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THE SUITABILITY OF EXPERT SYSTEM APPLICATION IN CZECH SMALL AND MEDIUM-SIZED ENTERPRISES

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Abstract

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Small and medium-sized enterprises play an important role in the economy of Czech Republic. Expert systems are one of the alternatives evaluated the effectiveness of the relationship between supplier and customer. Currently, measurement and increase in efficiency of supplier-customer relations is very topical subject.
The requirements for tools the improvement supplier- customer relationship can be specified on the base the literature analysis. The article defines basic requirements for expert system. The presentation of expert system and its suitability in the surroundings of small and medium sized enterprises is the part of this article. The comparison of the expert system possibilities and the compiled requirements leads to suitability analysis of selected solution. Actual questions and the way of future work are derived from current results, presented in the paper.
The article defined the directions of development this expert system.

Keywords: SME's, hierarchic expert system, decision-making task, knowledge system, language model, supply chain

INTRODUCTION

The Comission Regulation (EC). 364/2004 divided the SMEs to next categories:

- micro-enterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 2 million,
- small enterprise is defined as an enterprise which employ fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed EUR 10 million,
- medium-sized enterprises (SMEs) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding EUR 43 million (European Union, 2004).

The research objects of this article are enterprises in categories small and medium sized.

Ministry of Industry and Trading of Czech Republic (MIT) presents that support of small and medium sized enterprises is the one from priorities for Czech government. MIT introduces that SMEs represent more than 1 million economic subjects, 99,84 % all entrepreneurs. SMEs employ over 1,8 mill employers, their export makes 51 %, their import makes 56 %. (Czech Republic, Ministry of Industry and Trading, 2013)

Small firms rely routinely on network relationships to help them overcome the obstacles associated with entering new markets. This is particularly true for firms in transitional economies, such as Czech Republic and other countries in Central and Eastern Europe. (Musteen M., Francis J., Datta D. K., 2010)

Turbulence is characteristic condition of entrepreneurship for the present time.

Some authors say that approximately 50–70 % of production costs are spent on purchased materials

I: *The basic evaluation criteria*

Classification model	Dimension	Criterion
Item	Complexity of supplier market	Entry barriers
		Co-development of product specification
		Market concentration
		Product uniqueness
	Importance of purchase	Environmental contribution
		Alignment with the core competencies of the buyer
		Value-added profile
Supplier	Potential for partnership	Commitment to improvement and cost reduction
		Ease of communication
		Financial capability
		Technical capability
	Delivery performance	Delivery reliability
		Price performance
		Quality of conformance
		Problem resolution

Source: Osiro L., Lima-junior F. R., Carpinetti.L.C.R. (2014)

and components. Purchasing decisions affect important activities such as inventory management and production planning and control and have a significant influence on the cost, quality and delivery of products of the buying company. Thus, managing the performance of suppliers and supporting their continuous improvement has become very critical for managing organizations and supply chains. (Osiro L., Lima-junior F. R., Carpinetti. L. C. R., 2014)

The connection of the product standards may be broken at this time, the basis of the technical requirement is missed out, the acceptance criteria made by the demand sides may be fuzzy or beyond the defined requirement specification at the end of the supply chain. It is therefore necessary to establish an expert system, to project standards developed and used by the demand sides into all relevant parts and components, so that all suppliers have to follow the specific standards. (Jin C., Rong W., 2011)

This paper deals with the solution of problem the increasing of performance in suppler-customers relationship. This paper is oriented to requirements of production SMEs in Czech Republic.

The groups of tools for supplier-customer relationship performance measuring and increasing, for example collective planning (Nenadál J., 2006; Ballou, R. H., 2004)., risks sharing (Hallikas J., Puumalainen K., Vesterinen T., Virolainen V. -M., 2005)., collaborative learning (Hallikas J., Puumalainen K., Vesterinen T., Virolainen V. -M., 2005) and others.

The main goal of this paper is the analysis of application suitability the expert system (by Khitilova and Pokorný) to entrepreneurship conditions of Czech small and medium sized enterprises.

This main goal can be divided to partial aims:

- The description modern methods of SC (Supply Chain) performance evaluation and the modern tools of SC performance evaluation.
- The description of functioning principles of expert systems (including the presentation of expert system by Khitilova and Pokorný).
- The description of typical conditions of entrepreneurship SME in Czech Republic (based on the literature sources analysis).
- The analysis of suitability the concrete expert system (by Khitilova and Pokorný) for the increasing of performance SC SMEs in Czech Republic.

MATERIALS AND METHODS

The definition of performance supplier-customer relationship and supply chain

Performance is a characteristic that describes a method, how examined subject performs an operation on the basis of similarity with the reference method execution (during) this activity. Interpretation of this characteristic implies the ability of comparison the test and reference the phenomenon in terms of the specified criterial range. (Wagner, J., 2009).

Performance of SC (output size) can be monitored with various indicators. These include, for example:

- The proportion of deliveries without delay the total production (supply completeness).

- The total cost of storage.
- Time needed to increase production to meet impact requirements. (Sodomka P., Klčová H., 2010).

The description of tools for SC performance measuring in the first stage of SC

Modern evaluation criteria

Many papers (e.g. Gunasekaran A., Patel C., McGaughey R.E., 2004, Awasthi A., Chauhan S., Goyal S.K., 2010.; Che Z.H., Wang H.S., 2008; Razmi J., Rafiei H., Hashemi M., 2009; Shu M. -H., Wu H. -C., 2009) deal with description and analysis of actual suppliers evaluation criteria. Tab. I is one from the classifications.

Approaches and technics

Nowadays it exists many approaches for suppliers evaluation, for example DEA (Data envelopment analysis), Linear weighting methods (e.g. multi-objective linear programming), Mathematical programming (e.g. Archimedean goal programming (AGP) and Analytic network process (ANP), Cluster analysis).

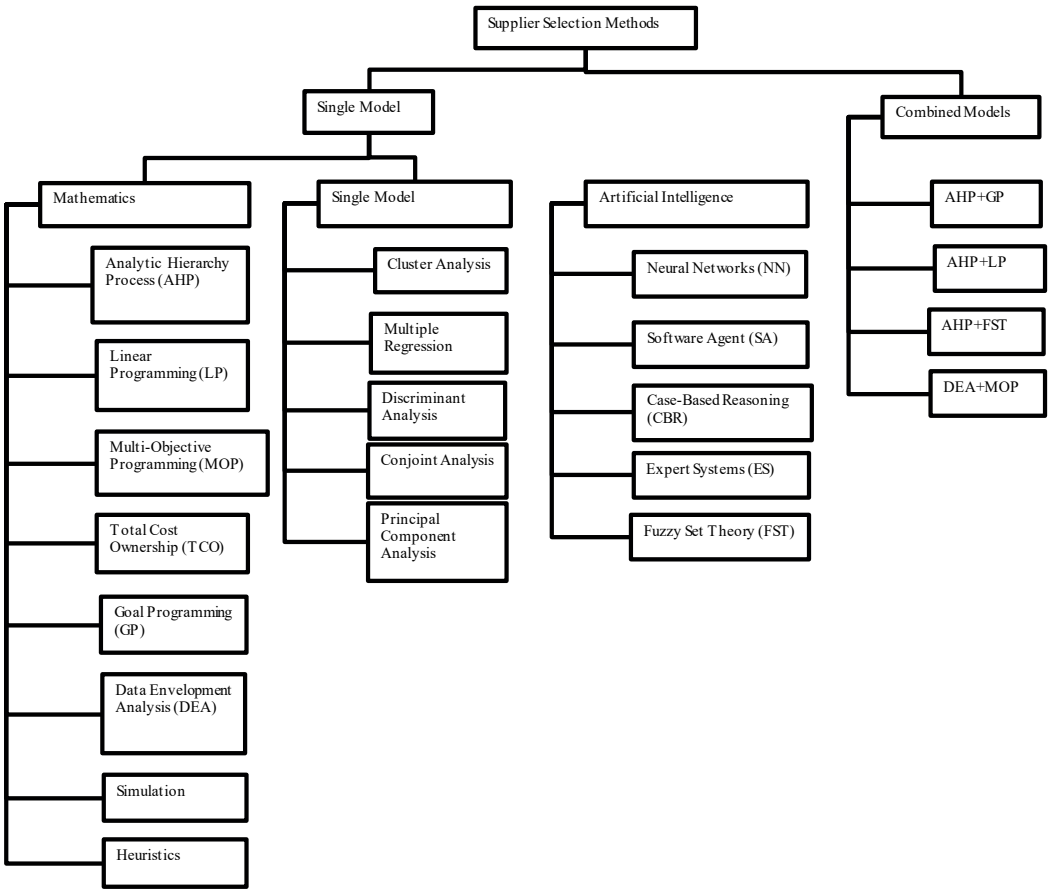
Chen Y.-J. wrote about existing analytical methods for supplier selection (Fig. 1).

Govindan K., Khodaverdi R., Vafadarnikjoo A. introduce DEMATEL approach for developing green practices and performances in a green supply chain. DEMATEL is a comprehensive method to create a structural model containing casual relationships between complex factors. This method is used to develop mutual relationships of criteria and their interdependencies. This method generates causal diagrams to describe mutual relationships and their influence degree on the criteria. It evaluates the strength of effects for each criterion. (Govindan K., Khodaverdi R.,Vafadarnikjoo A., 2015)

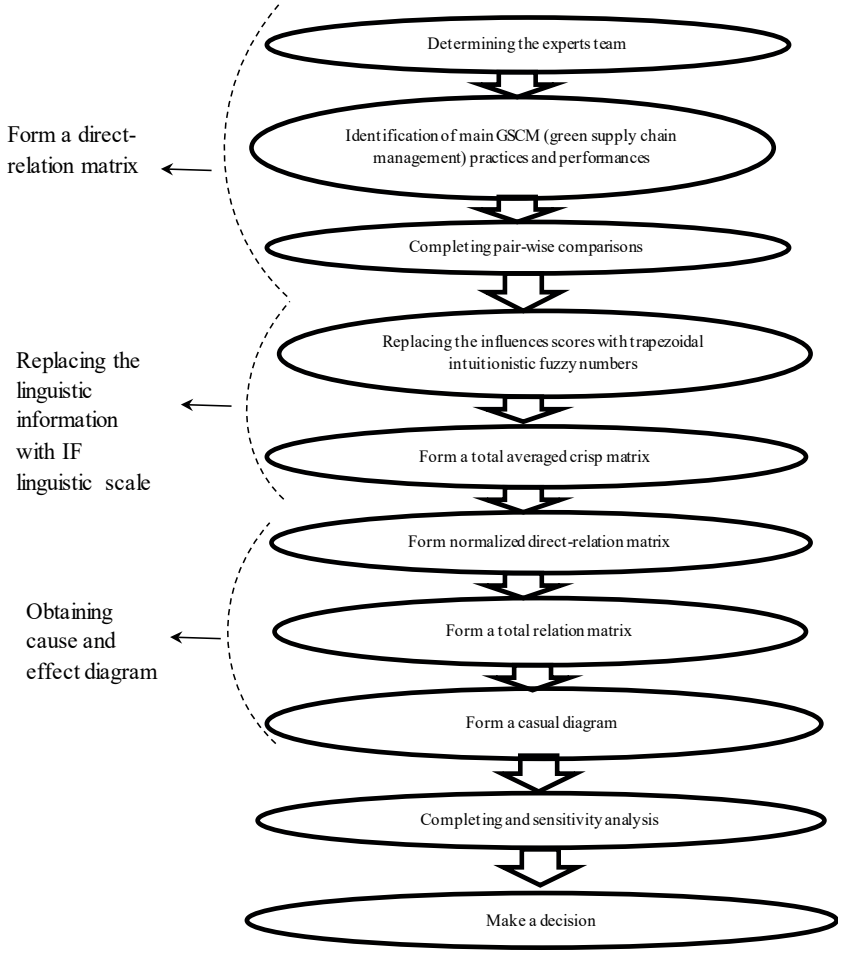
DEMATEL analysis procedure for GSCM (Green Supply Chain Management) is presented in Fig. 2.

The process of presented decision making is similar to expert system by Khitilova, Pokorný. Both of them have steps as form a direct-relation between criteria, replacing the linguistic information to scales, completing and sensitivity analysis. The presented DEMATEL analysis procedure is oriented to development and using of criteria relations in the area of green supply chain management.

In the next capture will be presented expert system by Khitilová, Pokorný. This expert system



1: *Existing analytical methods for supplier selection*
Source: Chen Y.-J. (2011)



2: *Steps of intuitionistic fuzzy DEMATEL method for development of Green Supply Chain Management*
Source: Govindan K., Khodaverdi R.,Vafadarnikjoo A. (2015)

is oriented to complete supplier evaluation in the concrete purchasing situation.

Expert system by Khitilova and Pokorny (ES)

Basic principles of functioning

A general model of the problem (knowledge base) is not mathematical but language. The If-Then rule statements are used to formulate the conditional statements that describe the behaviour of the system under modelling. For example the rule expresses linguistic dependency of linguistic output variable *Supplier Quality (SUQ)* on two input linguistic variables namely *Processes Quality (PRQ)* and *Product Quality(PQA)* is linguistically expressed in the form:

If process quality is high and product quality is sufficient, then supplier's quality is average

Then, the corresponding rule has the form:

IF (PRQ is HIGH) and (PQA is SUFFICIENT) THEN (SUQ is AVERAGE)

The linguistic values of the input/output linguistic variables are expressed using linguistic terms "insufficient, sufficient, average, high, and very high". The linguistic terms are represented as fuzzy sets. Their membership functions are usually expressed using a broken-line triangular approximation.(Khitilova E., Pokorný M., 2015)

Structure and content of expert system

The input/output linguistic variables are defined by an expert (Tab.II). The supplier suitability evaluation decision-making expert system is of a hierarchical type with 21 input and 1 output variable (Fig. 3).

The basic indicators of the suitability of suppliers by the authors include Quality (ES 3-1), Total costs (ES 3-2) Delivery terms (ES 3-3) Supplier flexibility (ES 3-4).

II: *Linguistic input/output variables of expert system*

Name of variable	IDENT
Communication	KOM
Results of quality control	KOK
Rate of technological development	TEV
Clean production application	ASV
Processes audit results	VAP
References	REF
Time of market	DPT
Processes quality	KPC
Compulsory product certification	PCP
Results of processes quality control	VKK
Product quality	KPR
Quality	KVA
Purchasing value	NHO
Transport costs	NDO
Costs of packaging	NBA
Costs of storage	NSK
Costs tariff	NCE
Total costs	NAK
Distance to supplier	VZD
Delivery time	DOL
Delivery terms	POD
Possibility of online orders	MOO
Possibility of product modification	MMP
Possibility of joint development	MSV
Possibility of activities delegation	MDC
Possibility of deferred payment	MOP
Supplier flexibility	FLD
Sustainability of supplier	VHD

Source: Khitilova E., Pokorný M. (2014)

The description of typical conditions of entrepreneurship for SMEs in Czech Republic

According to (Zelený, M., 2006), current business conditions can be expressed by the following points:

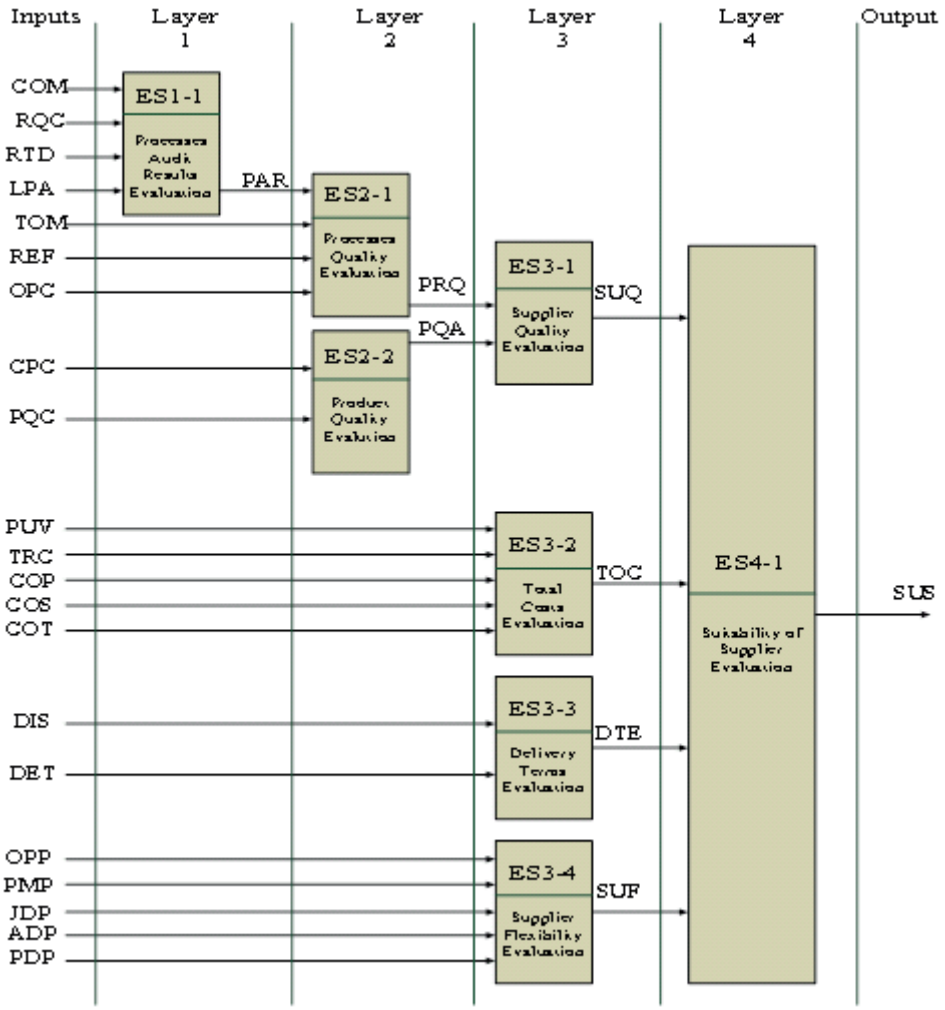
- Cooperation supplements or replace the competition. Businesses in the network or alliance cooperate, compete with the network itself.
- Global customer requires more and more "tailored" products and services.
- With the increasing outsourcing created long-term stable relationships.
- Co-location.
- A small and medium-sized enterprises and cooperation networks for SMEs become bearers of employment, stability and knowledge in the region.

As the key characteristics of small- and medium sized enterprises many authors introduce their liabilities of smallness and/or newness, cooperative internationalization. (Fink M., Harms R., Kraus S., 2014)

The authors Musteen M., Francis J., Datta D. K introduce the unique challenges SMEs in Czech republic and other countries in Central and Eastern Europe, for example those posed by relatively weak institutional environments, frequent changes in the legal system, and the presence of a significant grey economy, such firms often rely on personal relationships to survive and grow. (Musteen M., Francis J., Datta D. K., 2010)

The authors Hamplova E., Provaznikova K deals with Opinion and Attitudes of Entrepreneurs of Small and Medium-sized Business. They introduce some factors of discourage from entrepreneurship: cultural factors, administrative requirements, investment. (Hamplova E., Provaznikova K., 2014)

In assessing the attitudes of Czech entrepreneurs we came to the conclusion that their views of support and the society-wide importance of small and medium-sized business are very critical. The reason for this criticism is neither connected with administrative barriers is business nor the work of authorities representing the state administration and business regulation (Hamplova E., Provaznikova K., 2014)



3: *Structure of hierarchical expert system*
Source: Khitilova E., Pokorný M. (2015)

RESULTS

The suitability of expert systems application in the Czech SMEs

In general we can say that expert systems have broad application possibilities. Presented expert system (ES) can be applied in any enterprise for purposes of evaluating the supply chain. The list of evaluation criteria can be considered adequate in the current managerial practice, as well as the decision making principles. But it would be appropriate to add, modify existing expert system for SMEs. In the previous chapter it described what the specific conditions of small and medium enterprises in the Czech Republic. Based on this information, we can formulate the basic requirements for expert system:

- The accent on innovative approaches product/service.
- The accent on long-term cooperation.
- The accent on flexibility.
- The accent on ease of use.

The presented expert system is focused on the preference of long-term cooperation, flexibility and quality of the product/service. Thus, in its current form the presented expert system can be used for the purpose of evaluating suppliers in an environment of SMEs.

The application suitability of ES is caused by few reasons:

- The ES flexibility is achieved by possibility of criteria value changes and sensitivity of expert opinion to result.
- The condition of ES complexity is fulfilled with help the selection of evaluation criteria.
- The accent to quality: ES includes different viewpoints of quality (the level of processes quality as result of process audit, references and time on market.

DISCUSSION

There are many possibilities for supplier evaluation, from very simply to relatively hard.

One of the questions in modern logistics is: "How could we measure something, that doesn't have numerical scale or something, about that we don't have completely information?"

The expert systems are one from the possibilities for the answering this question.

The suitability of presented tool for supplier evaluation is provided by different viewpoints: logistic information, presented and actual quality, assumptions for long-term partnership.

The presented ES corresponds with mentioned requirements for supplier evaluation in Czech SMEs.

The accurate results of application suitability will be achieved through the series of experiments in the enterprises for definite purchasing situations.

CONCLUSION

Many authors introduce the importance and necessity of small and SMEs role in the state economy. The specific conditions and characteristic features of SMEs entrepreneurship can be defined on the base of literature analysis. The conditions of SMEs in the Czech Republic are defined.

The requirements to suitable tool for supplier- customer relationship are defined in the article. The several tools fulfilled the presented requirements. One of them is expert system. There are presented the current trends in supplier-customer relationships evaluation. There are described the modern criteria of evaluation for supply customer relationship.

This article described the expert system by Khitilova a Pokorny.

Author analysed the suitability this expert system in the terms of SMEs in the Czech Republic. The article determines the directions of further research.

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