ANNALS OF THE FACULTY OF ENGINEERING HUNEDOARA
2006, Tome IV, Fascicole 1, (ISSN 1584 – 2665)
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA

MATHEMATICAL DESCRIPTION OF QUALITY ASSURANCE LOGISTICS

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ABSTRACT
Handling of logistical quality parameters on the ground of requirements and possibilities of customers with insurance of quality parameters. Optimization of assurance logistical parameters with reduction of costs. Search of optimal assurance logistical parameters on the ground of cost functions in the light of possibilities and requirements of customers. Possibilities and requirements of customers satisfactory (with minimum cost) definition of quality assurance logistical parameters. Accentuated role of quality assurance logistics in the contact of supplier-user. Framing of quality assurance logistical activities series in accordance with reality on the ground of possibilities a requirement of customers.

KEYWORDS:
quality requirements of customers, possibilities of customer, logistical quality requirements of customers, logistical elements of possibilities of customer, quality properties of given product structure, evaluations system of quality assurance logistics, quality assurance logistical net of product.

1. INTRODUCTION

In practice, if we talk about quality then we have to take a complex, but from the point of the consumer a subjective idea have to be taken into regard. The consumer might have expectations, like fast transportation time, avoid of mixture of different products automatic product identity process etc. The execution of the different consumer expectations can be preceded on given conditions, for example payment of service fee, given special logistical background. The consumer should fulfill one part of the conditions and this part is dependent on his/her possibilities. For example if the consumer would like to carry out container goods transportation but the container handling system is missing then there is no possibility.

In such a case the investment possibilities should be investigated for the containment goods transportation, what kind of benefit can be obtained after the introduction of such a system. If the consumer's possibilities give the possibilities then this quality demand will be kept, if not then this demand should be changed. So, from the point of quality the consumers demands and possibilities belong to the real market, that is the general consumers expectations and possibilities determine the real quality parameters for a given consumers cycle.

2. COMPLEXITY OF QUALITY ASSURANCE LOGISTICS

Let us suppose that the prescribed quality of a given product or service is a complex thought in which the logistics has got a determinable feature.

The story of prescribed quality of a given product or service can be seen in Figure 1.

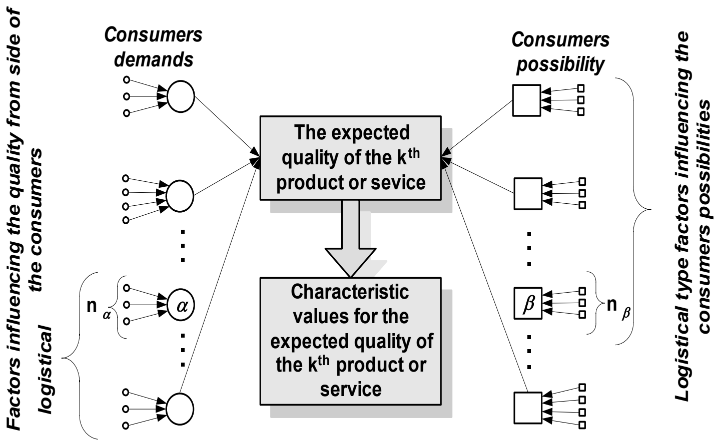

FIGURE 1. Evolution of the process for the expected quality

On base of Figure 1. it can be concluded

- the real expectation α are formed by n_α pieces of influencing factors
- the β real consumer's satisfaction are influenced by n_β factors
- the expected quality of the k^{th} product or service can be defined by concrete characteristic values from which some of them are clearly connected with logistical activities.

Let us investigate, that in case of given product or service how the parameters describing the expected quality are varying. It is shown in figure 2.

On base of the Figure, it can be stated, that

- the quality of the product k can be described n_k pieces of E_{k_a} quality values,
- to a given value of E_{k_a} on object function F_{k_a} can be determined which *k* could be have maximum or minimum character.

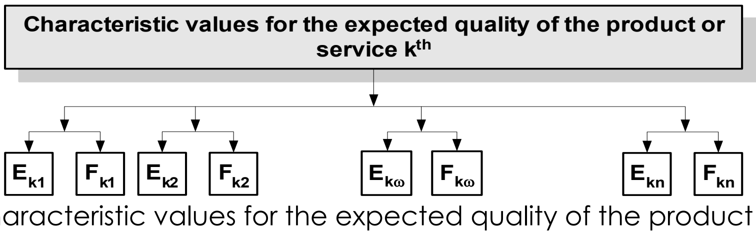

Figure 2. Characteristic values for the expected quality of the product or service k^{th}

By using the Figure 2. for each of the products or services quality characteristic values can be given. The structure can be seen in Figure 3.

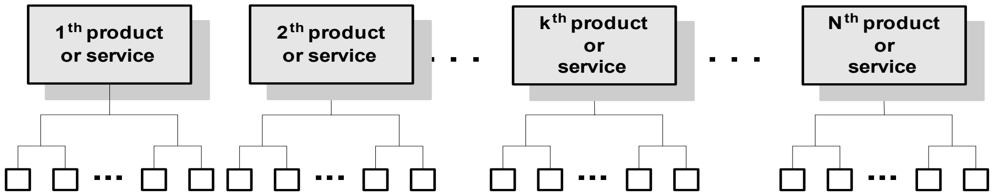

Figure 3. Quality characteristics of a given product structure

In case of product or service k[th] $n_{k,\alpha}$ pieces of logistical characteristic values $\left(E_{k,\alpha}\right)$ and $\left(F_{k,\alpha}\right)$ logistical characteristic objects functions can be given.

Creation of the values $E_{k,\alpha}$ are based on the consumer's expectations and possibilities and the belonging object function $F_{k,\alpha}$ shows whether the optimisation can be grained either by its increase or decrease.

Investigation the process how the value of $E_{k,\alpha}$ is obtained the following statements can be said:

- the logistical quality value α of the product or service k[th] are influenced by $n_{k,\alpha,\gamma}$ pieces of influencing factors $\left(T_{k,\alpha,\gamma}\right)$,
- the α factor influencing the logistical value of γ. for the product or service of k is dependent on $n_{k,\alpha,\gamma,\omega}$ pieces of parameters $\left(P_{k,\alpha,\gamma,\omega}\right)$,
- considering the product or service k[th] α the change of parameters ω which influence the logistical value γ. and depend on γ., there are $n_{k,\alpha,\gamma,\omega,\eta}$ possibilities $\left(V_{k,\alpha,\gamma,\omega,\eta}\right)$

On base of the Figure 4 it cam also be concluded, that:

- the change of the logistical type values for the product or service k[th] are going through a logistical chain of influence that is a net,
- this chain of influence is hierarchive, is can be seen in the figure it contains 4 levels: $E_{k,\alpha} \rightarrow T_{k,\alpha,\gamma} \rightarrow P_{k,\alpha,\gamma,\omega} \rightarrow V_{k,\alpha,\gamma,\omega,\eta}$,
- or the change of the α logistical type quality value $\left(E_{k,\alpha}\right)$ of an arbitrary product or service *k[th]* number of influencing factors $\left(T_{k,\alpha,\gamma}\right)$, are contributing,
- the change or one arbitrary influencing factor $\left(P_{k,\alpha,\gamma,\omega}\right)$ is function of more parameters $\left(P_{k,\alpha,\gamma,\omega}\right)$,
- for the variation of any arbitrary parameter $\left(P_{k,\alpha,\gamma,\omega}\right)$ there are more possibilities $\left(V_{k,\alpha,\gamma,\omega,\eta}\right)$,
- one given influencing parameter make changes for one or more logistical type quality values,
- one parameter can be fitted to one or more influencing factors.

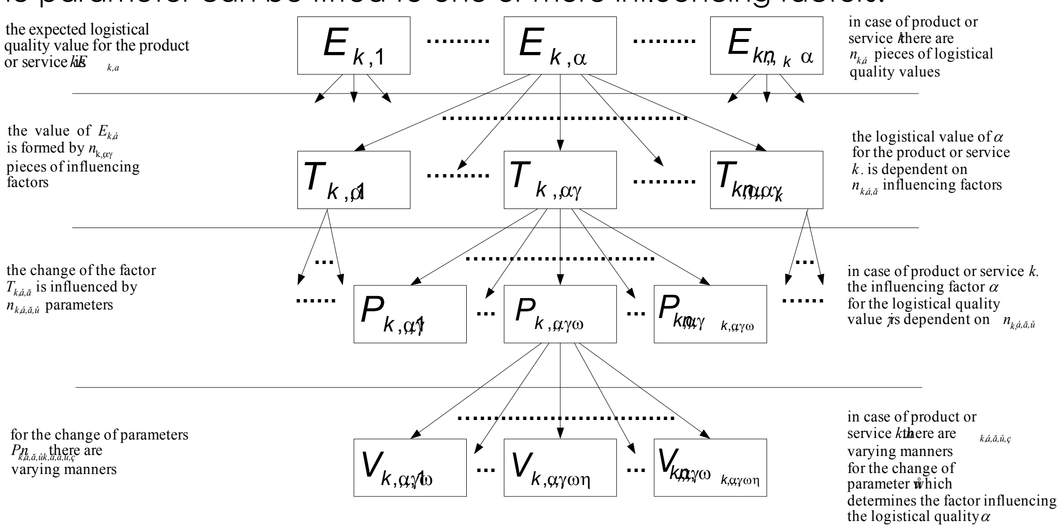

Figure 4. The evolution system for the logistics of the quality assurance procedure

The connecting net for the logistical evolution system of the quality assurance given in Figure 4. can be transformed by introduction of the new denotation system into the net given in Figure 5.

The explanation of denotations of Figure 5.:

P_i - the i[th] parameter which influence the logistical type quality value of the investigated product or service $(i = 1,2,\rightarrow n)$

$V_{i,\beta}$ - the β th possibility for the change of the i[th] parameter $(\beta = 1,2,\cdots p_i)$

$T_{j,}$ - the j^{th} influencing parameter $(j = 1,2,\cdots m)$

E_k, - a the k^{th} logistical nature quality value $(k = 1,2,\rightarrow r)$

The practical forming of the structure given in Figure 5. will be shown by an example.

Let us suppose for example the for the logistical type quality value – the transit time from the send of the purchase up to the arrival at the user is $E_k = prescribed$.

3. ANALYSIS OF PARAMETERS

Let us examine what kind of factors influence the above given value. Such kind of factor are:

- the applied traffic sub branch (T_i)
- the applied type ERKE $T_{(i+1)}$
- the applied product identity manner $T_{(i+2)}$ etc.

The factors are dependent on more parameters, for example

- the applied traffic sub branch can be
  - public high way,
  - train,
  - combination etc.

One parameter can be started in more variations, for example in case of public roads

- truck,
- van, etc.

On foundation of the above the logistical net or effectiveness can be constructed. Of course, for given problems the actual logistical net of effectiveness should be determined all the time.

The evolution of the expected logistical type quality values $E_1, E_2, \cdots E_k \cdots E_r$, of the given product or service van be influenced by the variation of the parameters $P_1, P_2, \cdots P_i \cdots P_n$.

The total number of the variation possibilities can be determined on the base, that any variation could be combined by any from the others. For the change of given P_i parameters there are n_{p_i} pieces of variations. Any parameter variation can be combined by any other parameter variation, so forming a given parameter series. The number of possible parameter series can be determined on base of (1).

$$PS = \underset{i=1}{\overset{n}{\pi}} n_{p_i} = n_1 \cdot n_2 \cdots n_i \cdots n_{p_i} \tag{1}$$

where:

PS - is the maximum number of the parameter series,

n_{p_i} - is the number of the possible variation of the changes of the parameter i,

i - is the running index of the parameters,

n - maximum number of the parameters.

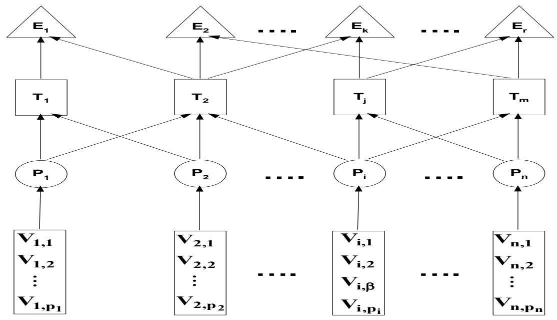

Figure 5. Logistical quality assurance net of a given product

One given parameter series scan be characterised by the actual values of n pieces of parameters. In this way the possible parameter series variations can be given by a matrix $P(n,PS)$:

$$P = \begin{array}{c} \\ 1 \\ 2 \\ \vdots \\ i \\ \vdots \\ n \end{array} \begin{array}{c} 1 \quad 2 \quad \cdots \quad \lambda \quad \cdots \quad PS \\ \left[\begin{array}{ccc} & & \\ & & \\ & P_{i,\lambda} & \\ & & \\ & & \end{array} \right] \end{array} \qquad (2)$$

On base of (2) the followings can be given:

- P - the matrix of the possible parameter series variations,
- i - the running index of the parameters,
- n - the maximum number of the parameters,
- λ - the running index of the parameter series variations,
- PS - maximum number of the parameter series variations,
- $P_{i,\lambda}$ - the value of parameter i. in case of a λ. parameter series.

On base of the parameter series variations and by using the quality assurance logistical net seen in Figure 5 it can be concluded, that both in cases of influencing factors on logistical type values and of logistical nature quality values suitable constructed T and E matrixes can be defined established by the matrix P. Structure of matrix T, and the structure of the matrix E are presented in (3) respectivelly (4)

$$T = \begin{array}{c} \\ 1 \\ 2 \\ \vdots \\ j \\ \vdots \\ m \end{array} \begin{array}{c} 1 \quad 2 \quad \cdots \quad \lambda \quad \cdots \quad PS \\ \left[\begin{array}{ccc} & & \\ & & \\ & & \\ & & \\ & & \end{array} \right] \end{array} \qquad (3) \qquad E = \begin{array}{c} \\ 1 \\ 2 \\ \vdots \\ k \\ \vdots \\ r \end{array} \begin{array}{c} 1 \quad 2 \quad \cdots \quad \lambda \quad \cdots \quad PS \\ \left[\begin{array}{ccc} & & \\ & & \\ & E_{k,\lambda} & \\ & & \\ & & \end{array} \right] \end{array} \qquad (4)$$

On base of (3) the followings can be given:

- T - matrix involving the factors which influence the expected logistical type quality values of the given product,
- $T_{j,\lambda}$ - value of the j^{th} influencing factor in case of λ^{th} parameter series,
- λ - running index of the parameter series variation,
- PS - maximum number of the parameter series variations,
- j - running index of the factors which influence the logistical type quality values,
- m - maximum number of the influencing factors.

On base of (4) the followings can be given:

- E - matrix of the possible, logistical type quality values,
- $E_{k,\lambda}$ - the k^{th} logistical type quality characteristic value in case of the λ^{th} parameter series,
- k - running index of the logistical type quality characteristic,
- r - maximum number of the logistical type quality characteristic,
- $\lambda.$ - a running index of the parameter series variation,
- PS - maximum number of the parameter series-variations.

On base of Figure 1. i. e. the consumers' expectations and possibilities for a given product or service the necessary values of the logistical type quality characteristics can be defined. Let the denoted by the vector ES.

$$ES = \{ES_1, ES_2, \cdots ES_k, \cdots ES_r\} \tag{5}$$

On base of (5) the following can be given:

ES - vector of the necessary values for the logistical type quality characteristics,

ES_k - the necessary value of the k^{th} logistical type quality characteristic,

k - running index of the logistical type quality characteristic,

r - maximum number of the logistical type quality characteristic.

The question is, which from the possible logistical type quality characteristics, belonging to the parameter series variations are fitted to the consumer expectations and possibilities.

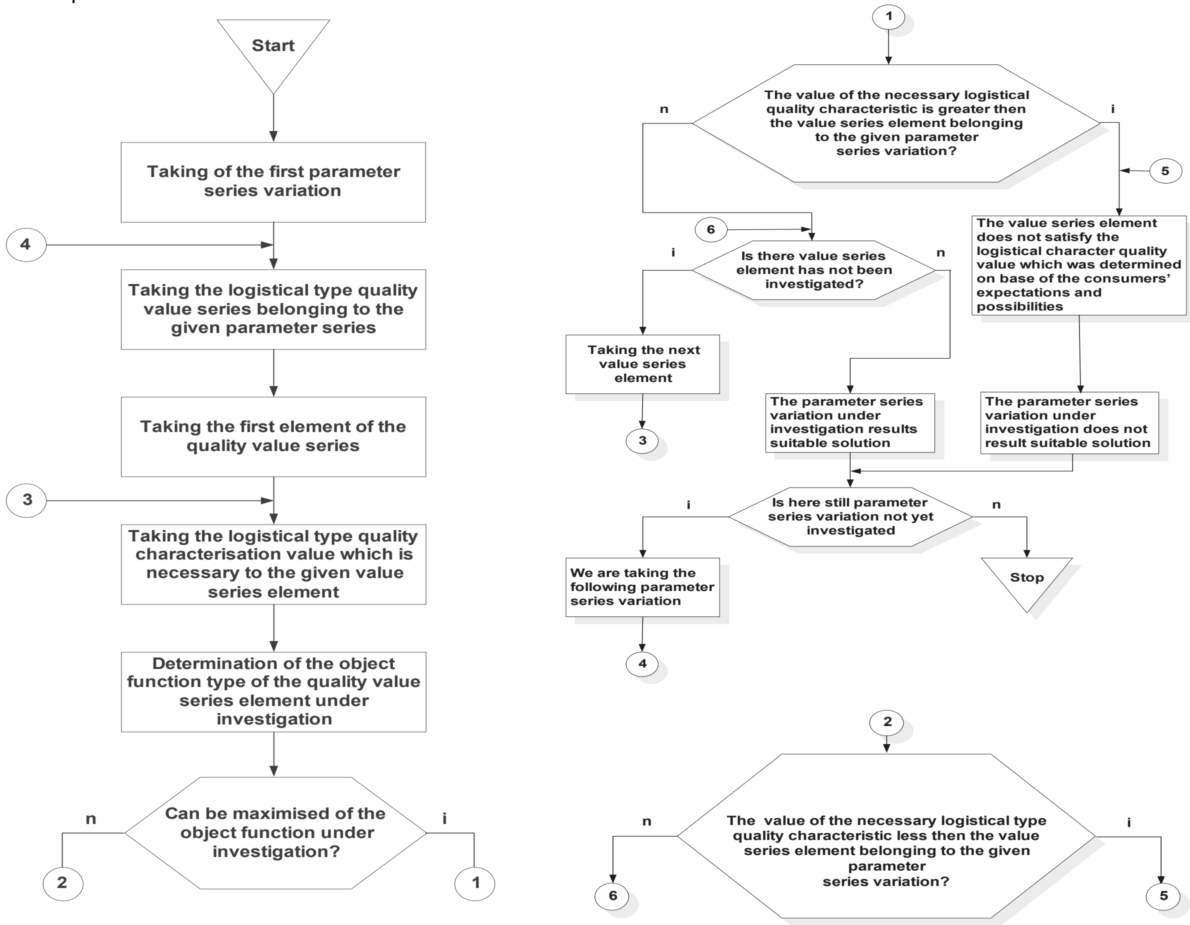

Figure 6. Text type flow chart for searching of suitable solutions on base of the possible variations

The text type description of the searching algorithm to get it, can be seen in Figure 6.

By using the algorithm given by the Figure 6. the matrix of the logistical type quality values given originally by (4) has been modified in the following way:

$$EM = \begin{array}{c|ccccc} & 1 & 2 & \cdots \nu & \cdots & NM \\ \hline 1 & & & & & \\ 2 & & & & & \\ \vdots & & & EM_{k,v} & & \\ k & & & & & \\ \vdots & & & & & \\ r & & & & & \end{array} \tag{6}$$

On base of (6) the followings can be given:

EM - matrix of the logistical type quality assurance characteristics in case of executable parameter series variation which serve the suitable values,

$EM_{k,v}$ - the k^{th} logistical type quality characteristic in case of v^{th} suitable parameter series variation,

k - running index of the logistical type quality characteristic,

r - the maximum number of the logistical type quality characteristics,

v - running index of the suitable parameter series variations,

NM - the maximum number of the suitable parameter series variation.

4. EXAMINATION OF CUSTOMER SATISFACTION BY USAGE OF PARAMETERS

In all of the cases it is true, that

$$NM \leq PS \tag{7}$$

that is the suitable number of the parameter series variations should not be greater then the number of the totally constructable parameter series variations.

The following questions of the investigation:

$$NM = 0 \tag{8}$$

If (8) is s valid, then the logistical type quality values, determined on base of the consumers expectations and possibilities can not be gained totally by the variation possibilities of the parameter series in hand. It means that the technical and informatics background to be involved should be improved and in addition one part of the logistical type quality values are not fitted to the consumers' demands.

If (8) is not valid, then the assurance of the logistical type quality parameters can be done as requested by consumers expectations and possibilities.

If the equation

$$NM = 1 \tag{9}$$

is valid, then any further investigation can be neglected due to the executable variation. The values of the logistical type quality parameters can be realized only by one parameter series variation.

If the equation

$$NM > 1 \tag{10}$$

is valid then the desire values of the logistical type quality parameters can be gained by any one of NM pieces of parameter series variation.

In such a situation from the more possible solutions it is expedient to determine the optimal parameter series variation by using a suitable object function.

5. CONCLUSION

In practice basically the following two deterministic conditions should be satisfied:

- all of the logistical type quality characteristics determined on base of the consumers expectations and possibilities should be assured,
- from the suitable parameter series variations the cheapest one should be applied.

For this purpose cost functions have to be constructed in function of the parameter variations. The details of it can be the topic of an other paper.

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