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QFD – support to higher efficiency of industrial automotive production

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Abstract: This paper deals with transformation of the customer's requirements into the specified technical parameters by means of the QFD (Quality Function Deployment) method on condition that the customer disposes of basic technical knowledge. The relevant technical parameters are describing an engineering product, which is chosen from the automotive industry area. The QFD method enables elaboration of the individual functions of quality using a multi-phased mapping process in order to transform efficiently the customer's requirements into the real technical parameters of the given product. The chosen technical product is the petrol engine 1.2 Ecotec® installed in the passenger car and it is working in the functional connection with 5 stage manual gearbox. This article analyses in detail only the first phase of the petrol engine production, taking into consideration the given technical requirements. The following step of this process is the next phase, which is focused on the engine aggregates, further it is the phase of the engine aggregate production and the final phase is the global production.

Key words –QFD, automotive, petrol engine, industrial engineering, industrial management

1. Introduction

The QFD method (Quality Function Deployment) is a multi-phased mapping method developed for elaboration of quality functions. This method consists of several steps and it enables efficient transformation of the customer's requirements into the real technical parameters relating to the given product. This tool, introduced during the 1970s by the Japanese engineer Yoji Akao, is a universal instrument, which can be utilised not only in the phase of proposal and development of a new product, but also for improvement of the individual processes, as well as for projection of the production systems,(RUDY V2009).

The specific methodical procedure, which was developed for a successful application of the QFD method, is illustrated in Fig.1.

2. Methodical Procedure for Creation of the QFD Diagram

The chosen engineering product of automotive industry is the petrol engine 1.2 Ecotec® (51kW/70k), which is installed in passenger car and coupled with 5 stage manual gearbox, (SZENDRO G. 2015), Fig. 2.

Identification of the Customer's Requirements – What the customer wants

The main task of the first step, which is necessary for creation of the QFD diagram, demands definition of a target group of customers and to identify their requirements (concerning the petrol engine) by means of the specific procedures that are applying the tools VOC and CTQ, (JAGUSIAK-KOCIK M. 2014).

Afterwards, the solution team has to analyse these requirements in detail and to arrange them into the set of priority requirements using either the affinity diagram or the Kano model. The given set of requirements, which is prepared in this way, creates a base needed for following assembly of the QFD diagram, (NAGYOVÁ A. 2016).

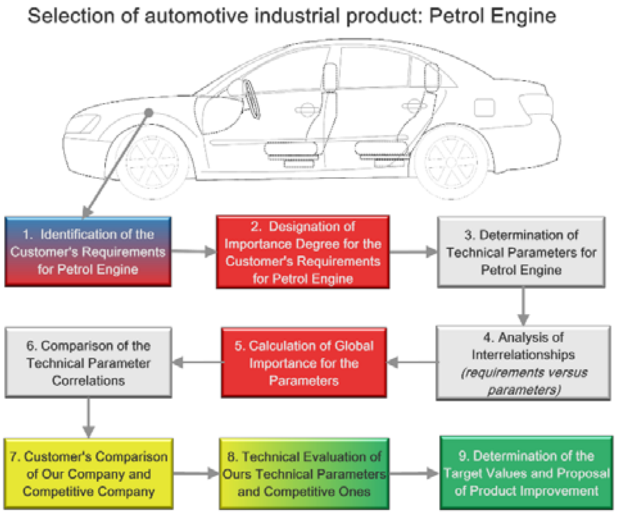

Fig. 1 Procedure developed for application of the QFD method

Source: own study

Fig.2 Petrol Engine 1.2 ECOTEC®

Source: own study

Designation of Importance Degree for the Customer's Requirements – How much the customer needs them

It is necessary to designate a degree of importance to each of the customer's requirements. A suitably selected evaluation scale is based on a collective decision of the solution team, taking into consideration the solution team experiences or it is also possible to use the results obtained from the previous Kano model application. The next evaluation scale was chosen, in this case: 1- the least important requirement, 3 –the most important requirement (SZKLARZYK P. 2014).

Determination of Technical Parameters – Definition of values

This step has to ensure a mutual co-operation between the department of design and the department of technology or production, because the main task of these departments consists of suggestion of technical specifications needed during the design proposal of the petrol engine in accordance with the customer's requirements, whereas there is defined a tendency or direction for a future improvement of the individual technical parameters (KRYNKE M. 2015).

This direction offers information about a necessity to increase or to reduce value of the given parameter in order to reach a higher quality level. Eventually, the given parameter value is defined invariably, (KRYNKE M. 2014).

Analysis of Interrelationships – Looking for interconnections

The functional analyses of the relationships are performed within this step among the customer's requirements and the technical parameters in order to consider whether the given technical parameters of the petrol engine are important with regard to fulfilment of certain customer's requirements. It is necessary to define a proper evaluation range in this step, as well. For example: 3 – strong relationship, 2 – moderate relationship, 1 – weak relationship, 0 – without a relationship (no relationship).

Calculation of Global Importance for the Parameters – Evaluation of technical parameters

The main purpose of this step is identification of such technical parameters, which are the most important with regard to the customer's requirements and therefore the priority of these parameters is the highest during the phase of the petrol engine design. The calculation process creates a sum of the arithmetical products between the degree of dependence and the degree of importance for each of the technical parameters. The parameters with the highest calculated values, obtained within the framework of the performed evaluation process, are the most relevant technical parameters (BIGOŠ P. 2012)

Comparison of the Technical Parameter Correlations – Diagram shelter

It is necessary to compare not only the customer's requirements with the technical parameters, but also to analyse the functional correlations among the individual technical parameters. In the case that a correlation between two technical parameters is positive, i.e. if increasing of one parameter causes an increase of the second parameters, then the parameters are marked with the sign (+). In the case of a negative correlation, i.e. if increasing one parameter reduces the value of the other parameter, the parameters are marked with the sign (-). The third possibility is a variable correlation, i.e. the correlation is either positive or negative. The variable correlation can be reached, for example, by changing another constructional parameter and the sign (∗) is applied in that case. If there is no relevant correlation between two parameters, the corresponding field is without infilling, i.e. this field remains empty, (GIRMANOVÁ L.2009).

Customer's Evaluation – Monitoring of competitors

Before composition of this QFD diagram part it is necessary to choose the competitive engines of the same type or the same price category, which are produced by the most important competitors (A and B). Afterwards it is possible to compare the proposed or the present state of the customer's requirement fulfilments with the situation concerning fulfilment of the customer's requirements by our competition. A suitably defined evaluation scale is a necessity in this step, too. There is chosen, for example: 1 – represents the weakest evaluation, 2 – means a moderate evaluation and 3 – is the best evaluation. The plan for a following improvement of the petrol engine production should be scheduled according to the results obtained from the above-mentioned comparisons (TOPOLŠEK D. 2015)

Technical Evaluation – Monitoring of technical and competitive parameters

The main intention of this step is comparison of the relevant technical parameters with the competition. The used evaluation method is similar to the previous step, however the data collection process is a more complicated task with regard to the fact that the individual companies are protecting their own know-how. From this reason it is possible to apply only the publicly accessible information presented on the web-pages of the companies or in the production catalogues published by the competitive companies (JAGUSIAK-KOCIK M. 2013).

Determination of the Target Values and Proposal of Product Improvement – Finalisation of the First House from QFD method

The project solution team is able to identify possible disadvantages of the petrol engine thanks to the performed technical comparisons and the customer's comparisons (BORKOWSKI S. 2013).

Consequently, this team has to set-up the target parameters for their own petrol engine so that it could be competitive. At the same time it is necessary to consider, which of the target parameters can be ensured and maintained during the long time period by the production company

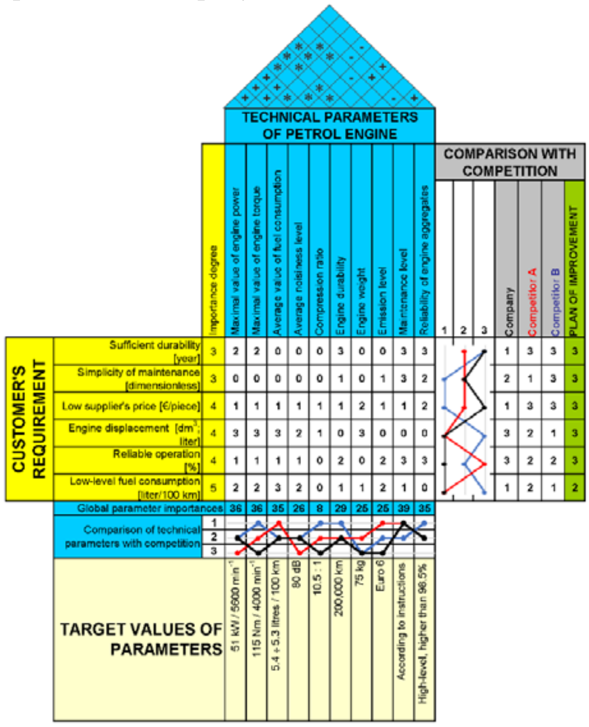

Fig. 3 The final QFD diagram with shelter and with the target values necessary for production of the petrol engine

Source: own study

3. Conclusions

Assembly of the QFD method diagram represents a four-matrix approach. This fact means that after determination of the target parameters of the petrol engine only the first phase from the group of four phases as a whole is complete. The final QFD diagram, created for the first phase, is presented in Fig.3. This diagram includes two shelters and it defines the target values required for intended innovative production of the petrol engine.

The results obtained from the first part of the QFD diagram are necessary for a following development of the second part of the QFD diagram, as well as for the third part and fourth part of this diagram consequently. The results or outputs obtained from the previous parts represent inputs for the following QFD diagram parts at the same time.

The functional differences among the individual matrixes consist in the next characteristics: the second part of the QFD diagram is specified for transformation of the technical parameters (outputs from the first part) into the individual machine design parts or aggregates of the petrol engine.

The third part of the QFD diagram transforms the petrol engine constructional parts or components (outputs from the second part) into the parameters of the petrol engine production process.

Finally, the fourth part of the QFD diagram performs transformation of the production process parameters (outputs from the third part) into the parameters of the whole production system with regard to the global production. It is important to emphasize a fact that this article analysed in detail only the first phase of the petrol engine production, taking into consideration the given technical requirements, (BIGOŠ P. 2011).

Affiliation

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