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Production engineering tools for civil engineering practice – the case of QFD

Narzędzia inżynierii produkcji w budownictwie – przypadek QFD

Abstract

This article is a part of a series of papers which discuss the usefulness of production engineering tools for general civil engineering. Applications of selected production engineering tools in civil engineering are presented in these papers. The diverse nature of the tools is considered while outlining detailed areas of their application in civil engineering. The features of the tools make them representative of production engineering methodology. Thus, information about the civil engineering applications of the tools also makes it possible to draw practical conclusions about the general usefulness of production engineering methodology in civil engineering. The applications of quality function deployment (QFD) are utilised in this regard in the article.

Keywords: civil engineering, construction, decision, support, production engineering, tool, application, QFD

Streszczenie

Artykuł stanowi część cyklu prac poświęconych użyteczności narzędzi inżynierii produkcji w szeroko pojmowanym budownictwie. Uwzględniając zróżnicowany charakter wybranych narzędzi inżynierii produkcji, przedstawiono w cyklu szczegółowe obszary ich zastosowań w budownictwie. Cechy wybranych narzędzi sprawiają, że dobrze ilustrują one metodykę inżynierii produkcji. Dlatego na podstawie informacji dotyczących ich zastosowań w budownictwie, można sformułować praktyczne wnioski dotyczące przydatności metod inżynierii produkcji w budownictwie. W artykule wykorzystano w tym celu narzędzie narzędzie QFD (*quality function deployment*).

Słowa kluczowe: budownictwo, decyzja, wspomaganie, inżynieria produkcji, narzędzie, zastosowanie, QFD

1. Introduction

The present article illustrates the usefulness of production engineering (PE) tools using examples of quality function deployment (QFD) applications, instead. The paper is structured as follows: QFD is described in section 2; section 3 deals with civil applications of the tool; the usefulness of the tool is concluded in the final section.

2. QFD

The QFD tool facilitates meeting customer needs while preparing products, services and processes. The needs are expressed by th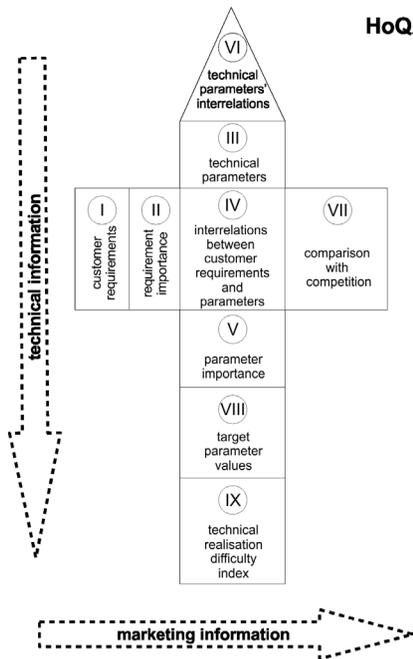e so-called voice of customer (VoC) which is defined by a set of customer requirements (CRs). The tool allows the translation of the VoC into a set of technical requirements (TRs) which are utilised by a producer, a service provider or a process performer to describe the provided product, service or process, respectively. CRs are translated into TRs thanks to the application of a house of quality (HoQ) diagram (Fig. 1) which expresses relationships between both groups of requirements.

Analysis of the Scopus bibliographic database contents reveals that there are over fifty database records which deal with the application of the tool in civil engineering. QFD has undergone some modifications for the purpose of enhancement; it also enhances other tools by means of mutual support. Standalone QFD tool applications nevertheless seem capable of providing sufficient means for the illustration of the potential of the tool in civil engineering.

Fig. 1. HoQ application

3. QFD applications in civil engineering

QFD is utilised in civil engineering in five distinct areas. Design support makes the first application area. The following goals are considered in this regard:
▸ preparing structural engineering design models for organisation analysis [1];
▸ shaping low-cost building design solutions while raising quality and speeding up construction [2], improving building design reliability and quality while meeting the needs of diverse stakeholder groups [3], assessing of usefulness of material and

constructional solutions while limiting potential changes in construction [4], and supporting the integrated redesigning of dwellings for families with disabled persons [5];

▶ defining expectations and profiles of high building users [6], identifying key satisfaction factors for owners of ultra-modern villas [7] and roles played by stakeholders who are involved in sustainable choice of thermal insulation solutions [8];

▶ defining requirements relating to public buildings [9] and functional requirements towards wooden sound insulation plates [10], the identification of key factors for environmental-friendly hospital design while taking into account the needs of potential users [11];

▶ preparing and implementing a knowledge-based system for supporting the assessment and the choice of material and structural design solutions for high building elevations [12, 13], preparing a software tool for the multi-goal optimisation of design solutions to facilitate the implementation of office building thermal modernisation policy [14];

▶ design of an intelligent decision support system for safety management in construction [15].

Within the field of civil engineering, QFD is also applied in the area of planning the implementation of construction projects. The following example goals may be considered in this regard:

▶ comprehensive consideration of investor needs while preparing the implementation of a construction project [16] as well as comprehensive assessment [17] and prequalification [18] of potential contractors;

▶ defining public preferences with regard to projects concerning infrastructure [19];

▶ the consideration of the explicit and implicit needs of users of the building hardware [20].

The third QFD application area is devoted to construction project implementation assessment. For example, the tool may be applied to validate the compatibility of project implementation effects with investors' design, constructional, occupational, and maintenance requirements [21].

The assessment of a construction enterprise and effects of its performance constitutes the fourth QFD application area in civil engineering. The tool may be applied to assess:

▶ quality of constructor services in the case of a design/build construction project [22, 23];

▶ design/build enterprise effectiveness [24];

▶ human resources of a construction enterprise *see above note* [25].

The fifth QFD application area in civil engineering may deal with the following general goals:

▶ the identification of key factors for making design/build enterprise staff [26] and circle of professionals (architects and building engineers) [27] interested in the application of QFD as well as outlining a rational QFD implementation procedure [28];

▶ defining level for data visualisation which is necessary for improving the effectiveness of communication in civil engineering [29];

▶ facilitating the transformation of a competition-driven building market to a quality-driven building market [30].

4. Conclusions

QFD is a typical PE tool which is primarily aimed at improving quality and reliability of processes and their outputs (products, services). Similar to other typical PE tools, it is characterised by its universality, flexibility and the openness. Such features facilitate its adoption to solve diverse decision making problems in civil engineering. These problems cover the full spectrum of civil engineering-related activities from building design through to the dismantling of used buildings.

Although the success of QFD applications in civil engineering can be assessed by several factors, it seems that two factors in particular deserve special attention. The first of these deals with promoting quality and reliability in building design and construction as well as in the usage, maintenance and dismantling of used buildings. The reliable consideration of customer needs and requirements is the second of these factors. This is why QFD facilitates satisfying stakeholders involved in all civil engineering-related activities.

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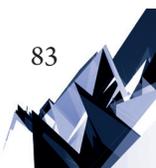
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