Project success evaluation model based on FIS

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Abstract

Purpose of the article The article presents the expert fuzzy model for evaluation of project success. It is also verified and further specified there. The fuzzy inference system (FIS) consists of three input variables one rule block and one output variable. The fuzzy inference system for evaluation of project success is presented in the form of a case study.

Methodology/methods Methods of analysis, synthesis and techniques of mathematical fuzzy modelling (fuzzy sets, fuzzy logic) were used to fulfil the aim. The Gaussian curve membership function (gaussmf) was used.

Scientific aim The aim of the article is to present an expert decision-making fuzzy model for evaluation of project success in the form of a case study.

Findings The reliable proposed expert decision-making fuzzy model consists three input variables (Project Status, Project Risk, Project Quality), one rule block (with 125 fuzzy rules) and one output variable (Project Success). The inputs variables and output variable have five attributes (VL – very large, L – large, M – medium, S – small, VS – very small).

Conclusions The proposed fuzzy model is used as a tool for support of decision-making in project management. The project managers can systematically evaluate the basic project processes and the project success as a whole. They have the opportunity of using the fuzzy model for experimentation or simulations and they can relatively fast apply appropriate measures in project management. The proposed fuzzy model is recommended to use in the realisation phases of the project.

Keywords: project management, decision-making, project success, fuzzy logic, soft computing.

JEL Classification: C44, M11, M21

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Introduction

Project management is a widely discussed discipline nowadays. This fact is substantiated by numerous scientific articles, books and publications dealing with these problems (Bergantiños, Vidal-Puga, 2009; Pérez, Rambaud, García, 2005; Rosenau, 2007; Schwable, 2011; Doležal, Máchal, Lacko, 2012; Smejkal, Rais, 2013). This discipline is also included in the courses of numerous faculties focusing on economy both in the Czech Republic and abroad. Experts are also associated in various professional organizations or associations (Společnost pro projektové řízení Česká republika, 2011; International Project Management Association, 2011).

The article presents the possibility of project success evaluation by using fuzzy logic. The scientific aim is to propose the expert decision-making fuzzy model for evaluation of project success. Methods of analysis, synthesis and techniques of mathematical fuzzy modelling (fuzzy sets, fuzzy logic) were used to fulfil the aim.

The application of fuzzy logic is based on fuzzy set theory (Zadeh, 1965; Zimmermann, 2001; Klir, Yuan, 1995). Many authors have focused on the theory of fuzzy sets and applications of fuzzy logic in project management (Relich, 2012).

The problem of project success is also a scientific goal for some authors (Doskočil, Škapa, Olšová, 2016; Khan, Rasheed, 2015; Kemmeter, 2014; Schibi, 2013, etc.). The issue of project success is the discussion subject among a many of experts both in project management and other areas (Joslin, Muller, 2015; Obrová, Smolíková, 2013; Todorovic et al., 2015).

There are a large number of metrics for the measurement of project success. A number of authors agree on some of these, while others are appearing as new. The studies by authors such as (Yang et al., 2011; Zwikael et al., 2014) consider research into new dimensions of project success. In the opinion of the authors, the metrics differ according to the type of project, the phase in which the project is found, the method of expression: absolute or relative (Samset, 1998), and individual interest groups which often have their own way of perceiving project success (Davis, 2014). The traditional measure of project success is based on what is known as the triple imperative of a project and is associated with the fulfilment of the time period, costs and goals of the project (de Carvalho et al., 2015).

1 Materials and Method

A fuzzy set is a set whose elements have degrees of membership. Fuzzy set was introduced by Lotfi A. Zadeh in 1965 as an extension of the classical notion of set and can be applied in many fields of human activity. Fuzzy set determines "how much" the element belongs to the set. This is the basic principle of fuzzy set (Zadeh, 1965).

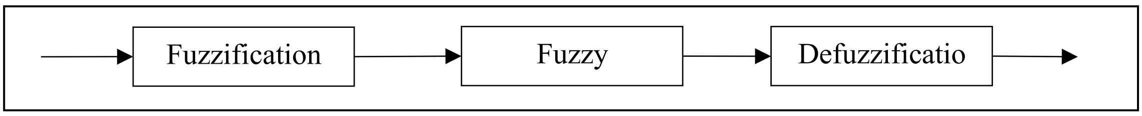
A fuzzy set A is defined as (U, μA), where U is the relevant universal set and $\mu_A:U\rightarrow\langle 0,1\rangle$ is a membership function, which assigns each element from U to fuzzy set A. The membership of the element $x\in U$ of a fuzzy set A is indicated $\mu_A(x)$. We call F(U) the set of all fuzzy set. Then the "classical" set A is the fuzzy set where: $\mu_A:U\rightarrow\{0,1\}$. Thus $x\in A\Leftrightarrow\mu_A(x)=0$ and $x\notin A\Leftrightarrow\mu_A(x)=1$. Let $U_i, i=1,2,\ldots,n$, be universals. Then the fuzzy relation R on $U=U_1\times U_1\times\ldots U_n$ is a fuzzy set R on the universal U.

The interval numbers are a special case of fuzzy number, so arithmetic operations with interval number have properties of operations with fuzzy numbers. Arithmetic operations on interval numbers are defined following relationships (Dostál, 2011):

$$[a;b]+[c;d]=[a+c;b+d]$$
$$[a;b]-[c;d]=[a-d;b-c]$$
$$[a;b]\cdot[c;d]=[min\{ac,ad,bc,bd\};max\{ac,ad,bc,bd\}]$$
$$[a;b]/[c;d]=[a;b]\cdot\left[{}^{1}/_{d};{}^{1}/_{c}\right]\ for\ 0\notin[c;d]$$

The fuzzy logic theory is described in many books such as (Zadeh, 1965). The fuzzy application in non-technical field is described in (Dostál, 2011).

The fuzzy logic system consists of three fundamental steps: fuzzification, fuzzy inference, and defuzzification. See Figure 1.



Source: Dostál, 2011

Figure 1 Decision making solved by means of fuzzy logic

The first step (fuzzification) means the transformation of numerical values into ordinary language, if necessary. For example, project risk has the linguistic values such as no, very low, low, medium, high, and very high risk. The variable usually has from three to seven attributes (terms). The degree of membership of attributes is expressed by mathematical functions. There are many shapes of membership functions. The types of membership functions that are used in practice are for example Λ and Π. There are many other types of standard membership functions on the list including spline ones. The attribute and membership functions concern input and output variables.

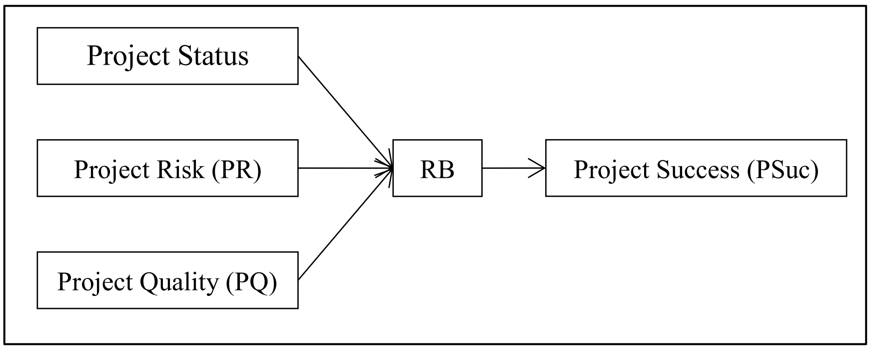
The second step (fuzzy inference) defines the system behaviour by means of the rules such as <IF>, <THEN>, <WITH>. The conditional clauses create this rule, which evaluates the input variables. These conditional clauses have the form <IF> I1 is mfa <AND> I2 is mfb . . . <AND> IN−1 is mfy <AND>IN is mfz <THEN> O1 is mfO1 <WITH> s. The written conditional clause could be described by words: If the input I1 is mfa and I2 is mfb and . . . and IN−1 is mfy and IN is mfz then O1 is mfO1 with the weight s, where the value s is in the range <0–1>. These rules must be set up and then they may be used for further pro-cessing. The fuzzy rules represent the expert systems. Each combination of attribute values that inputs into the system and occurs in the condition <IF>, <THEN>, <WITH> represents one rule. Next it is necessary to determine the degree of supports for each rule; it is the weight of the rule in the system. It is possible to change the weight rules during the process of optimization of the system. For the part of rules behind <IF>, it is necessary to find the corresponding attribute behind the part <THEN>. These rules are created by ex-perts. The <OR> could be instead <AND>.

The third step (defuzzification) means the transformation of linguistic values to numerical ones, if necessary. For example the linguistic variables for Risk are very low, low, medium, high, and very high. During the consecutive entry of data the model with fuzzy logic works as an automat. There can be a lot of variables on the input.

2 Results

The case study presents the expert fuzzy model for evaluation of project success. The Fuzzy logic Toolbox of the MATLAB software was used for the creating of the decision making model. At first is it necessary to design the variables, their attributes and their membership functions.

The proposed expert decision-making fuzzy model consists of three input variables one rule block and one output variable. The inputs are represented by the variables Project Status (PS), Project Risk (PR) and Project Quality (PQ). Output variable is Project Success (PSuc). See Figure 2.



Source: own research

Figure 2 The scheme of the model

Project Status can be analysed using methods as Earned Value Management (EVM), Structure / Status / Deviation (SSD), Milestone Trend Analysis (MTA) etc. (Doležal, Máchal, Lacko, 2012). Project Risk can be analysed using methods as Risk Project Analysis (RIPRAN) method Scoring method or others. The RIPRAN method is a trademark, registered author of the Industrial Property Office in Prague under reg.no. 283536 (Lacko, 2015). Project Quality can be analysed using the European Standards EN ISO 9000 (010300):2005 or EN ISO 10006 (010333): 2004.

The inputs variables and output variable have five attributes: VL – very large, L – large, M – medium, S – small, VS – very small. The membership function of type gaussmf is used.See Figure 3.

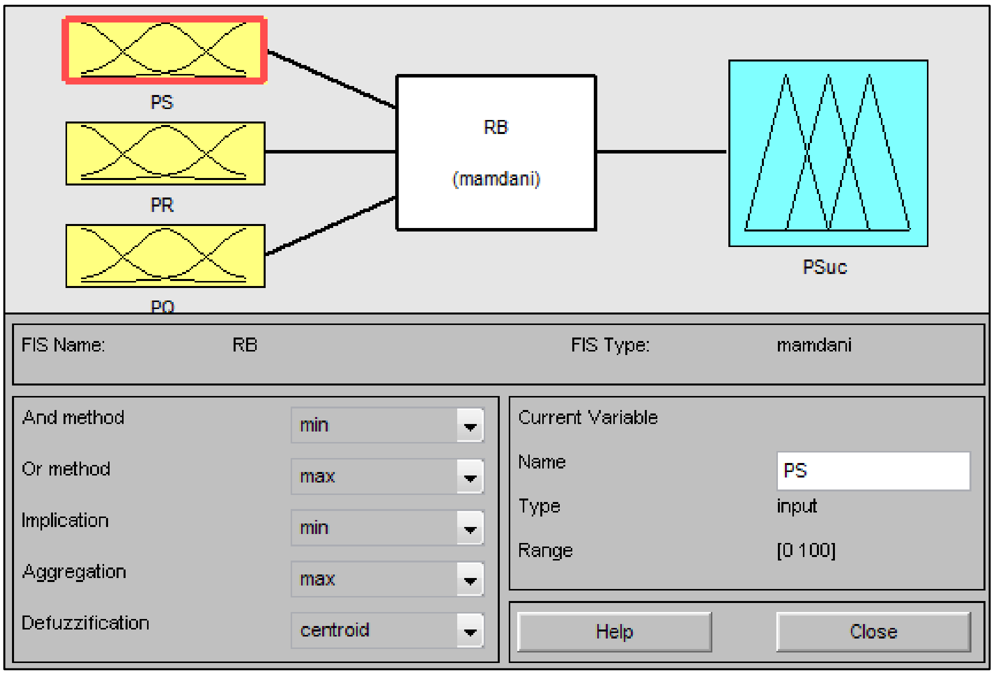


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Figure 3 Build-up model

The Figure 4 shows the part of rule block (RB). There are 125 rules total and degrees of support that set up the relation between input and output variables. The list and combination of rules for the project suc-cess rate evaluation system is based on empirical research into the given subject carried out by the con-trolled interview technique.

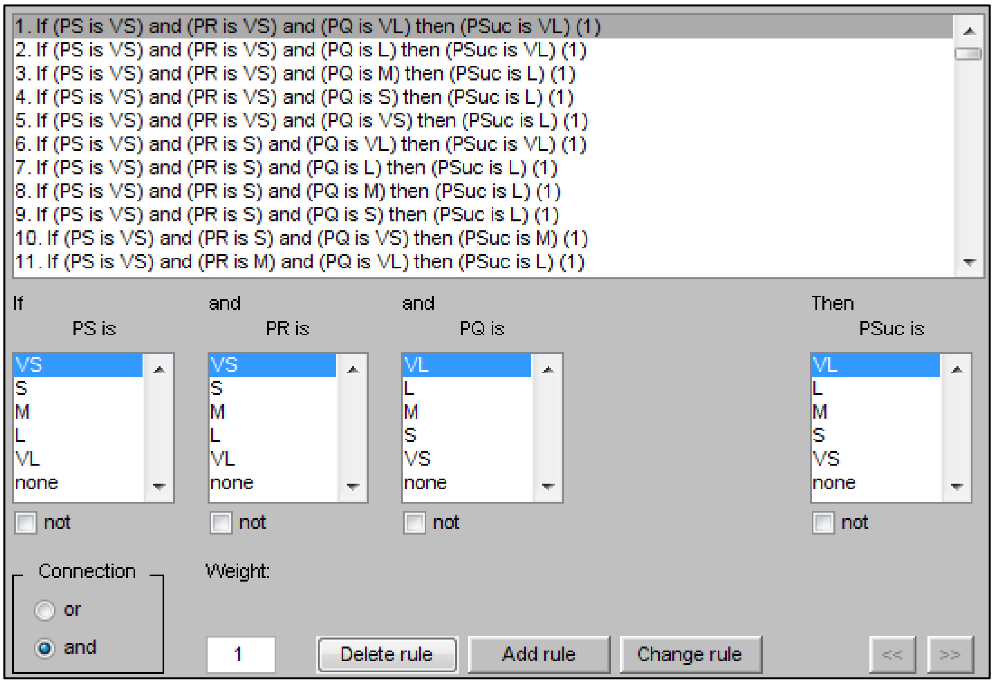

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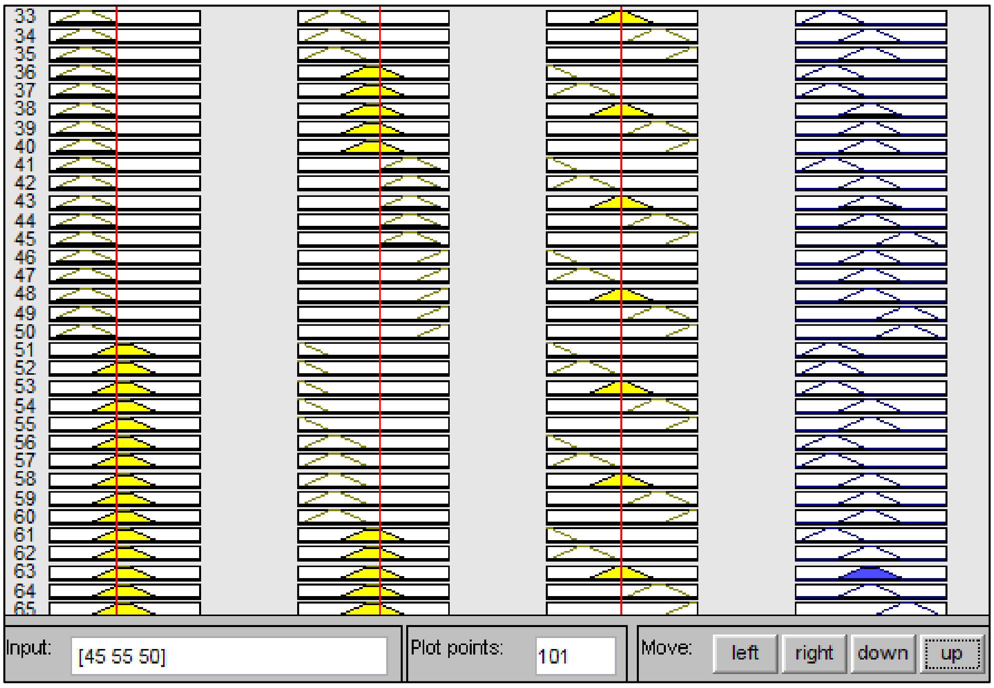
Figure 4 Rule block and some rules

The Figure 5 shows the evaluation of project success for a concrete project. The input variables are set up as PS = 45, PR = 55, PQ = 50. This leads to the output PSuc = 50 which means that project success is medium. Using the 63th rule is expressed by the output variable PSuc coloration.



Source: own research

Figure 5 The evaluation of concrete project success

The model contains basic input variables which are used in project practice for a long time as criteria for the evaluation of project success. The fuzzy model is set to expert data. These data can by change or can by different in others project. The fuzzy model must by changed, if exist some new criteria. Also must be changed if new relations between criteria would be identified or other important aspects. Then the model must be verified again. Only verified model can be used in the practice as a tool for support of managerial decision-making. For these reasons, the proposed model cannot be considered as a final.

The proposed fuzzy model is implemented by means of abstract modelling. The fuzzy modelling was applied first and foremost in view of the ability of fuzzy sets to work with vague concepts. These concepts are widely used in everyday project practice. It would be very complicated to use the exact mathematical modelling in the project success evaluation.

The M-File could be build-up to implement the fuzzy interface system in MATLAB. It could be used for enter of input values and automatically evaluate project success.

The proposed fuzzy model is recommended for use primarily in the implementation and realisation phase of the project cycle and then repeatedly after each project milestone (according to WBS – Work Breakdown Structure).

3 Conclusion

The use of fuzzy logic is the advantage especially at decision making processes where the description by algorithms is very difficult and criteria are multiplied. The advantage is that the linguistic variables are used. Analogously the man makes decision during the mental and physical activities. The solution of cer-tain case is found on the principle of rules that were defined by fuzzy logic for similar cases.

The aim of the article was to present an expert decision-making fuzzy model for evaluation of project success. This fuzzy model was based on three basic project processes evaluation – project status, project risk and project quality (fuzzy inputs). These fuzzy inputs have five attributes (VL – very large, L – large, M – medium, S – small, VS – very small). The output is the fuzzy value of project success. The member-ship function of type gaussmf was used during the fuzzy modelling.

The proposed fuzzy model is used as a tool for project managers. They can evaluation the basic project processes and the project success as a whole. They get the opportunity of using the fuzzy model for experimentation or simulations. The information about project development could be done relatively in time.

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