

Pareto Analysis - A TQM Implementing Tool For R & D

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Abstract

The R&D (Research and Development) work is the first stage of the product life cycle. Its outcomes have a major effect on the product's quality, cost and success in the market. Despite of its importance, companies usually have a difficult task to implement TQM (Total Quality Management) in their R&D work. Although TQM concept has been widely discussed in many R&D units, the implementation of TQM in R&D work is rather a modest phenomenon. The paradox is that the R&D's innovative culture seems not compatible for TQM's rational process. Hence, lacking of quantified measures and efficient tools have created major barriers for TQM implementation. For improvement, Pareto analysis - a classical TQM tool is introduced to measure R&D work. The outcomes of analysis are used to support TQM decision making for managing the R&D projects, based on the criteria of cost, customers needs and team competence or other TQM elements. The options, limits and further application areas of this method are also discussed here.

Introduction

It has been well recognized that implementing of TQM (Total Quality Management) in product manufacturing and service, along with customer satisfaction becomes a key survived tool for any business enterprise. The TQM philosophy has also adapted into many companies and becoming a new business culture. The overview of quality study indicates that the TQM has been widely applied in many non-product manufacturing sectors, such as health care, process industries and government, even education sector. The main trend is to implement TQM widely into service sectors.

However, it is also being notice that implementing TQM in R&D (Research and Development) work is rather modest. There is relatively less progress in this field compared with others, and there are few research institutions established their quality systems. The TQM implementation in R&D work is an interesting, but still less matured issue compared with other quality issues. The issue is interesting because there are many uncovered problems and questions waiting for the answers, but there are presumably opportunities as well. On the other hand, the issue is less matured because there are still many barriers for the implementation.

It is hard to define or measure the quality of R&D work or the criteria for the good quality of such work. Few relevant studies have been done with aspect of R&D laboratory measurements (Wasserman 1994). There are still many problems concerning with definition and measurement of general R&D work. Three of them are addressed as the follows:

1. The quantification of R&D work (Bodnarczuk 1994)
2. The utilization of R&D results versus their investment (Straze & Yanai 1994)
3. The contradiction of R&D culture and production culture (Kopelman 1994)

The current study will focus on the problems above and discuss the possible solution with its options, limits and further application areas. The study suggests a classical

TQM tool - Pareto analysis as the possible solution, using to measure R&D work (problem 1). The results of the measurement can also be used as basic data for the consideration of R&D investment versus returning profits (problem 2), and the conciliation of R&D and production cultures (problem 3).

The coming report consists of the following sections: The principles and special elements of R&D work; Pareto analysis - a quantitative approach to rank the quality significance; Options, limits and further application areas; Suggestions to the further research work.

The Principles and Special Elements of the R&D Work

The R&D work is the first stage of a product life cycle. It bears the evidences of innovation, creativity and perfection (Holt 1983, p 13) of engineering thought. However, such efforts have their disadvantages. Sometimes it takes long time to see the result from an idea because there is a long process between them, and sometimes there is no result being seen because only few of ideas have survived through the process.

These few survived ideas are obviously the product of many failure ideas. In fact, Innovation, creativity and perfection mean many ideas, frequent discussions, long term improvement and never satisfaction attitudes. The principles of the R&D work are therefore formulated to the following points:

- It should provide the sufficient time to perform the innovation process.
- It should provide resources for the experiments of the product and prototype.
- It should provide the space for creative ideas and their unsuccessful results.

Spending more time with slow outcomes, putting more resources to the experimental work, and giving more space to the unsuccessful results. These approaches seem not familiar with TQM's rational principles. The differences between the R&D principles and TQM principles create the greatest barriers for the implementation of TQM in R&D work.

Managers also realize that the quantification of R&D work is not necessarily a linear relationship with outcomes. It is not always true that the more work has been done, the better product becomes. The success ratio of the investment is not always as high as other divisions, even 20:1 is considered as good or acceptable in this field (Straze & Yanai 1994). The R&D work is by principle different from other manufacturing activities.

Such principal difference may also bring the cultural differences between the R&D units and other production units. Good quality of R&D work means also understanding of other production units' cultures. On the other hand, production units may show their toleration and cooperation to R&D request. Though they are different cultures between R&D and other process divisions, too little research work has been done within product and process joint design and engineering (Godfrey 1993).

This situation is undesirable for the R&D work and TQM implementation. Thus, many business companies consider the principles of R&D as the framework for theoretical research and try to replace them with the special elements of the R&D work in practice. This is a closed approach for integrating of R&D culture and production culture. The special elements of the R&D work are rather an integrated part of planning system for a company. For instance, the R&D special elements are largely derived from the corporate strategy related to improvement, expansions and diversifications (Holt 1983, p.69). Several such elements of the R&D work are addressed as the follows:

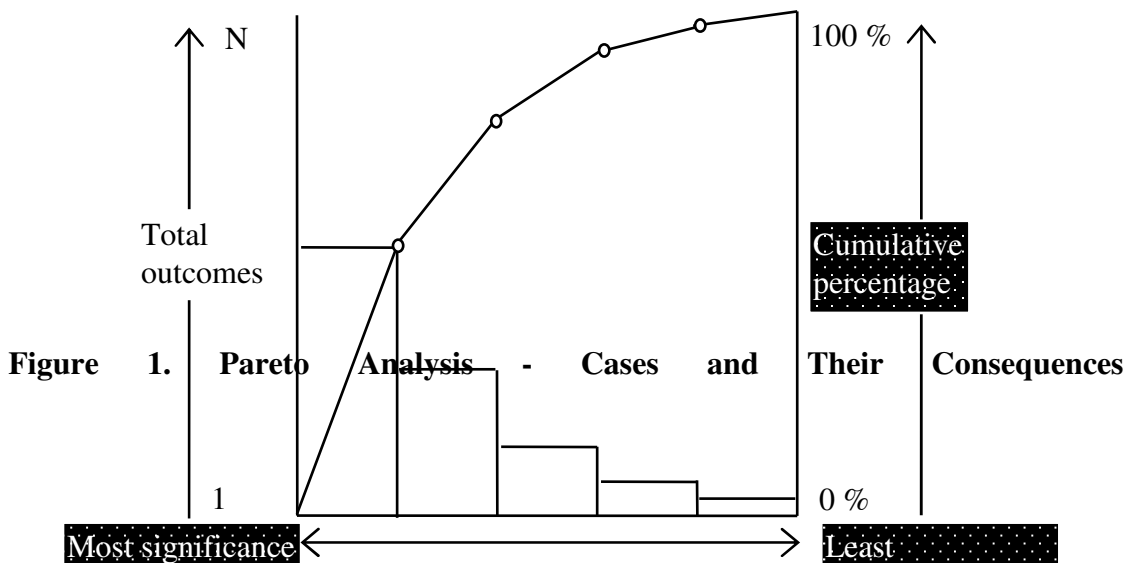
- Problem definition (concentrating the R&D work to the company's needs)
- Need research and assessment (on market and customers)
- Prototype testing in corporation with users (testing of customers' satisfaction)
- Engineering (detailed design of products and processes)
- Market testing (with a group of users) and market introduction (a few markets)

The elements above are nevertheless considered as types of the R&D work related to the company' s needs and therefore rather follow up the TQM' s principles. The implementation of TQM in the R&D work is preferable to consider such elements and integrate them into the company's quality system.

There are still questions about quantification of the R&D work and implementing TQM in the R&D elements above. The key approach is defining the problems and quantifying them. One of the efficient models for such an approach is Pareto analysis.

Pareto Analysis - A Quantitative Approach to Rank the Quality significance

Pareto analysis is a classical technique for ranking the problems or activities after their importance. The principle was found by Italian economist Vilfredo Pareto and it brought the evidence that a small number of problems or activities usually have caused large proportion of the troubles or consequences (Logothetis 1992, p.206). The common name is called 80-20% principle, or say 80% of results are carried by 20% activities.



The technique is traditionally used for the implementation of TQM in the improvement process by measuring the working activities and their outcomes. It was also used to measure the manpower and related personality (Kondo 1994), and some was used to support purchase management (Rolstadås 1983, p.266). The basic principle of Pareto analysis is quantifying the problems and qualifying their relationships to the significance by their consequences. The most significant consequences are caused by a small number of activities or problems. It is then possible to draw the similar interpretation to a business company: The most profitable company's outcomes were designed by few R&D projects, or the most costly problems were caused by few R&D mistakes.

It is necessary to collect information or data from the R&D work in order to analyze the problems by Pareto model. The information or data is essentially different from other TQM processes since there is no "visible" product in the R&D work yet, but projects. This has caused that the evaluation of the R&D work is mainly project based. The project budget, spending or other documentation may be considered as the basic record for the information data.

Options, Limits and Further Application Areas

The R&D work is highly innovative, creative, and flexible performance of a research team, but has relatively indirect relationships to the outcomes or profits of the company. Measuring the performance of the R&D work by Pareto analysis is an approach to link a company's R&D credit and its outcomes and establish a rational process between them. If this approach succeed, the TQM is considerably well implemented in the R&D work.

There are several options concerning to the applications of Pareto analysis. According to the TQM implementing methods in other processes, the criteria as cost, budget, customers needs, and team competence are considered as the actual elements for the measurement. The practical implementation may have the following alternatives in the Pareto analysis (listing over cases versus consequences):

- Listing cost estimation of the R&D projects versus profits of the products.
- Budgeting the R&D projects versus their implementation in manufacturing.
- Ranking the prototype models versus customers needs and opinions.
- Measuring team competence versus individual efforts by project outcomes
- Comparing the R&D product design versus the R&D process engineering.

These alternatives are used to rank the significance of the R&D projects. The general approach is ranking the R&D activities, such as project cost, budget, prototype models, team project resources, hours, manpower, etc. by number of their appearance (cases), against their outcomes, profits, opinions or whatever (consequences). It will be possible to distinguish the ratio of investment and returning profits, or appearance of R&D activities versus their significance.

Managers may apply this analysis model to support their decision making in the R&D management. Because such decision making system has also closed link with products' outcomes and a company's profits. It is an integrated part of TQM system for the company. The R&D projects are presumably preferred or downgraded by a such analysis model, which is also quantitatively based.

The limits of the approach are that the long term and non-profit-making R&D activities are downgraded or abandoned. Usually, such R&D activities are far ahead of customers' expectation to the product and therefore it is also hard to poll customers' needs or opinions. For instance, a R&D project of product design or process engineering with environmental consciousness and security protection is presumably hard to be preferred by a such model simply because a such approach dose cost more.

Considering the implementation of Pareto analysis towards three TQM problems in general R&D work, mentioned previously in the introduction section:

1. The quantification of R&D work (Bodnarczuk 1994)
2. The utilization of R&D results versus their investment (Straze & Yanai 1994)
3. The contradiction of R&D culture and production culture (Kopelman 1994)

It seems that Pareto analysis is an efficient approach to quantify the R&D activities and therefore is compatible for the problem 1. The analysis may also use to rank the R&D investment versus their utilization from earlier experience.

However, the utilization of R&D results versus their investment is a question about financial power of a company. Large companies have powerful financial resources are usually able to wait R&D results over long term before turning profits. Small companies are unable to do so since they are depended on quick cash flow and balance. Hence, Pareto analysis may be compatible for the problem 2, but may not efficient one.

Using Pareto analysis to solving the problem 3 is rather an issue of human resource management. Two different cultures between R&D and production manufacturing are usually confronted each other, and the confrontation creates the barriers for the integration of the R&D activities as a part of the TQM system. The limit or dilemma is finding a quantitative scale or system to measure both cultures. The suggestions are either using traditional questionnaire surveys or looking for secondary data such as common projects of R&D and production manufacturing versus their success ratio.

Pareto analysis was invented for the economic study, but applied widely in TQM and other fields. The philosophy is simple and logical: Concentrating on small number with large outcomes. The R&D work has traditionally been conducted by the philosophy of innovation, creativity and freedom of thought. It must be a good combination to using Pareto philosophy and implementing it into the R&D work as a research strategy. For the R&D work, it is time for rethinking.

It may also recommend further application areas of Pareto analysis in the R&D work, such as pure theoretical R&D work, managing courses and majors at the universities or colleges, forecasting latent trend by major activities, or seeking the potential quality

criteria among the public. There are many areas that may be suitable for using of Pareto analysis. It is a question of further development of the model.

However, the criteria or elements for the analysis model are not necessarily profitable, or even not quantitative. The greatest challenge is adapting the compatible criteria or elements for the model so that the relevant activities are ranked in a proper way. Questionnaire survey and secondary data are for example possible options.

Suggestions to the Further Research Work

Much of further research work needs to be done in this field. Considerably, it suggests both macro aspect and micro aspect for further research approaches. Macro aspect of further research work is concentrated on application of TQM philosophy in the R&D work. The approach is based on the management level with emphasize of information system integration (Zhang & Burns 1994). Finding opportunities is therefore a key element of this aspect. It may include:

- Introducing and implementing Just In Time principle into the R&D daily work.
- Avoiding duplex or overlapped design work at or from the R&D stage.
- Emphasizing process engineering design and its integrating to product design.

Contrarily, micro aspect of further research work prefers to focus TQM techniques and their possible usage for the R&D work. Beside of Pareto analysis as previously mentioned, it is actual to implement design techniques such as Design for Assembly or Design for Manufacturability (Taylor, English & Graves 1994) in the R&D stage. Cause-and-effect diagram is also an available technique using at the school management (Schargel 1994) or the course system (Spanbauer 1992,p.112). Other TQM techniques such as risk analysis, brainstorming, statistical process control (SPC), quality function deployment (QFD) are also considerably interesting for this aspect.

Implementing TQM principles in the R&D work is a long term and hard process. It needs engagement from the R&D staff and encouragement from top managers, as well as understanding and cooperating from other staff members. There is also need for more discussions about R&D philosophies and strategies and their consequences to the rest of TQM implementation processes.

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Author's Backgrounds

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