Life Cycle Costing: Some Possibilities of Use Within Quality Management

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BIOGRAPHICAL NOTES

prof. Ing. Jaroslav Nenadál, Ph.D. was born in 1946. He graduated at Technical University for Transport and Communications in Žilina. He has been working as a professor at VSB-Technical University of Ostrava since 1993. He is very experienced in the field of quality management. As a professor he was appointed in a branch of Quality Management in 1998. He is a member of Czech Society for Quality Prague. He acts as representative of VSB-TUO at European Foundation for Quality Management (EFQM) in Brussels. From 1995 to 2013 was a head of certification body for certification of persons ACM DTO CZ in Ostrava. He is professionally oriented mainly to implementation of various methods and tools within quality management. He published 27 books, 146 papers at conference proceedings and 101 articles at journals, mostly oriented to quality management systems implementation and improvement.

KEY WORDS

Quality, quality management, life cycle costing, design review, purchasing, customer feedback, reliability.

ABSTRACT

Life cycle costing is as an accounting method used for a long time throughout the world, mainly when organizations need to assess various alternatives for equipment and projects. But within the quality management processes is such approach implemented rarely, in spite of fact that there we can implement some internationally recognized standards. The article will stress logic linkage among quality management standards focused on life cycle costing and will present some possibilities where this costing should be valuable. They are areas of design and development, purchasing, infrastructure management, products marketing and delivery and customer satisfaction measurement. A joint customer value analysis and analysis of life cycle costs will be described more detailed here by way of real case.

1. Introduction

Any organization strives to achieve long-term success, especially in the last three decades of an increasingly – competitive environment. Lot of them uses a quality management approach on this purpose. Therefore, quality management is recognized as natural part of overall company management system. The EN ISO 9004:2009 standard defines eight quality management principles, as customer focus, leadership, involvement of people, process approach, system approach to management, continual improvement, factual approach to decision making and mutually beneficial supplier relationship – see [1] for example. Customer focus asks for meeting of all customer (and

other stakeholders) needs and expectations. Ever-increasing customer need is obtaining the highest value for money. A life cycle costing is directly concerned with optimizing value for money.

Life cycle costing is not new concept: the first recommendations in this field occurred in late of 1970s already. We can say the life cycle costing is a sequence of accounting activities to determine total sum of costs associated with certain product, mostly represented by assets or part thereof.. Such costs are named obviously as the life cycle costs. F. Freiberg correctly assumes the life cycle costing as a part of life cycle management [2]. Methodology of life cycle costing is widely described by many authors – [3 – 7] for example. We are able to find there also definitions of "life cycle costs" term. On purpose of this article, we will accept the definition of life cycle costs according the EN 60300 – 3 – 3 standard: "it is total costs of a system or equipment to the user of the purchase and installation, use and maintenance during stated period of life." [8]. Generally it means, the life cycle costs are summations of costs from inception for disposal of the system. The EN 60300 – 3 – 3 standard also comprises usual life cycle costs break-down. Life cycle can comprise very long time period (in case of buildings such period may be more than 50 years). Any user must spend costs of operation, maintenance and disposal 2 – 20 times greater than initial procurement costs during this period [9]. Therefore, it stands to reason that calculation, monitoring and analysis of life cycle costs should be a standard part of activities of both, the producers as well as the customers. Our experience approved the life cycle costing is mostly used when evaluating alternatives for equipment and projects. Approaches to life cycle costing at environmental management are known and recognized too [10]. But systematic use of life cycle costing within quality management is still rather limited and underestimated at Czech companies. The following text will show certain possibilities of life cycle costing in this area of interest.

2. Life Cycle Costing within Quality Management

Regardless official definition at the EN ISO 9000:2005 standard, let us see the quality management as integral part of overall company management system which aims to reach the highest level of customer satisfaction and loyalty through the most effective way. The fundamental requirements for quality management systems are defined at international standards as the EN ISO 9001 or the ISO/TS 16949. When consulting these standards, we can discover minimally five basic areas where life cycle costing could be addressed:

a)design and development,
b)purchasing,
c)infrastructure management,
d)products marketing and delivery,
e)customer satisfaction measurement.

There is not sufficient space to introduce all areas in detail in this article. That is why, areas from a) to d) will be presented only briefly. On the other hand, the possibility of life cycle analysis (as a part of life cycle costing) within customer feedback will be emphasized.

Regarding to the design and development, clause 7.3.4 of the EN ISO 9001 says: "At suitable stages, systematic review of design and development shall be performed in accordance with planned arrangements" [11]. The necessity to perform design review is only declared there, but recommendations how to do the design review gives another standard – the EN 61 160 [12]. Annex B of this standard identifies main goals of design review, within them does not absent the goal associated to evaluation of life cycle costs effectiveness. And finally: procedures how to evaluate such effectiveness can be found at the EN 60300 – 3 – 3 standard [8] Fig. 1 shows mutual and logic standards linkage focused on life cycle costing within quality management systems (QMS).

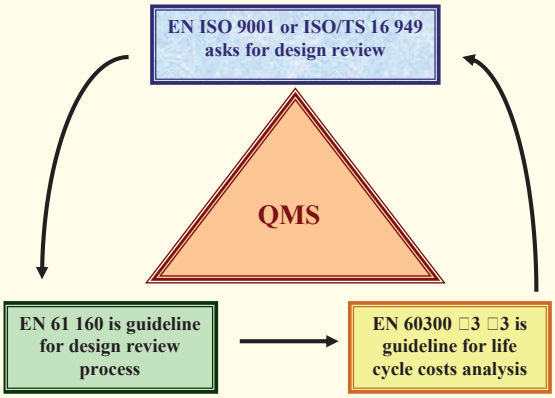

Fig. 1: *Life cycle costing - mutual standards linkage*

Designers, technologists and other persons engaged in product design and development should be responsible for systematic implementation of life cycle costs analysis to:

- *compare possible technical solutions,*
- *identify and influence the system or equipment characteristics, which are important to minimize life cycle costs items,*
- *evaluate level of system reliability through financial units,*
- *identify areas for customer value for money increasing.*

When purchasing, the EN ISO 9001 requires at clause 7.4.1: "The organization shall evaluate and select suppliers based on their ability to supply products in accordance with the organization´s requirements. Criteria for selection, evaluation and re-evaluation shall be established." [11]. Different selection criteria as well as procedures of supplier selection and evaluation are naturally used by all organizations at present. But our experience is, that as the most frequent economic criterion (unfortunately, it is often the only criterion!) serves the lowest price, including purchasing machines, information and transport systems or other hardware. It is obvious the lowest price can be very dangerous and unquestionably also insidious criterion! On the other hand: life cycle costing in procurement determines the lowest cost of ownership of a fixed asset during asset´s economic life. Therefore the life cycle costs analysis should be used also by persons who are responsible for objective and effective supplier selection, especially when we are going to purchase products with long service life.

According to the EN ISO 9001 (clause. 6.3), organization shall maintain infrastructure needed to achieve conformity to product requirements [11]. The ISO/TS 16 949 at clause 6.3.1 supplements: "methods shall be developed and implemented to evaluate and monitor the effectiveness of existing operations, including infrastructure maintenance". [13]. To evaluate effectiveness and performance of infrastructure maintenance, analysis of such life cycle costs parts as preventive or corrective maintenance, repair, spare an unavailability costs should be naturally and systematically performed by each maintenance manager.

Quality management systems standards, mentioned above, do not include any requirement regarding to product marketing and delivery. But it is not difficult to understand that convincing and efficient communication with customers about product advantages should comprise also information package focused on product life cycle costs. As, the lower level of these costs will be recognized by consumers, the more attractive product offer will be for them! Minimum of total life cycle costs seems to be very often decisive criterion for purchasers in competitive environment at present. It means the people from marketing offices should be another interested party in the field of life cycle costing!

Finally, we will pay attention to the customer feedback. This is crucial for any efficient and effective quality management systems. All international standards in area of quality management ask for customer satisfaction measurement and nearly every organization has already some methodology for such measurement.

But certain objective limitations of these methodologies should be briefly mentioned:

a) when measuring core customer satisfaction, we usually ask only "our" customers for response. Other customers and their opinions are mostly ignored,

b) competitive offering is not also respected there,

c) it is recommended to exclude any economic feature of the product (especially product price) from a list of customer satisfaction characteristics, as (and it seems to be logic) customers perceive any price negatively.

Such obstacles could be overcome by effective manner when we use customer value analysis or measurement with connection to the life cycle costing. Therefore, let me describe this very approach more detailed now as it is minimally known in practice of quality management (especially at Czech companies).

Customer value analysis namely goes beyond traditional customer satisfaction measurement as it focuses on two vital perspectives which are naturally viewed by each customer in case he or she is going to buy the product or take any service: level of his or her requirements fulfillment on the one hand and total resources consuming (declared mostly through overall customer´s costs) on the other hand. As B. T. Gale wrote: "customer value is simply quality, however the customer defines it, offered at the right price" [14]. Principal procedures and tools of customer value analysis are described by Gale [14] or Feuss [15]. In addition, the customer value analysis is a measurement method that is

also aimed at discovering company customer´s view of the perceived value of money delivered relative to that of their competitors´ customers. Besides this strategic set of information for cultivating customer retention policy, the customer value analysis, made by producer, has also other important functions:

- *it reliably discovers drivers of purchasing behaviour,*
- *it learns why customers buy from us or from our competition,*
- *it identifies alternative market positions,*
- *it predicts future customer loyalty or retention,*
- *it can be used as tool of competitive benchmarking,*
- *it recognizes how customers select from various suppliers,*
- *it creates impressive data for marketing value proposition,*
- *it discovers areas for our products and processes improvement.*

I am are sure the customer value analysis can bring useful information also for very consumers, especially in case they purchase complex technical systems, for examples machines, transport devices, etc. We tried to validate this hypothesis through customer value analysis focused on press machines that are important items of overall infrastructure of big machinery company at Ostrava. As we will see, some steps of life cycle costing were included into this analysis too.

We applied all basic tools as customer value tree, quality profile, market – perceived price profile, customer value map or head – to – head chart. How to commonly use these tools, we can find at Gale´s book [14]. There are three remarkable differences between traditional customer value analysis according to Gale [14] or Feuss [15] and our approach which should not be omitted:

a) we compared two types of press machines: eccentric press machines bought from supplier A and crank press machines purchased from competing supplier B,

b) 17 experienced managers from the company departments such as production, maintenance, quality, investments and industrial engineers as well as 6 competent press machines operators played a role as customers within special focus group. The focus group method was used as principal approach to the customer perception survey,

c) Item "perceived price" was substituted by item "perceived life cycle costs" in customer value tree.

We started our work through brainstorming conference with main goal to define main quality characteristics within the stream named as "perceived quality" and any important items of life cycle costs related to these press machines within the stream "perceived life cycle costs". An importance of these characteristics or costs items was also considered by way of pointing. The results of this action and breakdown to 10 quality characteristics (in perceived quality) and 14 costs items (in perceived life cycle costs) are presented at Fig. 2. The importance of each value stream was explored separately: it was evident that the users of press machines valued life cycle costs much more than they quality: the importance of perceived quality was defined as 30 %, in comparison to the perceived life cycle costs which took 70 %.

Next, we measured customer perception in a broader quantitative research phase: firstly, all participants of brainstorming conference were asked to estimate each quality characteristic on a scale of 1 to 10 (rating 10 means maximum of positive perception and on the contrary rating 1 belongs to absolutely negative customer perception). Individual ratings were discussed within the team and consensus regarding the final evaluation of any quality characteristic was reached. This set of data was used as a platform for quality profile analysis – see the results at fig. 3.

Partial quality indicator is pointed weight times ratio. Perceived quality ratio is calculated as sum of partial quality indicators divided by 100 points. We can see from Fig. 3 that value of perceived quality ratio is importantly below range 0.98 – 1.02 and it means that users perceived overall quality of the eccentric press machines (delivered by supplier A) as competitive disadvantage in comparison to the crank press machines from supplier B. Customer satisfaction for quality is commonly created as a sum of multiplying each quality characteristic rating by pointed weight, then divided by 100 points. The value of it is 7.45 for eccentric press and 8.6 for crank press. It confirms clearly the competitive disadvantage of supplier A.

The market – perceived price profile traditionally used when analyzing customer value was replaced by life cycle costs profile in our case. All items of these costs category were evaluated by each brainstorming conference participant when a scale of 1 to 10 was used there again – similarly as at qual-

ity profile. Also procedure of customer satisfaction for life cycle costs calculating is similar as customer satisfaction for quality. Life cycle costs competitiveness related to the eccentric press is calculated as 5.54/5.97 ratio. Perceived life cycle costs ratio for eccentric press is reserved value: 5.97/5.54. The results are obvious from Fig. 4. As customer satisfaction ratio at eccentric press machines is lower value compared to the crank press machines, the supplier B seems to be more attractive from the customer´s point of view.

Let us introduce the customer value map related to the compared press machines only in Fig. 5. Fair-value line (drawn by red colour) is deflected from horizontal axis for angle β when:

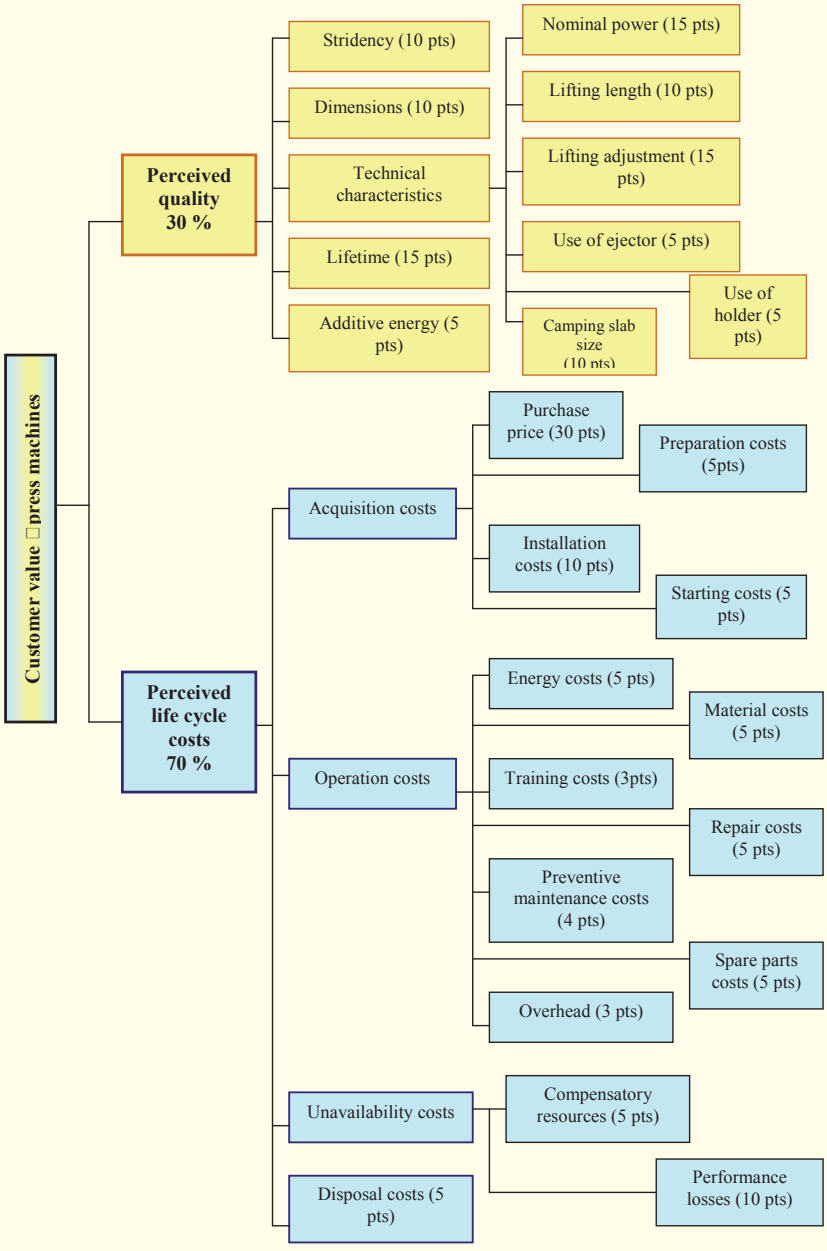

Fig. 2: *Customer value tree for press machines*

Quality characteristic (1)	*Weight (points)* (2)	*Eccentric press (Supplier A)* (3)	*Crank press (Supplier B)* (4)	*Ratio: (eccentric vs. crank press)* (5)=(3)x(4)	*Partial quality indicator* (6)=(2)x(5)
Stridency	10	4	6	0.67	6.7
Dimensions	10	8	8	1	10
Additive energy	5	7	10	0.7	3.5
Lifetime	15	10	10	1	15
Nominal power	15	8	10	0.8	12
Lifting length	10	7	9	0.78	7.8
Lifting adjustment	15	8	10	0.8	12
Clamping slab size	10	6	6	1	10
Use of ejector	5	6	6	1	5
Use of holder	5	8	8	1	5
Total pointing	100				
Perceived quality ratio					0.869
Customer satisfaction for quality		7.45	8.6		

Fig. 3: *Quality profile – press machines*

Life cycle costs items (1)	*Weight (points)* (2)	*Eccentric press (Supplier A)* (3)	*Crank press (Supplier B)* (4)	*Ratio: (eccentric vs. crank press)* (5)=(3)x(4)
Acquisition costs	30	5	5	1
Installation costs	10	8	6	1.33
Preparation costs	5	5	8	0.63
Starting costs	5	5	8	0.63
Energy costs	5	8	5	1.6
Material costs	5	6	6	1
Training costs	3	7	7	1
Repair costs	5	2	8	0.25
Preventive maintenance costs	4	5	7	0.71
Spare parts costs	5	3	7	0.43
Overhead	3	6	6	1
Compensatory resources costs	5	8	6	1.33
Performance losses	10	4	4	1
Disposal costs	5	8	8	1
Total pointing	100			
Customer satisfaction for life cycle costs		5.54	5.97	
Life cycle costs competitiveness ratio	0.93			
Perceived life cycle costs ratio	1.08			

Fig. 4: *Life cycle costs profile – press machines*

$$tg\beta = \frac{w_c}{w_q} = \frac{0.7}{0.3} = 2.33 \Rightarrow \beta = 66.5°$$

w_C – weight of life cycle cost items = 70 % or 0.7,
w_Q - weight of quality characteristics = 30 % or 0.3 (see Fig. 2).

Necessary data for customer value map were transferred from quality profile and life cycle costs profile. While eccentric press machine´s location over the fair-value line illustrates bad market position for supplier A (it is placed in worse customer value segment of the map), the location of crank press machines bellow fair-value line proved a very positive customer perception: supplier B overcomes supplier A on both streams. Moreover: mutual comparison of these locations has also brought very important set of information for any responsible person in the field of purchasing new press machines: supplier B should be preferred!

We fully demonstrated through this case that joint analysis focused on customer value and life cycle costs could be interesting approach not only for producers / suppliers but also for very customers / consumers, especially when explored products are technical systems with longer life time or other kind of assets.

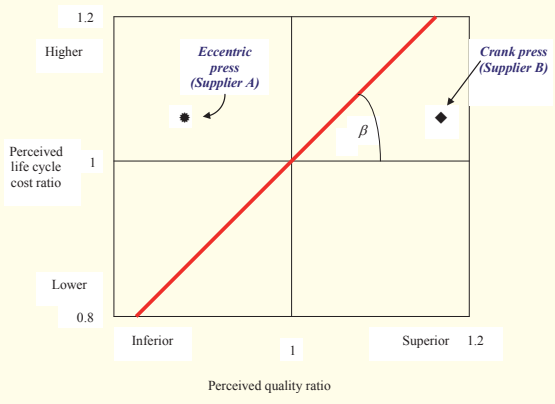

Fig. 5: *Value map for press machines*

3. Discussion and Conclusions

1. The company managers had not had any knowledge regarding to the customer value analysis until the time we started common work. After understanding its fundamentals, the marketing managers of this company decided to include immediately customer value analysis into current marketing process as rich and meaningful customer feedback in the frame of key product distribution – steel crash barriers.

2. When purchasing department of the company has been called for supplier selection, a lowest price was usually the only selection criterion - in spite of fact that it could be relatively biased one. Responsible company managers learned about more comprehensive method which was able to give fair picture towards real long lifetime product value: any consumer of these products make its purchase decisions based on how valuable is perceived quality related to perceived total amount of costs.

3. The implementing life cycle costs analysis makes core customer value analysis much more objective and efficient. Besides it delivers more correct data to the suppliers as well as to the consumers.

4. Described case approved again our premises: life cycle costing is rather underestimated and poorly known approach within processes of quality management at Czech companies. There is only limited knowledge and especially serious shortage of good will to apply this method – in spite of its indisputable advantages. Five areas of quality management where we can address life cycle costing, mentioned on this article should be seen as possible areas for improvement. Why? An answer is too simple: in today´s increasingly competitive global markets, all company managers are in bad need of correct information for decision makings on strategic level. There is no doubt about fact that information package aimed to the life cycle costing can contribute to this decision makings by important manner.

After all, ultimate goal of modern quality management is to continually improve customer experience and perception. We must not afford to ignore the life cycle costing methodology when we build and develop current quality management systems, regardless the type or size of the organization! As the money language is crucial communication tool within any supplier – customer relationships.

4. Acknowledgments

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