INTEGRATED QUALITY-ENVIRONMENT MANAGEMENT SYSTEM AND COST MODELLING PROCESS

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Pentru a fi performanți, interesul nu poate fi limitat numai la producția de valori sub aspect tehnic şi funcțional, ci trebuie luate în considerare funcțiile produsului/serviciului prin prisma costului implicat în condițiile unui preț impus de piață. În acest context, lucrarea prezintă aspecte noi privind modul de tratare a costului produsului prin punerea în evidență a costurilor datorate calității şi protecției mediului, pentru a putea evidenția în contabilitatea de gestiune costurile generate de noncalitate şi de poluarea mediulu, consumurilor nedorite. Sunt prezentate elementele principale ale metodei şi o variantă de utilizare posibilă economic şi tehnic prin care se pune în evidență eficiența sistemului de management integrat calitate-mediu În acest context lucrarea îşi propune să exprime matematic, o serie de costuri ce pot fi mai uşor cuantificate prin corelarea şi combinarea optimă a componentelor costului calității şi mediului în raport cu indicatorii de urmărire a nivelului tehnic şi calitativ al produselor.

In finalul lucrării sunt prezentate concluzii referitoare la modul de aplicare al metodei şi avantajele acesteia.

Performance cannot be achieved by technical and functional production of values but also by means of product/service uses based on market set costs. Hence, the present paper reveals new approaches to product costs by highlighting quality and environmental costs in order to emphasize non-quality and pollution ones in accounting. Moreover, the paper presents the main aspects of the approach as well as a prospective technical and economic use underlying the efficiency of the integrated quality-environment management system. Thus, the aim of this research is to mathematically convey a series of costs easily to quantify by optimum correlation and combination of the quality and environmental cost components as compared to indicators used to track the technical and qualitative level of products.

The present paper draws a conclusion upon the implementation procedure and the advantages of such a method.

Keywords: quality and environmental costs, integrated quality-environment management system (IQEMS)

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1. Introduction

The reduction of both total quality and environmental costs represents one of the main objectives of management in order to ensure the success and profit of the company. Within production systems, product/service check-ups, personnel's pro-active attitude towards the prevention of production flaws, defect products remedies, defects corrective measures, complaints handling processes may increase costs and decrease the profit. Hence, there is a must for a correct distribution of conformity costs as well as of those likely to reduce non-conformity. Non-quality costs are considered the result of typical flaws of purchased materials and production processes [1].

Our research deals with a model for the optimization of costs for a production system based on an integrated quality-environment management system to be monitored by means of stock-accounting. Thus, real data can be used to analyze the efficiency of an integrated quality-environment management system as well as its continuous improvement.

2. Costs- Based Total Cost Modelling Set by IQEMS

Since IQEMS and technological processes are linked together in order to highlight quality and environmental costs, the present paper suggests a two method combination approach [1].

Thus, there are two method combination approaches of cost:

- Calculation target-costing;
- Estimated costing assessment.

• Calculation target-costing –that sets global cost for the product lifecycle, implies the following stages:

- Stage 1 – target costing setup: mainly determined by market analysis and its main objective is the product lifecycle.

$$PGprod = PVprod + PMprod \tag{1}$$

$$PMprod = PMprod_{g} + PMprod_{pg} + PSprod_{c} \tag{2}$$

where:

- $PGprod$ – global product cost for the entire lifecycle
- $PVprod$ – product selling price
- $PMprod$ – product maintenance price for the entire lifecycle (from startup to shut-down).
- $PMprod_g$ – product maintenance price during warranty.
- $PMprod_{pg}$- product maintenance price for after warranty.

- $PSprod_c$ – shut-down price (product disuse and reuse).

- Stage 2 – target profit setup: based on the strategic planning fixed by the company on a medium run and on the range of similar competition products.

- Stage 3 – target costing setup provided by the difference between target costing and target profit.

$$CTprod = PVprod - PFprod \tag{3}$$

where:

- *CTprod* – poduct total target cost
- *PVprod* – product selling price
- PFprod –target profit per product

- Stage 4 – product organic breakdown based on its physical structure.

- Stage 5 – functional breakdown based on product analysis, taking into account the client's reiterated needs. The relation value-cost is optimized and defined as the capacity of a company to produce the required product, with its precise corresponding functions in accordance with the target costs.

• Estimated costing assessment – represents the total cost calculated by means of accounting data, when existing products are updated and planning data, when a new product is launched.

The method proposed to be used in order to assess the estimated costing as well as to monitor the costs within an integrated quality-environment management system is the calculation of process costs or per activity (ABC) in order to deal with processes or activities/operations for which defect costs are too high and analyze causes and take corrective measures necessary to sort them out. ABC method combines with the aforementioned IQEMS cost method. Hence, the following stages are to be considered:

- Activity analysis and process hierarchy setup:

(i) Determination of the production flow diagram by means of direct, indirect or collateral processes, taking into account IQEMS implications by production stages;

(ii) Hypothesis elaboration regarding the technical and IQEMS processes.

(iii) Determination of technical and economic risks regarding quality – environmental requirements;

(iv) Determination of importance criteria in view of classifying process-based production.

(v) Determination of indicators used to track the technical, qualitative and environmental level of products.

(vi)Activity analysis and process classification – based production.

(vii) Capacities and costs allocation.
(viii) Realization of processes resulting from breakdowns.
(ix) Classification of breakdowns within the main processes.

- Cost structure setup according to their distribution
- Production costs setup within an integrated quality-environment management system
- Setup of divided costs
- Cost structure setup according to the type of process
- Setup of IQEMS monitoring cost structure
- Setup of cost indicators and quantitative structures:

(i) Setup of reference dimensions underlying common, indirect costs distribution
(ii) Setup of criteria to determine reference dimensions
(iii)Setup of quantitative structures.

- Determination of quota for process/activity costs:

(iv) Determination of costs quota for processes based on the achieved volume - kv_i

$$kv_i = \frac{CP(i)}{KP(i)} \tag{4}$$

where:
CP(i) = costs for process "i".
KP(i) = process quantity used for the realization of "i".

(v) Determination of distribution process quota as compared to the respective volumes - kr_i.

$$kr_i = \frac{CP(i)}{CPC(i)} \times 100 \tag{5}$$

where:
kr_i= distribution cost quota for process "i"
CP(i) = costs for the neutral process "i".
CPC(i) = "i" process costs regardless of the achieved product/services quantities.

Calculation of the total cost quota for a production process – resulting from summing up volume based cost quotas and distribution – additional based ones -kt_i

$$kt_i = kv_i + kr_i \tag{6}$$

3. Production costs structure within an integrated quality-environment management system

The costs in the function to IQEMS can be structured in the following way:

- Environment-quality common costs – *CCqm*
- Quality specific costs –*CSq*
- Environmental specific costs – *CSm*

The following formula results:

$$CTqm = CCqm + CSq + CSm \tag{7}$$

where:

CTqm= total costs generated to the IQEMS

In the following, these costs are coined as IQEMS structure costs.

Structure of Process Divided Costs

We propose the following formula for the IQEMS costs structure [2]:

- *CP*- process cost
- *CSP* – subprocess cost
- *CAsp* – activity cost /subprocess operation cost

$$CP\ (i\ ) = \sum_{j_1=1}^{n} Kj_1 \times CSP\ (j_1) \tag{8}$$

$$CSP_{j_1} = \sum_{j_2}^{n_1} CAsp(j_2) \tag{9}$$

$$CP\ (i\ ) = \sum_{j_1=1}^{n_1} K(j_1) \bullet \sum_{j_2}^{n_2} CAsp\ (j_2) \tag{10}$$

where:

- $K(j_1)$ – coefficient of process weight - which represents unitary quotas to subprocess costs
- j_1- subprocess code
- j_2- activity code

These costs are named process divided costs.

4. Costs structure setup based on process type

Processes can be classified in:

- Management system process - where *CPqm* – IQEMS process cost

• Specific process of product/service for product realization –named technology process (ex. Soldering process) – where *CPth* – technology process cost

$$CTprod_{j_3} = CTqm_{j_3} + CTPth_{j_3} \tag{11}$$

where:

CTprod – product/service total cost

j_3 – product/service code

$CTqm_{j3}$ =total cost generated by application and monitoring of IQEMS for one product, what it represents a quota of the system implementation and project total costs, and it can have the following formula:

$$CTqm_{j_3} = k_{j3} \times CTqm = k1_{j_3} \times CCqm + k2_{j_3} \times CSq + k3_{j_3} \times CSm \tag{12}$$

where:

k_{j3},$k1_{j3}$, $k2_{j3}$, $k3_{j3}$ IQESM costs quota coefficient for types of products

$$k_{j_3} = \frac{k1_{j3} \times CCqm + k2_{j3} \times CSq + k3_{j3} \times CSm}{CTqm} \tag{13}$$

and

$$CTPth_{j_3} = \sum_{i=1}^{n} CPth(i) \tag{14}$$

where:

CTPth = total costs generated by technology processes in product realization j_3

i = technology process code

Costs correlated formula between the costs generated by IQEMS and the total cost of the product, which may take the following form:

$$\begin{aligned} CTprod_{j_3} &= k_{j_3} \times CTqm + \sum_{i=1}^{n} CPth(i) = \\ &= k1_{j_3} \times CCqm + k2_{j_3} \times CSq + k3_{j_3} \times CSm + \sum_{i=1}^{n} CPth(i) \end{aligned} \tag{15}$$

5. Structure of IQEMS monitoring costs– environmental and quality costs

Due to the implications of the actions used in IQEMS application and monitoring, the costs can be divided in [3]:

- Preventive action costs –*noted CMS(1)*
- Appraisal costs (monitoring, measuring and analysing)- *noted CMS(2)*
- Correction costs of the intern deviation– *noted CMS(3)*
- Corrective action costs of the intern deviation–*noted CMS(4)*
- Correction costs of the external deviation -*noted CMS(5)*
- Corrective action costs for the external deviation – *noted CMS(6)*

In order to simplify the formula, we have used the noted *CMS* – monitoring costs system.

$$CTMS = \sum_{j_4=1}^{6} CMS(j_4) = \sum_{j_4=1}^{6} CMSqm(j_4) + \sum_{j_4=1}^{6} CMSd(j_4) + \sum_{j_4=1}^{6} CMSm(j_4) \qquad (16)$$

where :

j_4= IQEMS monitoring costs type, and $j_4 \in \{1 \div 6\}$

CTSM = system monitoring total costs

6. The structure of the costs based on the distribution mode in the administration accountancy.

Regarding the distribution mode in the administration accountancy, the product costs are structured according to product direct costs, noted *CDprod* and product direct costs, noted *CIprod*

and:

$$CTprod = CDprod + CIprod \qquad (17)$$

where:

$$CDprod = \sum_{i_1}^{n} m_1(i_1) \times CP(i_1) \qquad (18)$$

and

$$CIprod = \sum_{i_1}^{n} m_2(i_1) \times CP(i_1) \qquad (19)$$

The following formulae have been used to obtain the costs structure according to process types used in production: formula (17), formula (18), formula (19) and formula (9).

$$CTprod = \sum_{i_1}^{n} m_1(i_1) \times CP(i_1) + \sum_{i_1}^{n} m_2(i_1) \times CP(i_1) = \\ = \sum \left[m_1(i_1) + m_2(i_1) \right] \times CP(i_1) \tag{20}$$

where:

i. $m_1(i_1)$, $m_2(i_1)$ – coefficients of processes weight
ii. $CP(i_1)$ – process cost
iii. i_1 – process code
iv. process examples: human resources management, purchasing management, infrastructure management, welding process) .

7. Product/service costs calculation based on cost modeling process of an Integated Quality-Environment Management System

The calculation of costs must provide previous and further information about product processes costs that have been used, the working place as well as about products, services, places and processes that the costs imply [4] .

This information is derived from formula (1) ÷ (16) used in order to obtain the structure of the product costs based on process types and IQEMS applications.

Combining both formula (20) and formula (10), we obtain a costs structure for product realization based on process types.

$$CTprod = \sum_{i_1}^{n} \left[m_1^{/}(i_1) + m_2^{/}(i_1) \right] \times CPth(i_1) + \sum \left[m_1^{//}(i_1) + m_2^{//}(i_1) \right] \times CTqm(i_1) \tag{21}$$

According to formula (21) and formula (12) and (16), we obtain a structure of the product realization costs based on process types costs divided in IQEMS monitoring costs– (environmental and quality costs)

$$CTprod = \sum_{i_1}^{n}\left[m_1^{/}(i_1)+m_2^{/}(i_1)\right]\times CPth(i_1)+\sum_{i_1}^{n}\left[m_1^{//}(i_1)+m_2^{//}(i_1)\right]\times$$

$$\sum_{i_2}^{n_1}\left[k_1(i_2)\times CCqm(i_2)+k_2(i_2)\times CSq(i_2)+k_3(i_2)\times CSm(i_2)\right]=$$

$$=\sum_{i_1}^{n}\left[m_1^{/}(i_1)+m_2^{/}(i_1)\right]\times CPth(i_1)+\sum_{i_1}^{n}\left[m_1^{//}(i_1)+m_2^{//}(i_1)\right]\times \tag{22}$$

$$\times\sum_{i_2}^{n_1}\left[\begin{array}{l} k_1(i_2)\times\sum_{j_4=1}^{6}CMSqm(i_2,j_4)+k_2(i_2)\times\sum_{j_4=1}^{6}CMSq(i_2,j_4)+ \\ +k_3(i_2)\times\sum_{j_4=1}^{6}CMSm(i_2,j_4)\end{array}\right]$$

9. Conclusions

The above outlined cost calculation models of a product by means of an integrated quality-environment management system allows their corresponding recording by means of internal stock accounting. They can be classified according to process importance in product/service realization. Hence, there can be clearly depicted the efficiency of each process per types of expenses, by means of well-known methods as stipulated by ISO10017/2005.

This method can be used in order to define costs according to weight process coefficients for production.

Accounting recording in order to monitor IQEMS reveals various advantages since it sets the following costs :

- Waste costs
- Remedy costs
- Corrective measures costs to reduce non-conformity
- Costs of materials used for waste and recycling
- Delays costs
- Complaints costs
- Calculation of costs, savings and benefits as provided by environmental projects
- Setup of quantifiable performance targets
- Environmental friendly production, pollution prevention and the development of environmental projects

- Environmental notification
- IQEMS continuous improvement by quality and environmental performance assurance of products/services considered the main line of activity.

R E F E R E N C E S

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