THE SELECTION OF AN APPROPRIATE DISTRUBUTION CHANNEL

David Hrdý[1], Petr Průša[2]

[1,2] University of Pardubice, Jan Perner Transport Faculty, Department of Transport management, marketing and logistics, Pardubice, Czech Republic

Abstract: Selection of distribution channel type is an important decision of every manufacturing company. Appropriate choice of distribution channel can save a considerable cost while maintaining a high level of customer service. Determination of an appropriate strategy for the management of enterprise distribution channel.

Keywords: distribution logistics, distribution channel, ANP.

1. Introduction

In this article, the selection of the type of distribution channel is proposed using ANP method to determine the strength of influence of input factors on the target set of potential options.
Submitted model is very clear, understandable and according to the proposed methodology easy to implement, while also providing clear and understandable results during selection of the type of distribution channel.
The proposed model is primarily targeting for distribution of high value stone which need to decide which distribution strategy should be chosen or if to switch to another distribution strategy more suitable for the company needs. From the perspective of Multiple Criteria Decision-Analysis (MCDM) there is a wide range of methods used for dealing with choice of not only the type of distribution channel. MCDM history goes back about 40 years ago, with Alias, et al. (2008) reviewed over 70 of these techniques. Aruldoss et al. (2013), for example, compiled the inventory of multi-criterial methods with examples of their application. A plenty of studies uses MDCM to select and evaluate a supplier. Ho, et. al. (2010) and Agarwal, et. al. (2011) prepared a summary of MCDM techniques and their use in choosing a supplier evaluation (Table 1).

Table 1
Review of MCDM techniques in the scientific literature

	Technique	Authors
Individual Approach	Data Envelopment Analysis (DEA)	Liu et al. (2000); Narasimhan et al. (2001); Talluri and Sarkis (2002); Sedel (2006); Saen (2007)
	Mathematical Programming	Wadhwan and Ravindran (2007); Narasimhan et al. (2006); Hong et al. (2005)
	Analytic Hierarchy Process (AHP)	Chan (2003); Liu and Hai (2005); Hou and Su (2007)
	Analytic Network Process (ANP)	Sarkis and Talluri (2002); Bayzit (2006); Gencer and Mohapatra (2006)
	Case-based reasoning (CBR)	Choy and Lee (2002); Choy et al. (2005)
	Fuzzy Methods (FST)	Sarkis and Mohapatra (2006); Florez Lopez (2007)
Combined Approach	AHP - DEA	Ramanathan (2007); Saen (2007); Sevkil et al. (2007)
	AHP - DEA - ANN	Ha and Krishman (2008)
	AHP - MODM	Xia and Wu (2007)
	ANN - CBR	Choy et al. (2003; 2004)
	ANN - MODM	Demirtas and USTUn (2008)
	DEA - MODM	Weber et al. (2000); Talluri et al. (2008)

Source: (Authors)

Singh & Malik, (2014) divided MCDM in their work into two categories: Multi-Attribute Decision Making (MADM) and Multi-Objective Decision Making (MODM). MADM focuses on the selection of the best alternative from the set of pre-defined alternatives where the set is limited by a number of input factors (Rao, 2007). One of the recent studies (Bernroider and Mitlöhner, 2015) seeks to raise awareness about the methodology of Multiple-attribute of Decision Making (MADM) in connection with Enterprise Resource plannig (ERP) projects. MODM on the other hand focuses on the design alternatives on the basis of the input factors (Zhang and Ruan, 2007). The possibilities are usually endless and aim is to choose the possibility that best fits the constraints and priorities set by the decision maker.

[1] Corresponding author: hrdy.david@gmail.com

The basis for the decision making in MCDM is Saaty's approach, which builds on a large number of studies. Sha and Che, (2006) used the AHP method to design a distribution chain network, where the focus was on the selection of a suitable partner, planning, distribution and manufacturing. Kahraman et al. (2003) dealt with a supplier selection using MCDM approach with help of the so-called Fuzzy AHP method.
The MCDM approach has appeared in a number of studies focused on distribution logistics. Mallen (1996) used this approach to select the distribution channel, where was this selection subdivided into several stages. Ho and Emrouznejad (2009) used a combination of AHP methods and logical operators for structural design of a distribution grid. Nilay Serbest and Vayvay (2008) proposed a model for selecting the most appropriate distribution channel using fuzzy AHP method.

2. Problem definition

Only very few manufacturers sell their goods directly to the final consumer. Between the producer and the final consumer there is a number of intermediaries, which make up the distribution chain. Distribution chain then can be understood as "part of the logistics chain that begins when the product leaves the company and ends at the final customer". Zylstra (2012) defined the objective of distribution chain as an overcoming of the time, space and property inconsistencies in the course of the movement of goods and services to customers. The structure of the distribution chain is determined by functions / activities that each organization in the chain carries out. From the discussed company's perspective, which is the position of the manufacturer, its aim is to optimize distribution logistics for the customer. The aim is to design and build a suitable model for selecting the distribution chain, which will help the company reduce losses in the distribution part of the logistics chain. Discussed company currently uses the local branches in the Czech and Slovak Republic. The given model should provide an answer as to whether this is desirable or recommend switching to another type of distribution channel.
Lambert (2000) stated that most of the distribution chains is formed as a network of vertically aligned companies, without any fixed structure. The specific structure largely depends on the nature of the distributed product and nature of the target market of the company. Even for companies producing similar products the "best" structure of the distribution chain cannot be unambiguously determined (Gašparik, 2006). This should be created in relation to the overall business and marketing objectives of the company. The distribution chains thus differ in their length and width. Length is the number of distribution levels between the manufacturer and the customer. The width is given by the number of participants involved in the distribution at given level.
The distribution system must be therefore regularly inspected and modified by the manufacturer. Modification of distribution channels is essential if they are not functioning as planned, or if the shopping behaviour of customers changed, the market expanded, new competition appeared, new ways of distribution are created or product moves to the next stage of its life cycle. No distribution channel remains competitive throughout the product's whole life cycle (Rosová, 2007). The first potential customers may be willing to pay the price for a big customer added-value, but other potential customers will move to a cheaper distribution routes.

3. Logical framework of the proposed model

The proposed model is based on the goal definition of the proposed study because of both maximization and minimization factors, and also include the dependencies between these factors (Kunz, 2010). To create the model all alternatives must be related to all limiting factors. As already mentioned, the creation of a model for the choice of distribution channel must take into account both the company's perspective (minimization of cost factors) and the customer 's perspective (maximization of customer service factors).

3.1. Alternatives

A high importance is apparent when selecting a suitable distribution model for the given company. Distribution costs vary with the use of different types of distribution channels and it is at the discretion of company management to state its goal. For the proposed model four basic types of distribution channels were identified:

- ***Direct distribution*** - Products are stored in a central warehouse, or directly at the manufacturer, without the use of distribution centres in the distribution chain. Orders are processed directly and manufacturer delivers the order directly to the customer,
- ***Cross-dock centre*** - goods are assembled, merged, or tailored to customer requirements only after the production in cross-dock centre with added value. The customer receives the all his orders in one package.
- ***Local branches or warehouses / distribution centres*** - local branches cover the market in order to achieve a strategic position for the customer.
- ***Offtake by the customer*** - storage is provided in warehouses, or directly at the manufacturer (also in local offices), with the difference that the picking up of the goods is directed by the customer.

3.2. Selected factors of customer service

From the customer's perspective it is important to maximize customer service. Costantino and Di Gravià (2014) determined the factors of customer service, affecting the production rate of individual types of distribution channels. Adjusted factors useful for the proposed model are:

- ***Product Availability*** - period determining how available the demanded product is in distribution chain, it is a unit of time, it is goal is to maximize system availability,
- ***Customer satisfaction*** - a factor tracking customer's satisfaction with a type of the distribution chain. It is obtained by querying about customer's experience, it is goal is to achieve maximum customer satisfaction.
- ***Consolidation of orders*** - not all types of distribution chains are suitable for merging orders, the goal is to merge multiple potential orders so that the customer receives only one complete order,
- ***Order tracking*** - an important factor guaranteeing the possibility of accurate tracking of orders throughout the whole order process,
- ***Reliability of supply*** - the percent accuracy of ordered goods delivery,
- ***Speed of delivery*** - or also the distribution chain performance, measuring the speed of delivery of orders,
- ***Reverse logistics*** – the difficulty of reverse logistics for different types of distribution channels.

3.3. Selected cost criteria

Perspective of the company is limited by cost factors (Costantino and Di Gravià, 2014). Revised factors are:

- Information - in the distribution chain everything has to be properly monitored, planned and kept in records, This obviously results in rising of costs for each different distribution channels,
- Storage - every distribution channel retains a certain quantity of goods, which raises the cost of storage, handling, transportation within the warehouse etc. Expenses again depend on a type of distribution channel,
- Operational – covers all expenses related to the management and administration of the given type of distribution channel. More complex distribution channel arrangement results in higher operating costs,
- Boot - the initial costs of implementing new type of distribution channel, or the cost of switching to this channel from another type of distribution channel,
- Transport - traffic volume in the transport chain. Cost factor with big influences on the final results of cost criteria.

4. Proposed model

To achieve the best possible results in the choice of the type of grid a two-phase model was designed. The model uses a modified version of Delphi method and a method of ANP, which provides partial results subsequently used in the TOPSIS method. The process of the proposed model is shown in Figure 1:

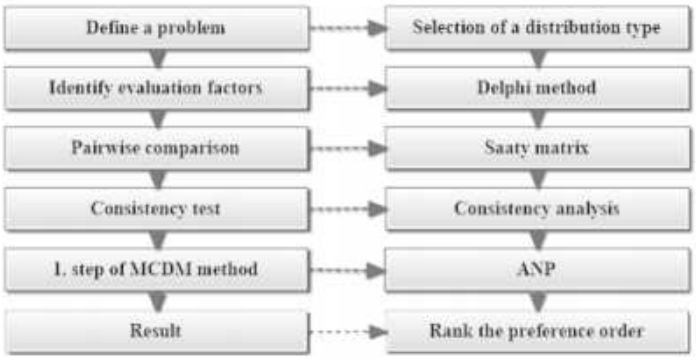

Fig. 1.
Proposed model

I. Delphi method

The first and most important step of the proposed model is a pairwise comparison of input factors and their influence on the resulting type of distribution routes. For this purpose, there is an assembled group of evaluators, consisting of logistics managers, researchers, but also professionals, in order to achieve the most correct evaluation of these factors possible.

For this purpose, the proposed method is Delphi (Linstone and Turoff, 1975) which is suitable for the determination of a professional estimate by a selected group of people. It's a technique that uses subjective opinions of members of the

expert group in order to obtain an overall consensus views. Delphi method can be simply seen as a kind of brainstorming session with clear rules.

II. Saaty method

To obtain the weighting of individual factors a use of Saaty method is recommended (1980). The input to this method is the pairwise comparison of individual factors obtained in Step I. Each expert group is also assigned a weight, which represents the degree of influence on the resulting model.

This method takes into account different preferences between criteria and a wide range scoring scale, which is intended for evaluation (Formula 1). Therefore, it is possible to detect even slight differences in preferences between the selected criteria, using the process of determining weight:

$$(s_{ij}) = \begin{cases} 1 - i \text{ and } j \text{ are equals;} \\ 3 - i \text{ is slightly favour over } j; \\ 5 - i \text{ is strongly favour over } j; \\ 7 - i \text{ is very strongly favour over } j; \\ 9 - i \text{ is absolutely favour over } j; \end{cases} \quad (1)$$

Values of 2, 4, 6, 8 are designed for evaluation of so-called interphase. This method compares each pair of criteria i and j. Their evaluations is entered in the Saaty matrix (Formula 2), according to the following rules:

$$S = \begin{pmatrix} 1 & s_{12} & \cdots & s_{1k} \\ 1/s_{12} & 1 & \cdots & s_{2k} \\ \vdots & \vdots & \ddots & \vdots \\ 1/s_{1k} & 1/s_{2k} & \cdots & 1 \end{pmatrix} \quad (2)$$

This methods is comprised of five steps (Saaty, 1980), which include weight calculation v_i by using standardized geometric mean of Saaty matrix's rows.

III. Consistency analysis

An important factor to whom it is necessary to pay attention during pairwise comparison is consistency (Saaty, 1980). In case that we do not only transfer the exact measurements to elemental scale but use judgment, there is almost always inconsistency. (If we say that a is 3 times greater than b, but only 1/5 times as good as c, c would have to be 15-times better than b to avoid inconsistency.) Given the characteristics of reciprocal matrices and eigenvalues the minor inconsistency does not have any effect during determining the vector priorities.

The degree of consistency below the 0.10 (10%) value is considered acceptable (Chan et al., 2006). For higher values the pairwise comparison matrix should be adjusted, otherwise the results of the entire model quickly lose their predictive value. Experimentally derived RI values reported by Saaty (1980) for a matrix of order 1-15 are shown in Table 2:

Table 2

Experimentally derived RI values

Level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Source: Saaty (1980)

IV. AHP / ANP method (Analytic Hierarchy Proces / Analytic Network Process)

Method of AHP (Saat, 1980, 1994), which is widely discussed in literature (Isiklar and Buyukozkan, 2007; Onut and Soner, 2007; Wu et al., 2009) is a method for priority setting which derives the relative priority based on pairwise comparisons of elements at the same hierarchical level using the absolute numbers at range from 1 to 9. Analytic Hierarchy Process (AHP) is a method that is appropriate for the hierarchical structure of the systems.

Absolute numbers of the scale are approximations of weights ratio w_j/w_k which make it possible to deduce the weights of w_j and w_k. AHP method uses a general model for the weight synthesis in a hierarchical structure where w_{ij} are local weights of $_i$ element on a given level with relation to the j element from previous level of hierarchical structure, w_j are weights of elements of previous levels of hierarchical structure and ui is a global element weight in terms of all elements of the previous hierarchical structure levels. Mathematically AHP method simply enrols via 3 steps, where we proceed from pairwise comparison matrix (Formula 2):

Method of ANP (Analytic Network Process) is a network generalization of AHP method (Analytic Hierarchy Process). Analytic network process (ANP) is a method that allows the system to include all possible interdependencies and feedbacks (Saaty, 2001). Strategic partnership of the chain units can be modelled using network structures. The structure of the ANP model is suitable for expressing dependencies within the network of supply / distribution relationships, where units of supply / distribution chains can be grouped into so-called clusters and linked by streams affecting their dependency. These model clusters can represent suppliers, manufacturers, distributors, customers and

these links between clusters represent possible influences between elements of different clusters and loops at individual clusters represent possible links between elements of the cluster.
For dealing with the network structures using ANP. There is a program available named Super Decisions by CDF company (Creative Decisions Foundation), which will be used in the proposed model.

5. The application of the proposed model

To determine the most accurate values of pairwise comparison there were three groups of evaluators created. The first group was composed practitioners in the form of logistics manager, purchasing manager and sales director. The second group consisted of a group of scientists, dealing with logistics, which drew on currently available studies and their own experience. The third group was the professional community, using different types of distribution channels in the form of transporters, customers and end customers.

I. Determination of input factors and suitable alternatives using a modified Delphi method

A model was designed based on the Delphi method, consisting of input conditions containing costs relevant to the choice of type of the distribution chain and the level of individual services, occurring in the distribution chain. From the perspective of each alternative of distribution channels four suggested types from Chapter II were assessed (Table 3):

Table 3
Input factors and a set of options for the proposed model

Selection of a distribution channel type	**FC - Costs**	FC1 - Information	**A - Alternatives**	A1 - Offtake by the customer
		FC2 - Storage		
		FC3 - Operational		A2 - Direct distribution
		FC4 - Boot		
		FC5 - Transport		A3 - Local branches or warehouses / distribution centers
	FSL – Customer service	FSL1 - Product Availability		
		FSL2 - Customer satisfaction		
		FSL3 - Consolidation of orders		A4 - Cross-dock center
		FSL4 - Order tracking		
		FSL5 - Reliability of supply		
		FSL6 - Speed of delivery		
		FSL7 - Reverse logistics		

Source: (Authors)

II. Assembling the resulting pairwise comparison matrix by using Saaty method

From the three resulting matrices obtained from each groups of evaluators, the resulting matrix was calculated using the Saaty method. Individual groups were assigned a weight according to the degree of their influence on the final model (Table 5). The resulting matrix is displayed is shown in the Table 6 and 7.

III. Determination of the linkages and the resulting weights by ANP

To determine the mutual linkages and calculate the resulting weights a Super Decisions program by CDF was used, which is useful in solving problems with multiple interrelated input factors. Solution by using AHP method would be slow and inefficient. The assembled model in the program is shown in Figure 2.

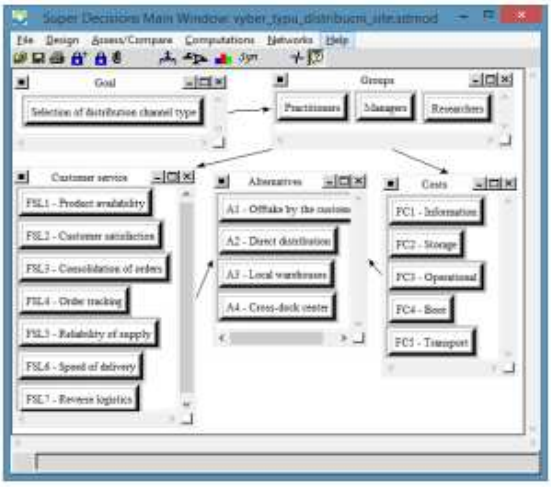

Fig. 2.
Proposed ANP model
Source :(Authors)

Paired comparisons obtained by using method of Delphi in step II. was entered into the program to individual evaluation groups and by exporting a unweighted matrix was obtained for each factor. This matrix is shown in Table 4 and 5.

Table 4
Unweighted ANP matrix of cost criteria

ANP matrix pro FC	*FC1*	*FC2*	*FC3*	*FC4*	*FC5*
A1	0.4587	0.0346	0.3225	0.0473	0.4364
A2	0.1508	0.5475	0.4860	0.6210	0.0857
A3	0.3558	0.1078	0.1094	0.0622	0.2601
A4	0.0348	0.3101	0.0821	0.2694	0.2178

Source :(Authors)

Table 5
Unweighted ANP matrix of customer service

ANP matrix pro FCL	*FSL1*	*FSL2*	*FSL3*	*FSL4*	*FSL5*	*FSL6*	*FSL7*
A1	0.0419	0.4177	0.2654	0.0500	0.1768	0.5426	0.6629
A2	0.5329	0.0776	0.0344	0.1800	0.0845	0.0401	0.0449
A3	0.0608	0.1746	0.1821	0.0858	0.2754	0.3352	0.2270
A4	0.3643	0.3301	0.5180	0.6842	0.4634	0.0821	0.0652

Source :(Authors)
In conclusion, we calculate the proposed model using an ANP method. The results are shown in Table 6.

Table 6
Result of the ANP method

Name	*Ideal*	*Normal*	*Raw*
A1 - Offtake by the customer	0.864610	0.277077	0.092359
A2 - Direct distribution	0.689286	0.220892	0.073631
A3 - Local warehouses	0.566574	0.181567	0.060522
A4 - Cross-dock center	1.000000	0.320465	0.106822

Source :(Authors)

The results are clear. The best option for the proposed issue is set up a distribution channel with one cross-dock centre or warehouse placed on the targeting market. The results have been counted with an APN method and 3 different values has been shown. Column Ideals (ideal variants) shows a variant with the higher weight as an ideal variant and the others are its shares. These results are used for comparing values between each other. Normal (normalized variants) shows weights normalized in the exact way then their sum is equal 1. These values we can see in the AHP method. Raw (gross variants) is a vector acquired directly from limited super matrix. These values are useful for future counting. The table 6 is graphically illustrated in Figure 3.

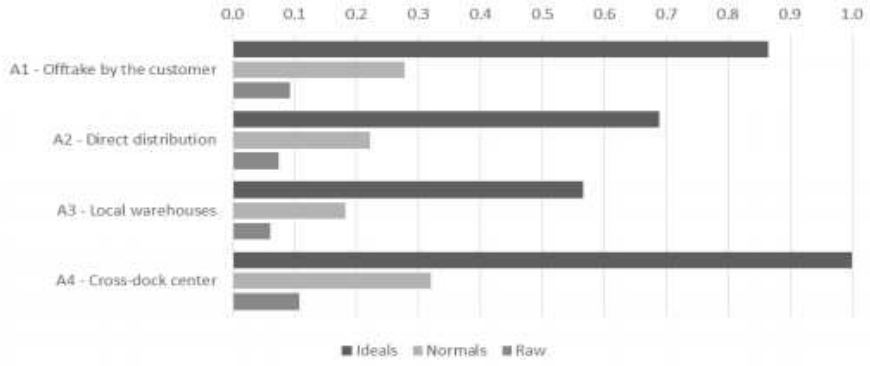

Fig. 3.
Graph of the results of the ANP method

The model results clearly show that the current model in the form of local branches is the least appropriate one. Introducing distribution channel in the form of cross-dock centre for the company is preferable from the viewpoint of the level of customer service and of the significant reduction of costs, which is shown primarily by eliminating losses in the distribution channel. The company cannot afford the complete abolition of local branches due to a local dealership, so the reduction will be implemented in local warehouses, which will result in sufficient cost reductions.

6. Conclusions and final discussion

Appropriate choice of the type of distribution channel can save the enterprise considerable amount of financial resources. This article focused on designing and building a model for selection of a suitable type of distribution channel, mainly for to the expenses reduction of existing distribution channel and simultaneously for assessment of its suitability for the company.

The proposed model provides a clear insight on the discussed issues of selecting the type of distribution channel for the company's management while considering various input factors, with the possibility to modify these factors within the proposed model. The presented model is able to work with both qualitative and quantitative criteria.

Despite the quality and clarity of the proposed model, the greatest threat to the accuracy and relevance of the model is the input formation of pair evaluation. This evaluation may have a profound impact on the outcome of the model and even at small inconsistency level of input evaluation the outcome may be affected. In the presented model, this is prevented by setting up three major evaluation teams of more members which ensures removal of fluctuations or inconsistency of evaluation. For each pair evaluation there is also a consistency analysis which immediately warns you. about any evaluation discrepancy.

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