistently offering training across a range of work functions.

Teamwork – individuals have the authority to delegate work to other team members.

In 2008 a significant study was completed by Kamal Birdi (and others) comparing the productivity of organizations that use the three SHRM practices versus organizations that use the operational practices of TQM, JIT, advanced manufacturing technologies (e.g. automation) and supply-chain partnering (long-term relationships). The study looked at the productivity of 308 companies over 22 years.[(1)]

The main conclusion of the Birdi study is that empowerment has the greatest positive effect on productivity. Extensive training ("training and education beyond the requirements of the immediate job") came in second in terms of having a positive effect on productivity. Teamwork appeared to "enhance" the effect of the other two SHRM practices.

Interestingly, Birdi's study seems to suggest that "none of operational practices were directly related to productivity".

Given all the work completed surrounding the development of SHRM, its fundamental concepts include the following.

- The HR function is central to carrying out the company's business strategies.
- All mangers within the organization perform some level of HR function.
- SHRM focuses on competitive advantage and increased productivity.
- Employees are the company's most important asset, the source of the company's competitive advantage.
- Everyone has a customer and is also a customer themselves.
- Developing metrics for the HR function is the way to manage the HR function.
- Success is gained "with the use" of employees, not "by the use" of employees.

A final note about SHRM. One of the best of examples of the implementation of SHRM is Google. The former Senior VP of their HR function, Laszlo Bock, set the stage for the way that Google is run today. Google's HR team is known as "People Operations" and every manager has a function within "POPS" (as they like to call it).

Conclusion

In this chapter we have discussed some of the greatest contributors to the quality movement (e.g. Pareto, Deming, Ishikawa, Juran, etc.). We have also looked at the evolution of quality management overtime (e.g. TQM, Lean, TPM and Six Sigma). We took a brief look at ISO 9000 and QMS. Finally, we reviewed one of the latest strategies that is used to promote productivity in the workplace, Strategic Human Resource Management.

In a world of finite resources, now more than ever, we need to focus on quality rather than quantity. Instead, we see fly ash from coal burning electric power plants making its way into gypsum (wall) board. We see substandard steel being used around the world. We have even seen melamine making its way into our milk supply. These examples of "poor quality" make cheap poor quality toys from Japan, some 70 years ago, seem rather innocuous.

References

1. Birdi K, Clegg C, Patterson M, Robinson A, Stride CB, Wall TD, Wood SJ. “The Impact of Human Resource and Operational Management Practices on Company Productivity: A Longitudinal Study”. *Personnel Psychology*, *61*: (2008), 467-501.