Quality Perspective: Managing Software Development Projects

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In order to better achieve its goals, any project is logically divided into phases that are composing the project life cycle. The name and number of these phases are industry dependent, so they are completely different from one field of activity to another. Typically, the phases are scheduled sequentially but in some cases a project may take clear advantages by running the phases concurrently. In contrary, according to the PMI's point of view, the project management methodology (also known as the project management process) is not depending by the industry or project type, so any kind of project, from any field, will use the same five process groups – initiating, planning, executing, monitoring & controlling and closing. The total costs related to quality efforts performed during a product lifecycle are known as COQ (Cost of Quality). Large software development projects need to pay a special attention to quality since failures can lead to money lost due to rework, warranties, liabilities or even lost business. In the modern economy, the Pareto principle was quickly extended to quality control, stating that most defects in production are the direct result of only a small percentage of the causes of all defects.
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1 The Project Management Process

According to **PMI** (*Project Management Institute*), the publisher of **PMBOK Guide** (*A Guide to the Project Management Body of Knowledge*), ***a project is a temporary endeavor undertaken to create a unique product, service or result***.

Any project has its own *life cycle*, a progression (generally sequential) of phases that are industry dependent, so projects from various fields will implement different stages. By using these phases, a project is actually divided into smaller logical parts/subsets that can be better managed, planned and controlled.

The life cycle is usually applied together with a *project management methodology/process* which includes, from a **PMI**'s point of view, the five *Project Management Process Groups – Initiating*, *Planning*, *Executing*, *Monitoring and Controlling*, *Closing*, as detailed into Figure 1. The *Project Management Process Groups* are industry independent and totally different than the project phases.

A project usually starts with the **Initiating Process Group** where it is decided if the project will be selected and accepted based on high-level planning efforts performed at this stage. Small projects are using a single set of project management process groups, while large projects are implementing one set of process groups for each phase.

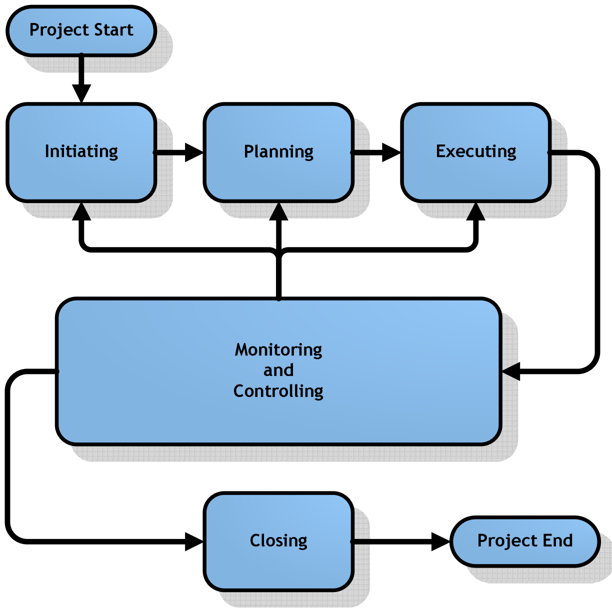

Fig. 1. Project Management Process Groups

The initiating process can happen by one of the following reasons (Figure 2):

– a new project just started
– a new phase is about to begin
– there are critical issues that demand the project to be completely reevaluated

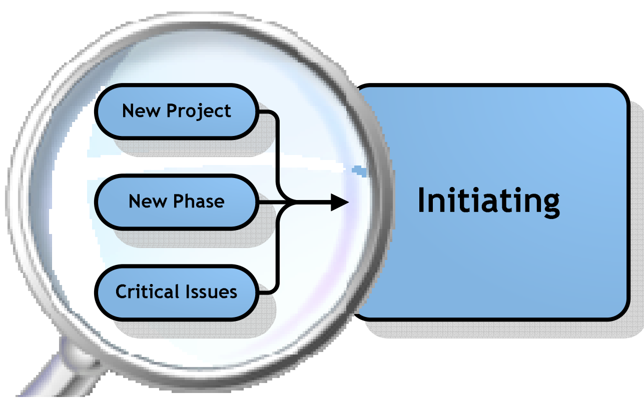

Fig. 2. Initiating Process Group

If the project is approved, it will move forward to the **Planning Process Group**, so detailed **Project Management Plans** are prepared. The planning process group occurs in one of the following situations (Figure 3):

- initiating process group is completed
- there are major issues that need the project to be re-planned.
- the ICC Board (Integrated Change Control Board) approved significant modifications that are affecting the initial plans

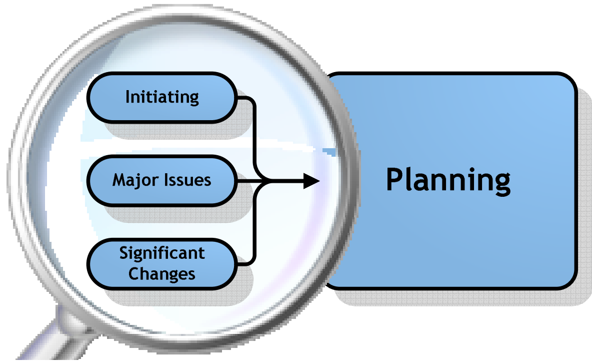

Fig. 3. Planning Process Group

The **Executing Process Group** will follow right after, so the work will be completed according to the plans. Executing can be started by one of the following reasons (Figure 4):

- planning process group finished
- there are non critical issues that do not need re-planning.

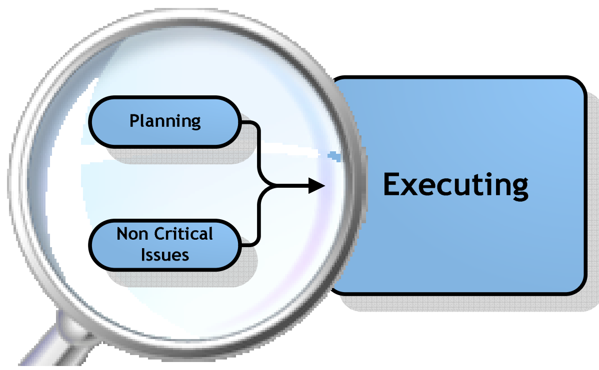

Fig. 4. Executing Process Group

The results of the executing will be supplied to the **Monitoring and Controlling Process Group** that will make sure the project is on the track in terms of scope, time, cost, risk and quality. The reasons to start the monitoring and controlling process group are presented into the Figure 5:

- executing process group just finished
- approved changes arrived – corrective/preventive actions or defect fixing

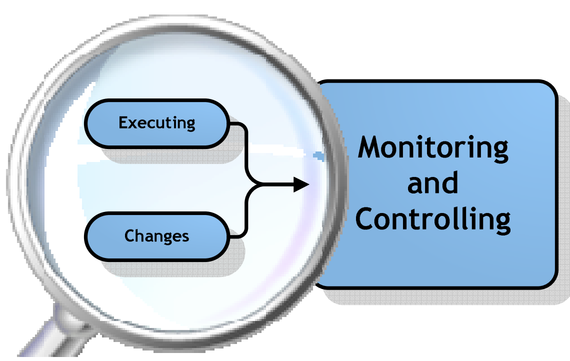

Fig. 5. Monitoring and Controlling Process Group

In the case when variations to the plan are encountered, depending on the severity of the identified issues the project will return back to one of the following process groups (Figure 1):

- *Initiating* – when the issues are critical so a decision point is needed in order to find out if the project would continue or not
- *Planning* – if major issues are discovered or significant changes are approved
- *Executing* – when there are no baselines affected by the changes

A project can enter into the **Closing** project group in one of the following situations (Figure 6):

- project or phase is complete
- project is cancelled before the work is finished

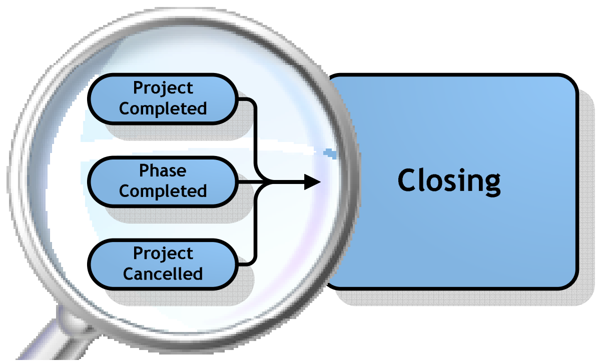

Fig. 6. Closing Process Group

Project closing is assisting the project manager to make sure all the work is completed according to the plans and the project met the objectives stated into the charter and project management plans.

Phase to Phase Relationships

As stated at the beginning of this paper, any project can be logically divided into several phases that can be better managed, planned and controlled. Typically, these phases are scheduled sequentially but in some cases a project may take clear advantages by running the phases concurrently.

In the case of a *sequential relationship* (Figure 7), one phase can start only after the previous one is finished, so it is clearly a step by step approach that doesn't allow fast tracking, even if the level of improbability is very low.

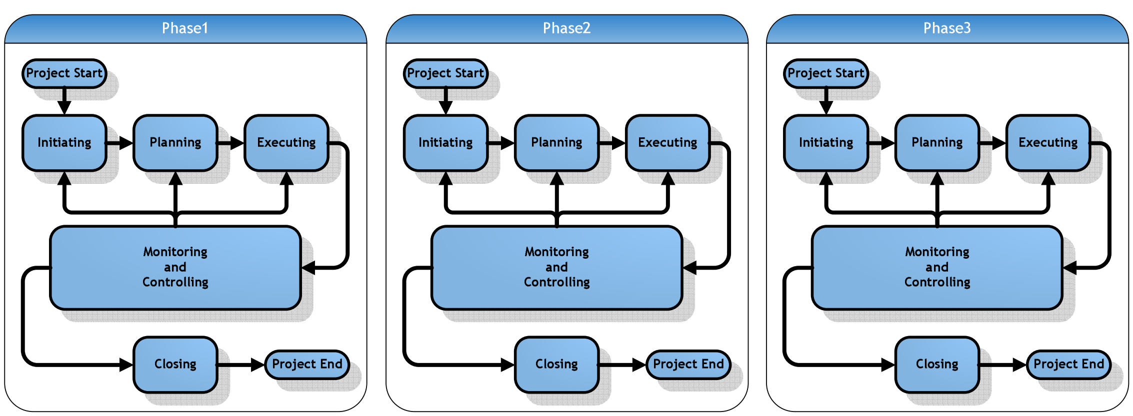

Fig. 7. Sequential Phases

An overlapping relationship indicates that one phase can start even if the previous one is not completed yet, by assuming all the corresponding risks in order to speed up the project schedule. Usually, the overlapping occurs only at the edge of successive phases, as presented into the Figure 8.

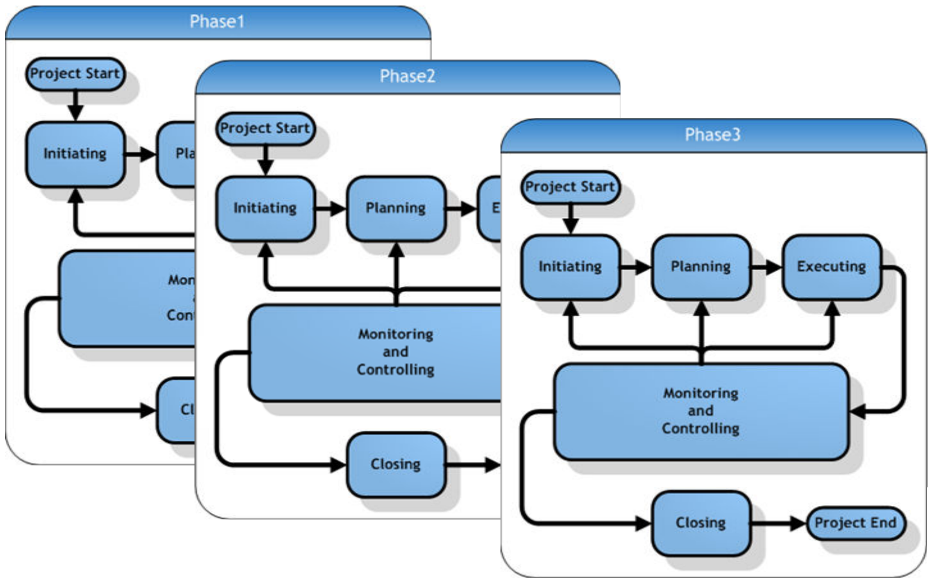

Fig. 8. Overlapping Phases

Iterative relationships can be used each time when a high degree of uncertainty is encountered, like the research projects. The work for the current stage is performed in the same time as planning for the next phase (Figure 9), so it is not possible to provide long term planning. While the work progresses, new gathered data help to update the project schedule.

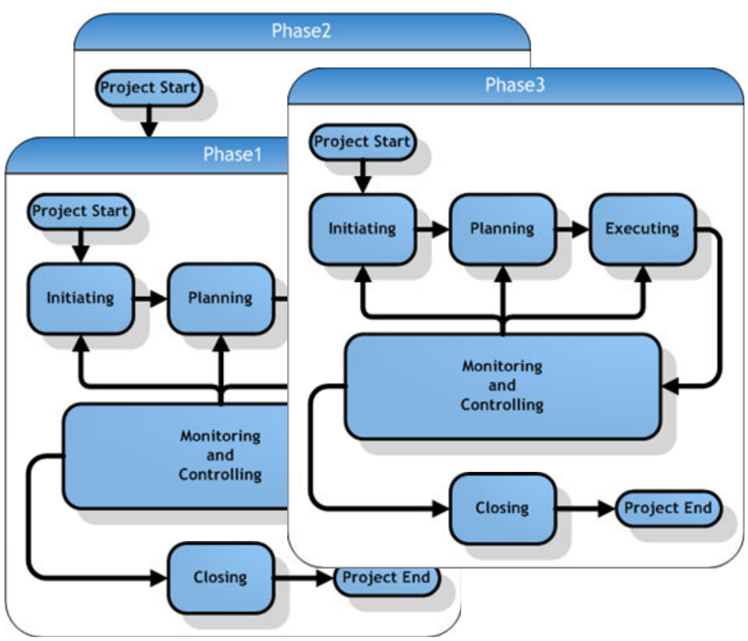

Fig. 9. Iterative Phases

Composite relationships can be found in multiphase projects that are using several types of relationships during the life cycle.

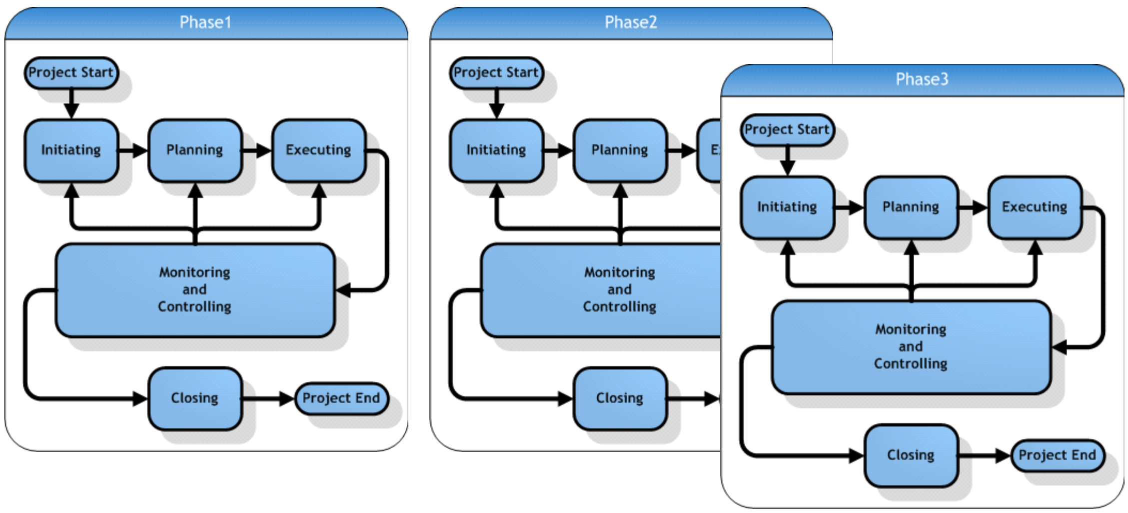

Fig. 10. Composite Relationships (Sequential and Overlapping)

The image above (Figure 10) illustrates the case of a project that is implementing both sequential and overlapping relationship types during its life cycle. It is possible to use all tree types of relationships during the phases of a single project.

Quality Highlights

Quality represents the degree to which the sum of characteristics of a product fulfills the requirements by meeting the customer demands and expectations. Low quality is always a problem.

Quality is affected by the balance between the components of the triple constraint triangle (also known as *Iron Triangle* or *Project Management Triangle*) – time, cost and scope that are acting as constraints (Figure 11).

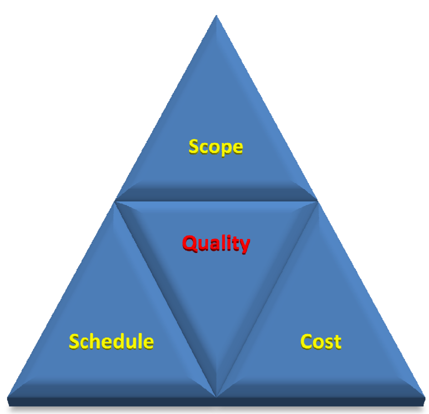

Fig. 11. The Iron Triangle focused on Quality

If one triangle's angle is changing, all the others should be modified accordingly, otherwise the quality will suffer. In our days, the Triple Constraint Triangle evolved to the new concept of *Iron Hexagon* – three new constraints were added, quality, risk and resources, as presented into the next image (Figure 12).

Fig. 12. The Iron Hexagon

Large software development projects need to pay a special attention to quality since failures can lead to money lost due to rework, warranties, liabilities or even lost business.

Project Quality Management

Project Quality Management applies uniformly for all types of projects, no matter what the project's final product is.

Modern quality management clearly sates the importance of all the following aspects:

- management responsibility – quality is a matter of management responsibility even if the success is shared by the entire team members
- prevention over inspection – quality is rather planned than inspected in
- continuous progress – permanent quality improvement
- customer satisfaction – counts not only the degree of meeting the customer requirements but also includes the fitness of use
- PDCA – Plan, Do, Check, Act cycles applied iteratively for a continuous quality improvement, also known as Deming's iterative four-step problem-solving cycle
- Total Quality Management – companies and their employees are encouraged to find ways to continuously improve the quality
- Impact of Poor Quality – over risks, schedule, costs, customer satisfaction
- Marginal Analysis – when this point is reached, any quality improvement is stopped since the incremental costs of achieving the quality level are equal with the benefits gained by improved quality
- Gold Plating – no extras are supposed to be offered to the customer since all the efforts and resources should be heavily focused on meeting the requirements, not the extra features that are not requested and maybe not even needed or wanted by the customer

The quality of the project deliverables cannot be obtained without a high quality management process, but a quality process does not guarantee quality products. The quality of the process is certified through quality standards. Modern quality approaches are recognizing the quality issues as actually being management responsibility.

The following types of changes that can be usually assumed:

- corrective actions – improve the performance in the near future
- preventive actions – reduce the probability of negative consequences
- defect repair – actually means repairing or replacing the product

Fig. 13. PMI's Project Quality Management Overview

According to Project Management Institute, the *Project Quality Management* includes the following *processes* (Figure 13, see above):

- *Plan Quality* – defines the quality standards for product and project and planning how the achievement of these standards will be confirmed; Plan Quality also takes into the consideration the permanent process improvement
- *Perform Quality Assurance* – mainly performed through quality audits
- *Perform Quality Control* – performs the necessary verifications needed to evaluate the level of quality and proposes the appropriate changes

The way in which the quality management fits into the five project management process groups is illustrated by the Figure 14. The *Plan Quality* occurs during the *Planning* process group, *Perform Quality Assurance* belongs to the *Executing*, while *Perform Quality Control* is mostly performed during the *Monitoring and Controlling* process.

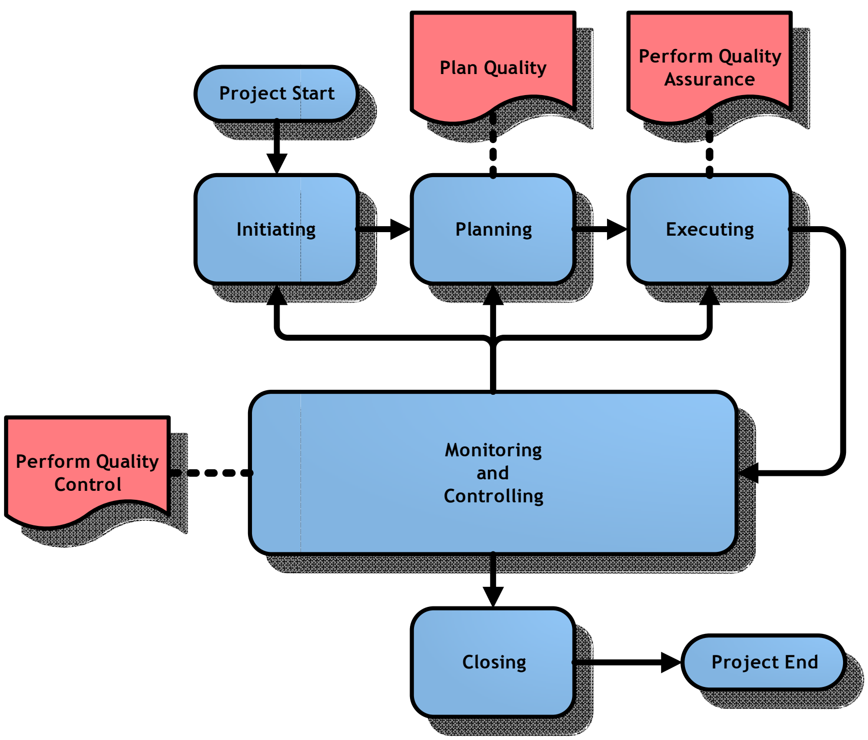

Fig. 14. Quality Management Processes

Plan Quality is mainly about demonstrating the compliance of the project with the identified/selected quality standards and requirements to be applied. The most common tools used for quality planning are cost-benefit analysis, control charts, benchmarking and flowcharting.

Perform Quality Control is trying to identify the poor quality causes and also may recommend corrective or preventive actions to be taken. Usually the quality control is performed by a dedicated department all over the project lifecycle.

Perform Quality Assurance is auditing the overall process by comparing the quality control results with the quality requirements. It is also contributing to the continuous process improvement.

The Pareto Principle Applied in Quality Management

The name of the *Pareto Principle* (also known as the *80/20 rule* or *Pareto's Principle of Unequal Distribution*) was originally suggested by the *Joseph Juran* (1904-2008), an American quality management consultant that was born in Romania (Braila).

He revealed the work of the 19th century Italian professor of political economy *Vilfredo Pareto* that discovered that the top 20% of any country's population accounts for more or less 80% of its total income. Initially, Pareto noticed the distribution for Italy but right after he extended the analysis on several other countries obtaining very similar results. Of course, the principle can be virtually applied in any area, like domestic behavior, for example – we can easily notice that we eat 20% of favorite food for 80% of time or, similarly, we spend 80% of time doing the most frequent 20% of activities.

Mathematically speaking, there is nothing special about the proportion of 80/20 but many real systems come across a ratio very closed by the Pareto's distribution.

In the modern economy, the principle was quickly extended to quality control, stating that most defects in production are the result of a small percentage of the causes of all defects. This is generally defined as "the vital few and the trivial many" or "the vital few and the useful many" (Figure 15).

Fig. 15. Pareto Principle, Vital Few vs. Useful Many

Starting from the Pareto Principle, Juran lately introduced the concept of CWQM (Company Wide Quality Management) that was based on three pillars (also known as *Juran Trilogy*):

- quality planning – is focused on identifying the customers together with their needs that should be satisfied;
- quality control – follows the process of producing goods and services that meet the previously identified needs;
- quality improvement – the efforts performed to constantly improve the previous processes.

In our days, the principle is still very applied in a variety of areas, especially into the quality control field. For example, in the IT industry it is considered that 80% of users are actually using only 20% of the features.

In the recent years, the principle was mostly applied on errors rather than features because it was observed that 80% of errors are actually generated by the 20% of the detected bugs, so a small proportion causes most of the errors (Figure 16).

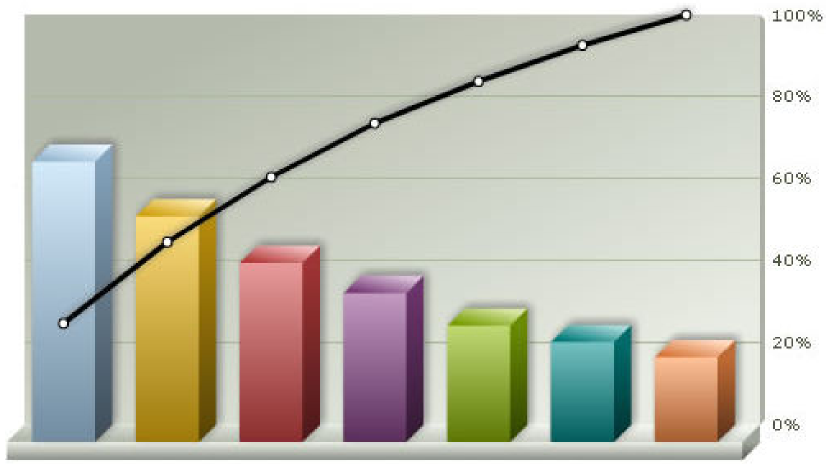

Fig. 16. Sample Pareto Chart

This is a winning strategy applied by the big software companies that are dealing with large software development projects since the customer satisfaction can be tremendously improved by correcting only a tiny amount of the reported errors.

CoQ (Cost of Quality)

The total costs related to quality efforts performed during a product lifecycle are known as **CoQ** (**Cost of Quality**) and usually these costs are falling in one of the following categories:

- **cost of good quality** - costs related to conformance in order to avoid the failures
  - prevention costs, generally achieved by training, audits, planning
  - inspection costs by performing validations and tests
- cost of poor quality - costs related to nonconformance, also known as failure costs, are the efforts necessary to be spent in order to correct the failures. These costs are generated by corrective actions required and defect repairs needed. The effects of this type of costs could tremendously affect the future of any company since severe quality problems can even lead to completely loosing the business:
  - internal failure costs – found by the project team during development
  - external failure costs – nonconformities discovered by the customers

There is a strong connection between these two types of costs, as illustrated by the Figure 17:

- low investments in prevention and inspection predictably lead to excessive high costs involved by taking the appropriate corrective actions, including defect repairs
- since the *cost of good quality* is rising exponentially while the quality level becomes higher, there is a point where any investment in quality becomes uneconomical
- there is a point (marked by the vertical line) where the *total quality costs* are reaching the minimum level

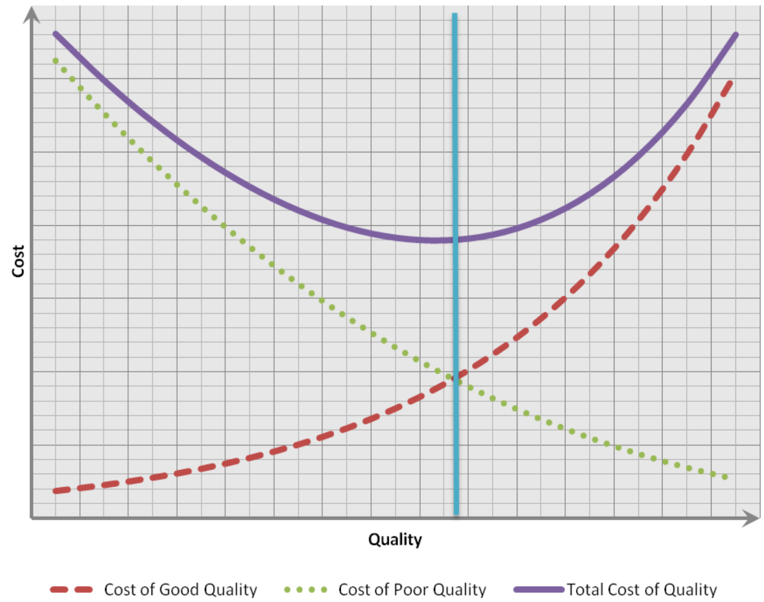

Fig. 17. Total Cost of Quality

Reaching a higher quality level should become an organizational objective for any company but being positioned above this minimum point (the vertical line, see the image above, Figure 17) turns out to be extremely important for any large software development project since such a case allows to obtain a great quality level at very low expenses.

Conclusions

Quality Management includes the *Plan Quality*, *Perform Quality Assurance* and *Perform Quality Control* processes and, very important, it also takes into account the **continuous process improvement**. The *Total Cost of Quality* decreases while the quality improvement process advances.

Quality management becomes more and more important while the project management approaches evolved from the triple constraint to the iron hexagon that asserts the quality is one of the important factors for the success of a project.

The rule of 1-10-100 (originally acknowledged in constructions) seems to be successfully applied also for the software development area. The rule basically states that a 100 monetary units needed to correct an issue discovered by the customer would actually cost 10 if revealed during internal tests and only 1 to be avoided during the initial stages of the project. If an issue is not corrected right when it occurs, it will cost more to repair it at a later time, and the fixing costs are growing exponentially in time, so it is very important to do the things right from the first time.

Cost of quality is usually divided into two main categories, good and poor quality costs. Low quality involves higher amounts to be spent for fixes and corrections and small investments for prevention, while a high quality level demands significant prevention efforts in order to reach a low rate of defects. There is also a point from which any investment in quality becomes uneconomical since the advantages gained are smaller than the investment.

Viewed from this perspective, the costs of poor quality (costs connected to the corrective actions and defect repairs, also known as failure costs) will always greatly exceed the costs related to conformance, so a very special attention should be paid to prevention and inspection by carefully investing the quality.

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