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Semantic Network in Information Processing for the Pork Market

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Anotace

Základním cílem příspěvku je zachytit prvky jednotlivých informačních rámů a jejich vzájemné vztahy a vyjádřit ztrátu informací a informační asymetrii v tržním prostředí pomocí sémantické sítě. Preference prvků v síti jsou vyhodnoceny analytickým síťovým procesem (ANP). Přínosem aplikace sémantické sítě v tržním prostředí je zvýšení informovanosti spotřebitelů a snižování informační asymetrie.

Využití sémantických sítí bude ukázáno na analýze informačního rámu výrobce, distributora a spotřebitele na trhu s vepřovým masem. Proces rozhodování v prostředí trhu s vepřovým masem je ovlivněn mnoha faktory. V informačním rámu spotřebitele vyjadřuje spotřebitel svá očekávání a preference, podle nichž se rozhoduje. Výrobce pracuje s větším rozsahem informací o výrobku, než je k dispozici pro spotřebitele. Distributor získává informace jak od výrobce, tak pomocí marketingových nástrojů od spotřebitele, tyto informace však obvykle nesděluje v úplném rozsahu spotřebiteli ani výrobci, čímž vzniká informační asymetrie.

Klíčová slova

Sémantická síť, efekt zarámování, rám výrobce, rám distributora, rám spotřebitele, informační asymetrie, analytický síťový proces.

Abstract

The main aim of this paper is to capture the elements of individual information frames and their relations using semantic network; and to express the loss of information and information asymmetry in the market environment. Preferences of elements in the network are evaluated by the Analytical network process. The benefits of applying semantic networks in the market environment are in increasing consumer information and reducing information asymmetry.

The use of semantic networks will be shown in the analysis of the information frames of the producer, distributor and consumer in the pork market. The consumer's frame expresses expectations and preferences, according to which decisions are made. Producer operates with greater range of information about the product than is available to the consumer. Distributor receives information from both the producer and from the consumer, but this information is not usually fully shared to the consumers or producers. This creates information asymmetry.

Key words

Semantic Network, Framing Effect, Producer's Frame, Distributor´s Frame, Consumer's Frame, Asymmetric Information, Analytic Network Process.

Introduction

The integral part of any decision-making is the information receiving and processing. As Fagley, Coleman and Simon (2010) mention decision-making is influenced by the quality of the information and its processing and by the effect of information distortion (framing effect). Tversky and Kahneman (1981) argue in their studies, that the framing effect included in some information can significantly influence decisions. There are various views on a particular issue in decision-making process. Bishop (2006) believes that if information is not sorted according to its relevance because we cannot properly decide who has the most important view, we may face the problem of being overloaded

with too much information resulting in either poor information acquisition or the whole process is very time consuming and thus very ineffective. Even when we sort information according to our preferences we may lose the information needed for successful decision making. To reduce these negative impact of the frames we need firstly to define and understand them, secondly, as pointed out by Druckman (2001), we need to evaluate them, and thirdly we need to use the appropriate method to limit them. For this kind of evaluation as Fagley, Coleman and Simon (2010) write we need to know the importance of various frames and included points of view.

The typical example of the frame's impact on decision is the information written on the product´s package. As Kozel (2006) detailed analyses, the packaging inevitably influences our purchase decisions. According to Lindsey-Mullikin and Petty (2011) and Vysekalová (2011), the product packaging can attract our attention; affect our emotions, but on the other hand, by its information content it can contribute to the rational purchase decision. Each consumer has his unique view when buying a specific product (his unique way of perceiving the situation) based on his personality. His purchase decision is influenced by the preferences and expectations; this process is represented by the framing effect of the decision situation, which discusses in detail Rydval (2010, 2012). The framing effect is manifested in the same manner in producer's, distributor's, and consumer's decision-making. To define the framing effect, the frames influencing producer's, distributor's, and consumer's behaviour the semantic networks can be used.

The semantic network was developed at the end of 1960s (Sowa, 2000). Semantic networks were originally used to express meanings of various expressions in natural language. However, their present form of directed graph consisting of nodes and edges they became more general graphical tool to represent knowledge, which consist of information about the particular fact (Xia, Bu, 2012, Steyvers, Tenenbaum, 2005).

According to Sowa (2000) semantic networks are used namely because of their ability to provide easily usable system to represent information focused mainly on organisation of large information sources, information integration in distribution and description of complex processes. Semantic networks offer the tool to represent knowledge and they display their connections and relationships.

Semantic network can display individual elements influencing the decisions of producers, distributors and consumers. It provides us with information about relationships in the network between individual elements and how they can influence the decision. However, it does not give us the quantitative information about the importance of individual elements and how much they influence higher level elements.

Therefore we suggest converting semantic network to network consisting of clusters and nodes for the Analytic network process (ANP). The Analytic Network Process is one of the multiple criteria decision-making methods. It decomposes decision problems into a network of smaller parts (sub-problems) that can more easily by analysed and evaluated. It is specific for this method that the human judgment is involved. (Saaty, 2001).Using this method we can determine the cardinal quantitative information evaluating the individual elements influence on other elements in the same or higher level of the semantic network and we can measure the influence of network's elements in decision-making process in the market environment.

The goal of this paper is to map and quantify the distortion of information which occurs in the decision-making. The suggested approach is based on the semantic networks which can capture the basic elements of the information frames and their mutual relationships to express the possible loss of information and its asymmetry. The relevance of the identified elements in the network is then estimated using Analytic Network Process. The practical application of the semantic network and the ANP is demonstrated in the case of the producer's, distributor's and consumer's information frames in the pork market environment.

Materials and methods

In the same situation different decision-makers obviously decide according to the different criteria, frames. The important decision-making information and knowledge for each of them can be included into the semantic networks which describe the basic elements of their information frames and their mutual relationships identified in the decision-making process. The impact and relevance of each element of the semantic network are measured using multi attribute approach ANP. The pairwise comparisons correspond

to the logical connections and relationships of the semantic network.

Semantic Network

Semantic (associative) network can be seen (Sowa, 2000) as a directed graph consisting of nodes and edges. Nodes represent individual objects of described world and edges connecting these nodes represent relationships between these objects. Very often we can meet with following types of the relations:

- IS-AN-INSTANCE-OF (ISA) relationship is used to express the fact that a particular object (an instance of a particular class) belongs to the specified class.
- A-KIND-OF (AKO) relationship can express that a class is a subclass of another class.
- A-PART-OF (APO) relationship serves to express that a certain class of objects is composed of certain parts.

The basic advantage of the semantic network is that it contains information similarly as information is stored in human memory, and it is machine-understandable. This means that it can be machine-processed - is it possible to analyse facts and information included in the semantic network and to acquire new knowledge about represented facts (Xia, Bu, 2012, Steyvers, Tenenbaum, 2005).

Semantic networks have following basic characteristics:

- The network is transparent - the finite number of nodes has only finite number of edges.
- The network allows quick navigation - from any part of the network it can be relatively quickly reaches any other part.
- The network can be structured defining the local sub-networks.
- The network has a natural „entry points“ – starting points for the navigation.

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Analytic Network Process

The Analytic Network Process (ANP) is a multiple criteria decision method considering the dependence across the elements and levels of the hierarchy because many decision problems cannot be structured hierarchically. Therefore, ANP is represented by a network, rather than a hierarchy. (Saaty, 1990, 1996, 2003)

The basic steps of the ANP method are following:

- The first step - definition of a network which describes inner dependence within a set (clusters) of elements, and outer dependence among different sets (clusters).
- The second step – the pairwise comparisons of the elements within and across the clusters are made. The consistency of these comparisons has to be checked.
- The third step - construction of the normalized supermatrix with the preferences derived from the previous pairwise comparisons
- The fourth step - the limiting supermatrix is computed and global preferences of decision elements are obtained (Saaty, 1996, 2001, 2003)

Evaluation of ANP network can have various forms, e.g. personal judgement or surveys. The ANP calculation is than supported by the software SuperDecisions system (SuperDecisions). The program was written by the Creative Decisions Foundation.

Results and discussion

Proposed approach is illustrated in the example of the pork market environment. This case study shows how semantic networks and the ANP help to model the producer’s, distributor’s and consumer’s preferences. Thus it helps to decide what information should be shown on the product packaging and makes the product more attractive for the consumers. Semantic networks and ANP may serve as a supporting tool in the marketing strategy.

Three basic semantic networks were identified (Rydval 2012):

- Semantic network of the producer’s frame - refers to the basic features and links of what affects the producer in selecting the information about his product.
- Semantic network of the consumer’s frame - refers to the basic features and links of what influences consumer demand

in certain product.

- Semantic network of the distributor's frame - refers to the basic features and links of what influences distributor in the selection of published information about the product.

Using structured interviews and analysis information on the packaging of the product the essential elements were identified. These elements are the basic elements of the three basic frames in the pork market. Rydval (2013) wrote the three basic frames are: producer's, distributor's and consumer's decision-making frames.

The created producer's and consumer's semantic networks are then integrated into a comprehensive network of distributor (Figure 1, Figure 2, Figure 3). This semantic network gives us the overview of what aspects should be taken by distributor into account when buying pork from producers and distributing pork to consumers.

Producer's frame

Semantic network of the producer's frame shows what affects the decision about information published on product packaging. Figure 1 shows that the Meat manufacturing of the production of pork and its distribution to the consumer consists of four sub-networks (areas of producer's attention), which influence producer's decision. These are:

- T*ypes of meat,*
- *Meat processing,*
- *Selling meat products,*
- *Product package, which consists of two other sub-networks:*
  - *Package design,*
  - *Product information, which include the Quality information sub-network.*

Red elements of semantic network represent information processed by the producer, but often not shared with the consumer or not interesting for the consumer. At the same time this information about the quality of pork is important for producers, which proves Rydval (2012) in the case study. This case study shows that the quality of pork is important for the producer of 43% (calculated using AHP approach).

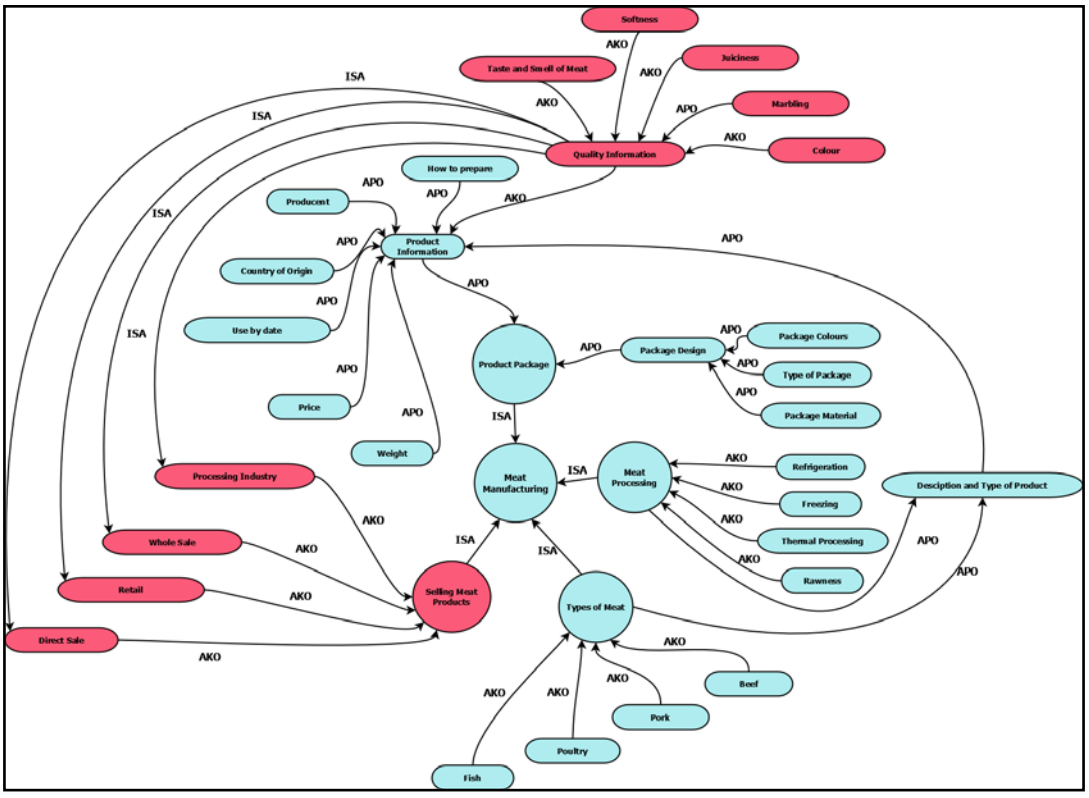

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Figure 1: Producer's semantic network of Meat manufacturing.

Consumer's frame

Semantic network of the consumer's frame shows what affects the perception of information (published on product packaging) when purchasing the pork. Figure 2 shows that the consumer´s frame Meat Purchase consists of five sub-networks (areas of consumer's attention), which influences his/her decision. These are:

- *Types of meat,*
- *Meat processing,*
- *Recommendations,*
- *Level of need satisfaction,*
- *Product package, which consists of two other sub-networks:*
  - *Package design,*
  - *Product information.*

The product information on the packaging includes: Weight, Price, Expiration date, Manufacturer, Country of origin, Distributor and usually Instructions for preparing the product, or important information about the ongoing marketing campaign.

Some of this information (basic elements of semantic network) contributes to the satisfaction of the psychological needs of consumers, which, together with the physiological needs of consumers leads to the customer satisfaction. The semantic network allows clearly display interrelationships of each element in the decision-making process and it can be used for further analysis of consumer behaviour.

Green elements of semantic network represent information processed by the consumer, but often not shared with the producer or not interesting for the producer.

Distributor's frame

Semantic network of the distributor's frame gives the overview of aspects which should be taken into account when distributor buys pork from producers and when distributes pork to consumers. Figure 3 shows that the Meat distribution frame consists of five sub-networks (areas of distributor's attention), which influences distributor's decision. These are:

- *Types of meat,*
- *Meat processing,*
- *Buying meat from distributor,*
- *Selling meat to consumer,*

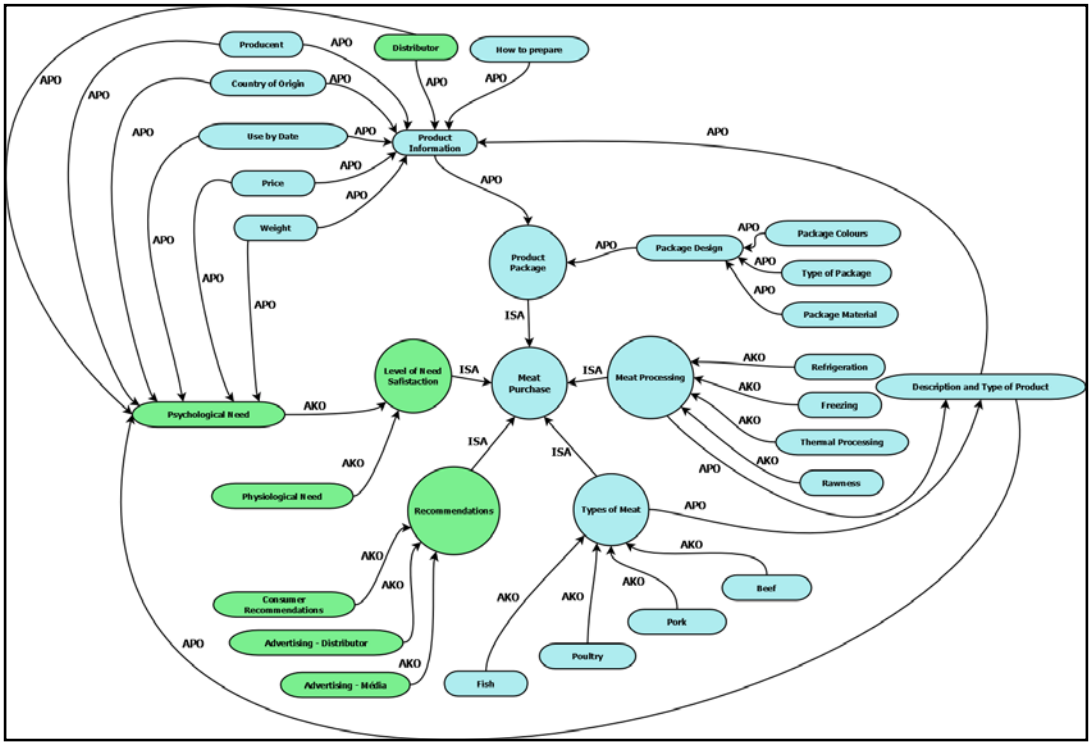

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Figure 2: Consumer's semantic network of Meat purchase.

- *Product package, which consists of two other sub-networks:*
  - *Package design,*
  - *Product information.*

The nodes of the semantic network represent the basic elements of the distributor‘s frame and individually oriented arrows between nodes represent connections and relationships between them. As shown in Figure 3, we can see that the distributor receives information about the quality of the pork from the producer. The distributor has information about consumer’s preferences and expectations, and using marketing tools he can affect the consumer’s behaviour. These steps may influence the decision-making process in consumer’s behaviour.

The information on the product packaging includes information that distributor considers as relevant to the attractiveness of the product for the consumer, in particular the Information on quality of meat, Product information and Price.

Information about the way of meat sale is important for producers to choose the form of the product distribution. Meat producer is responsible for publishing the correct information about the quality of the pork and the information is one of his main competitive advantages in the battle for the customers.

Figure 3 points to the fact that the distributor has the greatest amount of information about the product. Distributor has all the quality information from the producer (red in Figure 3) and by using various marketing tools he obtains information on what motivates consumers to buy a product (green in Figure 3). Yellow elements of semantic network represent information (received from marketing research) processed by the distributor, but often not shared with the producer or consumer. Figure 3 also clearly shows the product information asymmetry in the producer-distributor-consumer information chain. Information asymmetry is expressed in different availability of the information sub-networks. Some of them are available to the distributor, but not to the producer or to the consumer. The distributor can use or misuse this information as a competitive advantage in the battle for the customers.

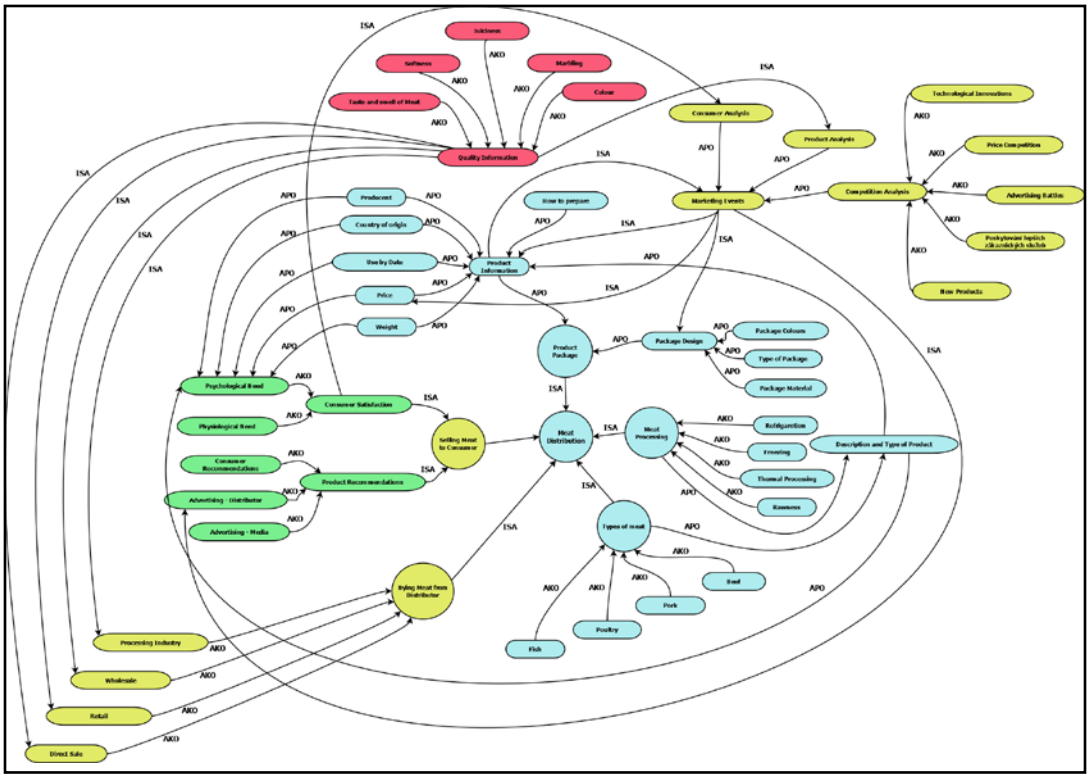

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Figure 3: Distributor’s semantic network of Meat distribution.

Quantification of the semantic networks

As shown in Figure 3, the distributor has the most available information within the pork market environment. The distributor's main problem is how to make his product more attractive to the customer. Some relevant distributor's questions (Vysekalová, 2011) are as follows:

- *What elements of the product design play the most important roll?*
- *What sort of information is important for the marketing events?*
- *What information on the product packaging, customer focused on?*
- *What takes the consumer in to account when buying pork?*

Distributor can get an adequate response for these questions with proper analysis and evaluation of the basic elements of the semantic network.

Field survey in Prague was carried out in the case study and responses from 203 customers and 9 producers of pork were received. The field survey took the form of an opinion poll. There were determined the preferences and expectations of the respondents in the pork market environment. The respondents aged 18-60 years were from Prague.

The impact and relevance of each element of the semantic network are measured using multi attribute approach ANP.

Based on the ANP the importance of the colour, material, and type of packaging in design of product packaging was calculated. As shown in Table 1 the colour is the most important for the design (75.31%), while packaging material (for instance paper used) is less important (only 6.29%).

Design of product packaging	colour of packaging	75.31%
	type of packaging	18.40%
	material of packaging	6.29%

Source: own processing

Table 1: Design of product packaging.

Table 2 shows that the consumer analysis in a successful marketing strategy is the most important (63.70%).

Analysis for marketing events	consumer analysis	63.70%
	product analysis - quality information	25.83%
	competition analysis	10.47%

Source: own processing

Table 2: Analysis for marketing events

In the Table 3 is calculated what kind of product information on product packaging is the most important for the consumer. The most important information is price of product (39.32%).

Product information	consumer analysis	63.70%
	price	39.32%
	marketing events	24.75%
	quantity	12.25%
	date of consumption	10.83%
	description and type of product	5.50%
	country of origin	3.26%
	producer	2.45%
	how to prepare	1.63%

Source: own processing

Table 3: Product information.

Table 4 shows what affects the selling the pork to the consumer.

Meat sale to the consumer	consumer analysis	63.70%
	satisfaction of psychological consumer´s needs	44.32%
	reference of product	38.32%
	advertising	12.17%
	satisfaction of physiological consumer´s needs	5.19%

Source: own processing

Table 4: Meat sale to the consumer.

And in the Table 5 there is calculated what kind of information is the most important for the consumer analysis. That the most important is the satisfaction of consumer´s psychological needs.

Consumer analysis	consumer analysis	63.70%
	satisfaction of psychological consumer´s needs	44.32%
	reference of product	38.32%
	satisfaction of physiological consumer´s needs	12.17%
	advertising	48.52%

Source: own processing

Table 5: Consumer analysis.

Using results of this analysis and evaluation of the basic elements of the semantic network distributor knows what information should be taken into account for preparing new marketing campaigns:

- To attract the product to the customer is necessary to use adequate colour and graphic design of product package.
- In preparing marketing events the distributor should focus his attention on data obtained from the analysis of the customer.
- With it, he learned that the most important information on the product packaging for the customer is the price and any other benefits of running marketing events.
- Distributor should take emphasis on meeting the psychological needs of the customer.

Conclusion

This paper deals with the describing, modelling, and analysis of the factors affecting our rational thinking, our ability to make rational decisions; in particular, with the framing effect in decision-making process and its graphical representation and quantification, using semantic networks and the ANP method.

The described case study shows that semantic network can be used to define the basic information frames of main subject of market environment. To define the frames and the construction of semantic networks can be used structured interviews (opinion poll).

The individual clusters and nodes with their logic consequences are used as the ANP network, and quantitative characteristics of semantic networks can be calculated. The data for this calculation can be received by the questioning of the relevant respondents from the market environment or by the experts' opinion.

By the comparison of semantic networks of individual actors of the market environment, transfer and loss of information in the producer-distributor-consumer chain can be defined. Using the comparison of the created semantic networks we can also identify the information asymmetry of market environment and the possible cause of externalities of the market process.

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References

[1] Bishop, J. Chapter 15 Drinking from the Fountain of Knowledge: Student Incentive to Study and Learn – Externalities, Information Problems and Peer Pressure. Handbook of the Economics of Education, 2006, Vol. 2, p. 909-944. ISBN: 978-0-444-52819-3.

[2] Druckman, J. N. Evaluating framing effects. Journal of Economic Psychology, 2001, Vol. 22, Iss.1. p. 91-101. ISSN 0167-4870.

[3] Fagley, N. S., Coleman, J. G., Simon A. F. Effects of framing, perspective taking, and perspective (affective focus) on choice. Personality and Individual Differences, 2010, Vol: 48, Iss. 3, p. 264-269. ISSN 0191-8869.

[4] Kozel, R. Moderní marketingový výzkum. Grada, Praha, 2006. ISBN 80-247-0966-X.

[5] Lindsey-Mullikin, J., Petty, R. S. Marketing tactics discouraging price search: Deception and competition. Journal of Business Research, 2011, Vol. 64, Iss. 1, p. 67-73. ISSN 0148-2963.

[6] Rydval, J., Bartoška, J. Quantification of Framing Effect using ANP. Mathematical Methods in Economics 2013, 2013, Jihlava, Professional Publishing, ISBN 978-80-87035-76-4.

[7] Rydval, J., Brožová, H. Quantification of Framing effect in education Process using ANP. Proceedings of Efficiency and Responsibility in Education International Conference 2011, Prague, CULS, 2011. ISBN 978-80-213-2183-0.

[8] Rydval, J., Hornická A. Reduction of framing effect in transport logistic using decision support system. Proceedings of Think Together 2011, Prague, CULS, 2011. ISBN 978-80-213-2169-4.

[9] Rydval, J. Reducing The Framing Effect in Decision Processes. Proceedings of UCOLIS 2010 - University Conference in Life Sciences, 2010, Prague, CULS, ISBN 978-80-213-2141-0.

[10] Rydval, J. Using AHP for analysing product information. Proceedings of Think Together 2012, Prague, CULS, 2012, ISBN 978-80-213-2275-2.

[11] Saaty, T. L. Decision Making with Dependence and Feedback: The Analytic Network Process. 1996, ISBN 0-9620317-9-8.

[12] Saaty, T. L. Decision Making with Dependence and Feedback: The Analytic Network Process, The Analytic Hierarchy Process Series. Pittsburgh: 2001, IX, RWS Publications.

[13] Saaty, T. L. How to make a decision: The analytic hierarchy process. European Journal of Operational Research, 1990, Vol. 48, Iss. 1, p. 9-26. ISSN 0377-2217.

[14] Saaty, T. L. The Analytic Hierarchy Process (AHP) for Decision Making and the Analytic Network Process (ANP) for Decision Making with Dependence and Feedback, Creative Decisions Foundation. 2003.

[15] Sowa, J. F. Knowledge Representation: Logical, Philosophical, and Computational Foundations, Brooks/Cole Publishing Co., Pacific Grove, CA, 2000, ISBN 0534949657.

[16] Steyvers, M., Tenenbaum, J. B. The Large-Scale Structure of Semantic Networks: Statistical Analyses and a Model of Semantic Growth, Cognitive Science, Vol. 29, Iss. 1, p. 41–78, 2005. ISSN:0364-0213.

[17] SuperDecisions Software for Decision-Making, [Online]. Available: http://www.superdecisions.com/ [Accessed: 15 Jun. 2014].

[18] Tversky, A., Kahneman, D. The framing of decisions and the psychology of choice. Science 211 (4481), 1981, p. 453-458. ISSN 0036-8075.

[19] Vysekalová, J. et al. Chování zákazníka: Jak odkrýt tajemství černé skříňky, Grada Publishing, Prague, 2011. ISBN 978-80-247-3528-3.

[20] Xia Z. Y., Bu Z. Community detection based on a semantic network, Knowledge-Based Systems, Vol. 26, 2012, p. 30-39, ISSN:0950-7051.