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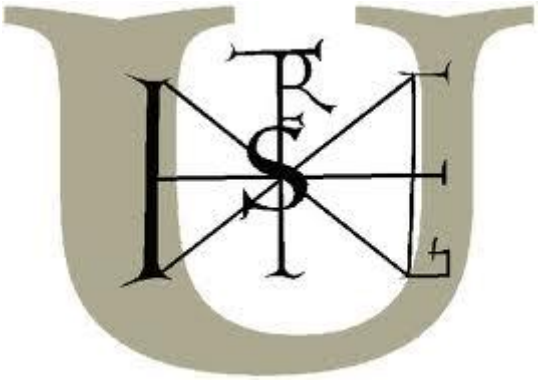

CLASSIFICATION METHOD ON COMPANY GROWTH MODELS FOR ANALYZING LOGISTICS ORGANIZATION

Theses of doctoral (PhD) dissertation

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1. INTRODUCTION

The focus area of my thesis work is the classification method for company growth models. The original aim of my research work was to map the development of logistics organization at Hungarian companies in industrial or commercial sector. During the research of this topic I have reviewed company growth models – Greiner's model (1972) in the first line – and I have faced the lack of a suitable method that could be used to assign companies to the model's (or other similar models') growth phases. Therefore I have changed the focus of my work: as a primary aim I have defined to build up a suitable method of classification for growth models to be able to reach the aim I have earlier set. For constructing such a model I have used fuzzy logic. Using my model I have assigned companies to the phases of the Greiner model, furthermore I have researched the presence, the functions and organizational configuration of their logistics organization.

1.1 Aim and expected results of the research

The first question of my research was the existence of a classification method for company growth models which does not need a years long period of personal observation on companies' daily operation and workflow. Regarding the available resources in this topic I have processed, the lack of such a method was proven. Therefore I have set the aim of my dissertation to set up a method for classification of companies in a growth model. In the frames of my research I test my method on a sample of Hungarian companies so it can be used for other growth models as well.

It was between the aims of my research work to map Hungarian manufacturing and commercial companies with more than 10 employees according to Greiner's model. I intended to define further economical and logistics parameters to each growth phase. Regarding to their statistical analysis I expected to gain information on the demographics of the focus companies too.

Inspecting the role and development stages of logistics organization are also in the focus of this research. I expected to set up a relation between company growth stages and the development phases of logistics organization.

I aimed to define clusters of the observed companies by their parameters measured in the frames of this research. I planned to give a more sophisticated picture of the sample companies and to define further classification logic than company growth models.

1.2 Structure of the dissertation

After classifying companies in growth phases I proposed to describe them by parameters of their logistics to get a deeper understanding on the role and importance of logistics organization in the company. For this I have researched the parameters influencing company logistics and logistics organization. In the frame of this topic I have analyzed the relationship between organizational configuration and organizational efficiency based on contingecy theory (chapter 2.1.1) and have reviewed the factors influencing the form of organization.

In chapter 2.1.2. I have analyzed industrial specialities that can influence company logistics. Chapter 2.1.3. is dealing with challenges and expectations a company has to face as being part of a supply chain. Forms of cooperation in a chain could affect organizational growth and logistics organization. There is another field which can be significant regarding to this topic: forms of outsourcing. Therefore I have included this topic in this part of the dissertation (chapter 2.3.5.).

Based on the topics mentioned above interaction between company logistics and forms of organization can be understood. In the further part of my work I have studied company growth models in depth (chapter 2.2.), which gives a theoretical basis for linking phases of company growth and logistics organizational development. I introduce some of the most important growth models in detail because understanding of their logic is critical to the primary research. Here I described related Hungarian researches and their results in the topic of company growth, I also rely on them by setting up my own concept of research. I suppose that the specialities of the Hungarian economical environment have quite a big effect on the expected result of my research – this idea is also implemented in my thesis.

Generality and subjectivity of company growth models make common approaches of survey evaluation questionable. Furthermore should be respected that growth and development mean a slow and continuous change which can not be described by discrete values – as it would suggested by growth models. For growth models contain many attributes which appear and disappear transitionally, I looked for an approach which can handle transitions and discrete values in a comprehensive system. More researchers (Bouchon-Meunier et al 2001:424, Zadeh, 1965:338-339, Zadeh, 2000:4, Kóczy-Tikk 2000:8, Kruse et.al. 2005:1-3) agree that fuzzy logic is suitable for such purposes. For this I have reviewed corresponding literature on fuzzy systems and approach, also its adaptability for my classification model. In chapter 2.4. I set up a short but comprehensive review of fuzzy logic's relevant elements which can be applied in my classification model.

Roles and functions of logistics organization got a great emphasis within the primary research since one of my aims was to describe the relationship between growth phases and the development of logistics organization (see 1.2.). Therefore summarizing the theoretical background of organizational configuration was inevitable (chapter 2.3.1.). The logistics organization is part of the company organization, so it has to fit into its structure. The evolution of the logistics organization is highly depending on the applied division of work and configuration. This topic is followed by the possible and typical forms of logistics organization that represent the roles and functions of logistics inside the organization (chapter 2.3.4.). For studying the consistency of company and logistics processes I used the results of a study performed on Hungarian manufacturing and commercial enterprises, that reveals the differences between the interpretation of logistics processes in theory and practice (chapters 2.3.2 and 2.3.3.).

After the theoretical summary I present my primary research (chapter 3.), which is a survey performed on a sample of Hungarian companies using a questionnaire. In this part of my dissertation I present the fuzzy method for classification of companies into growth phases. I also present the sample of companies I used for the survey, which is composed of 97 companies. It is followed by the detailed review of results, the hypothesis tests, and finally, the conclusions and recommendations (chapter 4.).

1.3 Hypotheses of the dissertation

I define the aims of the research as follows:

- Defining a method that is suitable for the exact classification of companies into growth models' phases.
- Classification of Hungarian manufacturing and commercial companies into Greiner's growth model using the method above; give a description of companies in each phase, and compare these characteristics with the originals given by Greiner.
- Studying the correspondence between the evolution of logistics organization and company growth based on the Greiner model.
- Define further groups of the sample companies based on the characteristics measured by the questionnaire, using cluster analysis; describe the clusters.

Based on the literature review I concluded that the classification problem of growth models can be solved by a questionnaire that contains descriptive attributes and require numerical answers. The biggest challenge of the classification is the comparison of the complex picture of the company based on the numerous answers and the descriptions given by the author of the growth model. The possible solution is a classification method based on fuzzy logic as I have indicated in the literature review.

H1 – A model can be created which is suitable for determining companies' actual phase of growth in Greiner's or other company growth model. This model should be based on a detailed questionnaire evaluated by fuzzy logic.

I suppose that by using such a model Hungarian companies can be assigned to Greiner's growth phases. Based on the classification a more detailed description can be given on the group of Hungarian manufacturing and commercial companies, than the general description in Greiner's original model. I would like to give special emphasis to logistics attributes and logistics organization.

H2 – After the classification of sample companies further characteristics can be defined to each growth phase of the Greiner model, which makes possible to give a more detailed description of the phases.

The evolutionary phases of logistics organization described by several models (see chapter 2.3.4.) follow a similar logic with company growth models (see chapter 2.2.). Company growth models, being general, do not include the description of the evolution of company functions, therefore these models do not make possible to study the relationship between the evolution of functions and the company as a whole. Linking the two conceptions can create the possibility of further researches or even the expansion of the original models.

H3 - Based on the primary research a parallelism between Greiner's growth phases and the growth phases of logistics organization by Bowesox et al. can be created.

Company growth models have only a limited ability to describe actors of a market. They give a general description of growth and their structure is not suitable (and it applies also to Greiner's model's) to be tailored on one particular market environment. For this, idiosyncrasies of the Hungarian market environment are not described by this model.

H4 – Companies surveyed in this research and classified according to Greiner's growth phases can be classified also by further attributes. These attributes give the possibility to observe idiosyncrasies of Hungarian companies and their deviations from the general model.

2. MATERIAL AND METHOD

My research is a one-time, cross-sectional and describing research. It is one-time and cross-sectional because only one sample was observed and this provides information for further analysis. It is a describing one because the major aim was to reveal cause and effect relationship between attributes of groups of companies and to describe behaviour of these groups.

2.1 Company sample

The observed companies were chosen by field of activity, where logistics is a relevant but not core activity and therefore the presence of the logistics organization is possible. Regarding to company size the minimum number on FTEs was 10. The observed companies are active in production and/or commerce. The basic unit of observation was one company.

Answers on the questionnaire were given by C-level managers in frames of a personal interview. Interviewers were trained university students doing their major in logistics. Questionnaires were prepared between February and May 2009, the number of interviews made was 120. Only 97 of them were analysed because others did not answer all of the questions of critical importance for classification.

While processing corresponding literature the lack of a classification method for company growth models became clear. This problem was considered as a basic barrier so made the creation of such a method important. The new method was created and it was tested on the sample. For it was the first time when Hungarian companies were classified in Greiner's model based on a questionnaire I did not have the possibility to define a representative sample. I only assumed to find companies which – based on their size and age – cover all phases of the model. I tried to keep a balance between commercial and manufacturing companies so special industrial properties do not distort the results. For the considerations above small companies are underrepresented, while large and medium-sized companies are overrepresented compared to the composition of Hungarian market.

2.2 The questionnaire

The aim of the questionnaire was to assign the sample companies to the phases of the growth model as precisely as possible, then examine the management and logistics characteristics in each phase. The first aim had particular importance in my research, therefore I present the method of creating the respective group of questions (question no. 9) in details. Since the observation of further characteristics of the growth phases and the evolution of logistics organization was also my aim, I was intent to gain a complex picture of the sample companies. For this I created three groups of questions: one for general attributes and

management (questions no. 1-8 and 10), one for company environment (questions no. 11-18) and one for company logistics (questions no.19-30).

After the composition of the questionnaire I tested it by doing personal interviews with three companies. This helped to find and correct imprecise or misunderstandable phrasings. I also checked the questions for their ability for processing and analysing by statistical programs.

2.3 Statistical methods

I processed and analysed the data of the survey with MS Excel and MINITAB softwares. The analyses I have done belong to three categories. The first is the classification of sample companies using my own classification method based on fuzzy logic. The method has four steps, which I present in details in section 2.4.

The second method aimed the grouping of sample companies based on state of growth and logistics characteristics. I achieved this by cluster analysis.

The third group of methods involved descriptive statistics, correlation and regression analyses. I used them for giving basic statistics on the sample and analysing the growth and logistics characteristics of the classified companies. Since these methods are generally used, I did not present their theoretical background in my dissertation.

2.4 Fuzzy classification method for company growth models

As I have appointed in the literature review, hardly any of the authors of growth models presented a method for assigning companies to the growth stages they had defined. The methods given by some authors are assigning companies to phases "by sight" or by considering only a few attributes. This defect of the models is mentioned by several critics of these models (Shirokova 2009, Hoy 2006, Lichtenstein-Levie 2009, Hanks et al. 1993, Dodge et al. 1994). Another defect is that most of the authors consider companies belonging to only one phase at one time, although several authors (e.g. Greiner 1972, Churchill-Lewis 1983, Hurst 1995, Baron-Shane 2005, Salamonné 2006, Lichtenstein-Levie 2009) point out that overlapping is possible. This means that companies can show characteristics of more than one phase at one time, and the transition between the phases is rather a slow process than a fast, revolutionary change.

For handling these defects I consider fuzzy methodology the most applicable. I tested the applicability of the model on the questionnaire based on Greiner's model. The advantage of the model is that besides it handles overlapping, it is still applicable to give a crisp result for the position of the company in the model by using a defuzzification process. The steps of the method are the following:

Step 1: Filling in the questionnaire
The representative of the company fills in the questionnaire. In question 9 he/she marks, how relevant are the statements of the questionnaire to their companies. The statements represent the phases of the Greiner model.

Step 2: The fuzzy membership function

After filling in the questionnaire the answers will be processed. According to fuzzy logic each attribute influences the grade of membership in every growth phase. If the attribute fits the actual phase, a positive answer raises the company's membership in that phase, while if the attribute does not characteristic in the actual phase, it decreases the company's membership grade. The different attributes influence membership grade in different ways:

a) starting attributes: they apply to companies in the early phases
b) maturity attributes: they apply to companies of late phases
c) phase attributes: they apply to (or around) one specific phase
d) crisis attributes: they apply to crisis phases

Based on the original model we defined for each attribute in which phase it appears, in which phase it becomes typical and in which phase it disappears. We described the relation between answers on different questions and membership degrees by a matrix of correspondence. The fields of the matrix contain the relationship of a possible value of an answer1 and the actual phase of the model. So if an answer is highly positive in a case when the attribute should be typical according to Greiner, the membership degree in the actual phase will be leveraged. Membership degrees formed this way will be defined to each phase, which result in a discrete fuzzy set (B).

Answers were registered on a 1-4 scale where 1 means not characteristic and 4 means typical for the company. Values of the 1-4 scale were lowered by 1 during the evaluation to simplify calculation by using zero as a minimum value (V = [0;3] instead of V = [1;4]). This step makes later visualization simpler too. Table 1 represents the correspondence matrix of the case V = 3 ("typical for my company"), where cells indicate the value of parameter K which influences membership degrees in different phases of the Greiner-model.

Table 1: An example on correspondence matrix (V = 3)

Question	1P	1C	2P	2C	3P	3C	4P	4C	5P	5C
1	1	0,75	0,5	0,25	0	0	0	0	0	0
2	0	0,25	0,5	0,75	1	1	1	1	1	1
3	1	0,75	0,5	0,25	0	0	0	0	0	0
4	0	1	1	0,5	0,25	0	0	0	0	0
5	0,33	1	0,66	0,33	0	0	0	0	0	0
6	0	1	0,5	0	0	0	0	0	0	0
..	..	..	..	..	..	..	..	..	..	..
n	..	..	..	..	..	..	..	..	..	..
WV,P	**4,06**	**10,75**	**13,91**	**19,06**	**20,71**	**25,24**	**23,24**	**20,3**	**24,25**	**20,3**

Source: own research

where:

V: possible answer values [0,3]
Q: question ID number [1,34]
P: phase ID (P: phase, C: crisis) {1P, 1C, 2P, 2C, 3P, 3C, 4P, 4C, 5P, 5C}
$K_{V,Q,P}$: correspondence between Q and P regarding to answer (V)
$W_{V,P}$: possible maximum value in a phase (fully represented): sum of K values in a column:

[1] For answers on questions like „Is it typical in your company … ?" there is a scale of possible answers from 1 to 4. After our first trials with our questionnaire we had the experience that by using a normal Likert scale top managers are likely to choose the middle to give an answer "I don't want to tell it."

$$W_{V,P} = \sum_{Q=1}^{34} K_Q \qquad (1)$$

Three further matrices contain the membership values for V = 2, 1 and 0 regarding all phases (P) and questions (Q).

For eliminating possible differences in level of representation of phases we standardized the matrix (Table 2), so that cell values were dividends of original cell value (K) and the possible maximum in the actual phase ($W_{V,P}$).

Table 2: An example on standardized correspondence matrix (V=3)

Question	1P	1C	2P	2C	3P	3C	4P	4C	5P	5C
1	1/4,06	0,75/10,75	0,5/13,91	0,25/19,06	0/20,71	0/25,24	0/23,24	0/20,3	0/24,25	0/20,3
2	0/4,06	0,25/10,75	0,5/13,91	0,75/19,06	1/20,71	1/25,24	1/23,24	1/20,3	1/24,25	1/20,3
3	1/4,06	0,75/10,75	0,5/13,91	0,25/19,06	0/20,71	0/25,24	0/23,24	0/20,3	0/24,25	0/20,3
4	0/4,06	1/10,75	1/13,91	0,5/19,06	0,25/20,71	0/25,24	0/23,24	0/20,3	0/24,25	0/20,3
5	0,33/4,06	1/10,75	0,66/13,91	0,33/19,06	0/20,71	0/25,24	0/23,24	0/20,3	0/24,25	0/20,3
6	0/4,06	1/10,75	0,5/13,91	0/19,06	0/20,71	0/25,24	0/23,24	0/20,3	0/24,25	0/20,3
..	..	..	..	..	..	..	..	..	..	..
N	..	..	..	..	..	..	..	..	..	..
Σ $SK_{V,Q,P}$	1	1	1	1	1	1	1	1	1	1

Source: own research

Where cell values are:

$$SK_{V,Q,P} = \frac{K_{V,Q,P}}{W_{V,P}} \qquad (2)$$

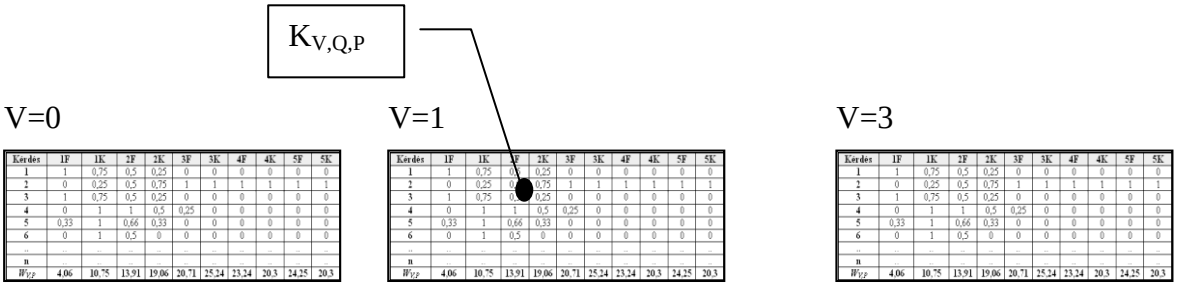
Step 3: Summarizing the membership values, calculation of fuzzy membership for each phase

According to given answers company's values can be composed from the four matrices ($FK_{Q,P}$). By summarizing these values a company-specific correspondence matrix can be built.

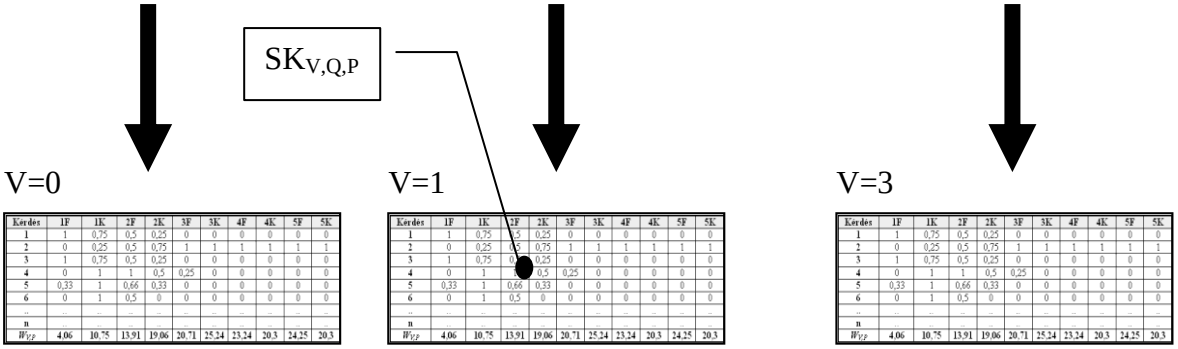
$FK_{Q,P}$: correspondence values filtered form the four standardized matrices according to company's given answers

Company-specific correspondence matrices can be composed through the following four steps:

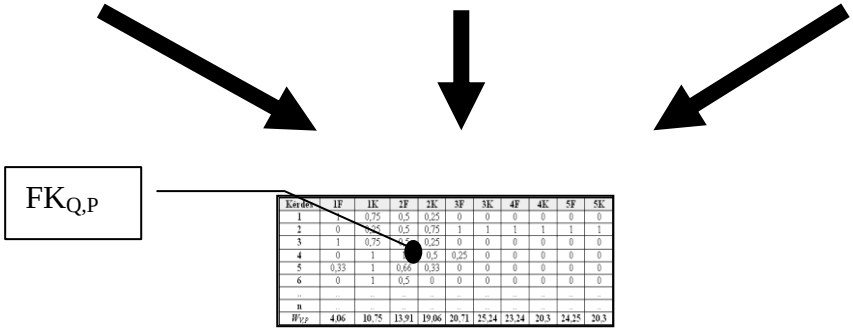
1.) Determination of correspondence values



2.) Standardization of correspondence values



3.) Filtering company-specific standardized values according to given answers



4.) Summarizing columns of company-specific correspondence matrix which step adds up discrete values of membership degree regarding to each phase:

$$\mu_P = \sum_{Q=1}^{34} FK_Q \tag{3}$$

The set of membership values gives the membership function of the company regarding to the phases of the Greiner model:

$$MF = \{\mu_{1Ph}, \mu_{CrK}, \mu_{2Ph}, \mu_{2Cr}, ..., \mu_{5Cr}\} \tag{4}$$

Pairing phases with membership values results the company's fuzzy set of membership values regarding to model's phases:

$$D_C = \{1Ph / \mu_{1Ph}, 1Cr / \mu_{1Cr}, 2Ph / \mu_{2Ph}, 2Cr / \mu_{2Cr}, ..., 5Cr / \mu_{5Cr}\} \quad (5)$$

where *D* is a discrete fuzzy set and index *c* indicates company ID.

Step 4: Defuzzification – choosing the phase which describes the company best

Defuzzification of the membership degree would be necessary for either research or practical (management, consultancy) purposes. We assessed the defuzzification methods mentioned in the literature upon their applicability in the case of growth models. There were two main problems regarding the nature of growth phases which had to be handled by the defuzzification method. According to the logic of company growth models it happens often that a company has the highest degree of membership of the first or last phase, so it has a maximum at a terminal value on axis x. Another problem is that we can not expect that all membership functions will be convex, so the defuzzification method has to handle nonconvex functions as well.

Centroid methods
COG and **COA** methods do not handle terminal values on axis x sufficiently. This is critical regarding to companies in phases 1P or 5C, so these methods are not applicable for this model.

WAM
We would have similar problems by using WAM like in the previous case (centroid methods).

FOM and LOM
These methods are suitable in the most cases where we have only one maximum and the set is convex. The only case when we can face problems is when neighbouring phases have the same (maximum) membership degree. In such a case these methods do not offer a solution.

MMP and MOM
Both methods use highest degree of membership to determinate defuzzificated result. As mentioned above managing cases where neighbouring phases have the same value (maximum) is essential – MMP method does not meet this criteria. As already mentioned handling the case of neighbouring maxima would be essential therefore MMP method is not suitable to use in this model. Using MOM we can face problems only in case of such a nonconvex set where only one phase separates two local maxima of the same membership degree (if there are more than one between them the set is abnormal). In this case we suggest to use a combination of MOM and COG (see below).

Defuzzification with MOM method is described by the equation (Kóczy - Tikk, 2000 p71):

$$y_{MOM} = \frac{\sum_{y \in MAX(B^*)} y}{|MAX(B^*)|} \quad (6)$$

where

y: defuzzificated value

B* discrete fuzzy set

In my model elements of the fuzzy set are identified by phase ID-s of Greiner's model instead of numbers, so the defuzzificated value will be the ID of the phase where membership degree is the highest. If at least two neighbouring phases have the same local maxima, the defuzzificated value will be the middle – according to MOM defuzzification rule. If the number of neighbouring phases with the same highest value is even there is no *y* value to choose (the set is discrete). In this case a deeper inspection of other answers should bring a more detailed result. But the section of the growth curve where the company can be found according to its answers can be determined. There is a theoretical possibility of having more than two phases with the same local maxima but it does not have much sense from practical point of view. If two (or more) phases have the highest value at the same time and there are more than one phases inbetween the company can be declared as abnormal according to the model. In this case a new interview should be done and answer consistency should be inspected.

If there are two phases representing the same, highest degree of membership and they are separated by a third phase having a lower degree a deterministic strategy should be followed according to the recommendation of Kóczy and Tikk (2001): a combined defuzzification method using COG and MOM can bring a reliable solution. After determining the centre of gravity (COG) of the set, distances of COG and the phases with the highest value should be calculated. The one which is nearer to COG will mean the crisp result. Using this process the one will be chosen where neighbouring phases have a relatively high degree of membership, therefore it can be more characteristic for the company.

3. RESULTS

3.1 Testing the classification method

I tested the success of classification using the questions of the questionnaire that I had not used for classification. According to the Greiner model the size of the companies show a growing trend along the phases of the model. The different types of organizational configuration show up as it is indicated by Greiner. The relationship between the owner and the professional manager in the sample mainly fits to the Greiner model and also to the Churchill-Lewis (1983) model, which is an adaptation of the Greiner model to SMEs. According to this, the owner as executive does not appear in the second half of the model. Existence of written planning, strategy-making and controlling in the sample companies corresponds with the model: in the initial phases it is not characteristic but in the late phases (from 3P) it is fully present.

3.2. Demographics of the Hungarian manufacturing and commercial companies by the Greiner model

After the classification I had the possibility to determine the characteristics of the sample companies assigned to each growth phase. Although some phases did not involve enough

companies to draw a statistically relevant conclusion, to nearly half of the phases this problem did not apply.

Most of the companies in phases 1P and 1C (<95%) did not reach the revenue of 3 mrd HUF and the employee number of 50. This rate decreases under 65% in phases 2P and 2C, which means that medium-sized companies are present in these phases in a considerable rate. Difference in number of employees is even greater between phases 1C-2P-2C. From phase 4P large companies are dominant.

The average age of companies in the separate phases is not a reliable measure in the Hungarian market due to the affiliate companies of multinationals – for which the age counts from the foundation of the Hungarian affiliate that distorts the results.

Regarding organizational configuration, for phase 1P the simple structure is typical. This configuration stays present even in phases 2P and 2C. From phase 1C functional organization is dominant. Divisional structure is present in a relatively high rate in phases 1C-2C, although it should appear only in the late phases according to the model. This can be explained by the presence of the affiliates of multinational companies that "import" the organizational structure of the parent company. In the case of some companies the reason for divisional structure is the diversity of scope of activity.

Nearly all of the growth models agree that the owner-director of the company substituted by a professional manager in a relatively early phase. This does not apply for sample companies (see Table 15 of the dissertation), for which the turning point is at phase 3C.

Methods of strategic planning are increasingly present along the phases of growth. In phases 1P and 1C less than half of the companies use these methods, which corresponds to the results of Salamonné (2008). From phase 3P all companies of the sample applied the methods of written strategy, vision and business planning.

Besides testing the classification method another question was whether the sample of Hungarian companies shows any deviation from the original model. This deviation was the remarkable difference between the original dimensions of growth defined by Greiner (age, revenue, number of employees) and the Hungarian companies. I calculated regression between these dimensions and the growth phases. The regression analysis resulted that number of employees and revenue determine the phase of growth in a relatively high degree (69.5%), while the effect of age is marginal (only 2.56%). I explained this phenomenon with the distorting effect of two groups of companies: young but developed affiliates of multinationals and old companies that had shrunk after the change of the political system. This phenomenon (the little correlation between age and growth stage) gives a reason to overview all growth models that use age as a determining factor for classification before applying them on the Hungarian market.

Over the attributes used by Greiner I analysed and determined the practice of measuring and planning of logistics activities. I also determined the presence and type (simple or integrated) of logistics organization in each phase. I gave the average size of logistics organization for the separate phases.

The use of ERP systems and its logistics module is a factor that has a marginal role in the original model. The reason for this is that Greiner published his model in 1972, when the

early versions of ERP systems were only applied by the most developed companies. Greiner mentions this question in his article in 1998 but does not define the differences between the original and the new situation (Greiner, 1998:65). It should be taken to consideration that the use of ERP systems depends on the economical and technical environment of the company, therefore a general model is not automatically applicable to the Hungarian situation

3.3. Relationship between logistics organization and company lifecycle

Based on the survey data I appointed the parallelism between the logistics organizations of the classified companies and the model of evolution of logistics organization published by Bowersox et al.

There were no companies in phases 1P and 1C where the name of the unit carrying out logistics activities contained the word "logistics". The typical organizational units doing logistics activities were "purchasing", "production", "warehouse", "sales" or "transportation" depending on the core activity of the company. The existence of an independent logistics organization did not occur in these phases.

Logistics organization appears first in phases 2P-2C. This unit involves at least the activities of physical distribution, and the word "logistics" appears in its name. However, logistics is not considered at strategic level, and activities such as purchasing, inventory management or packaging belong to the production unit.

For phases 3P and 3C I do not have statistically relevant results due to the small number of companies, but both of the two companies of these phases have logistics unit. The number of companies in the rest of the phases is still small to draw significant conclusions, but I have found that 15 out of the 16 companies have organizational unit dedicated to logistics, and in phases 5P-5C all companies have process organization (stage 4 in the Bowersox model).

For logistics activities I found that the first activities carried out by the logistics unit belong to physical distribution, while planning and control of logistics processes stay in the hands of top management or controlling even in higher levels of growth. Only 2 companies of the phases 5P and 5C delegated these tasks to the logistics organization.

3.4. Cluster analysis

I prepared the cluster analysis using the following three groups of variables:

- growth attributes
- logistics attributes
- attributes connected to the role of the company in the supply chain e

The analysis resulted in five clusters:

Cluster 1: Underdeveloped small companies
These companies belong to one of phases 1P-1C-2P. The characteristics they show are in correspondence with the attributes defined by Greiner for these phases, that gives a positive feedback to the classification. The organizational configuration is typically simple or functional, the roles of owner and manager have not been separated yet. Measuring and

planning is not common (only in short term in some cases), but the intention for development is clearly shown by the number of current projects.

Cluster 5: Stagnating finished goods manufacturers
This cluster involves finished goods manufacturers that based on their age (an average of 28 years) should belong to phases of high development but they are in one of phases 1P-2P. based on the number of employees they are small or medium, but based on revenue they are obviously in the small category. Their organization is mostly simple but functional organization also appears. Separation of owner and manager functions is uncharacteristic. Their logistics organization is very simple.

Cluster 4: Moderately developed commercial companies
Cluster 4 involves mainly commercial companies that belong to the growing and mature age category. They have a medium revenue, the number of employees fall into the small and medium category. They are between growth phases 1C and 2C, they reach the highest membership degree in phase 2P. The most typical organizational configuration is the functional organization. The separation of owner and manager roles is moderately present. In most cases logistics function does not have in independent organizational unit.

Cluster 2: Large suppliers
All companies in this cluster are suppliers of raw materials or components. Their age is mostly 5-10 years. Their revenue falls in the small or medium category but based on their number of employees they belong to the large companies. This is in accordance with their growth stage, which is 3C-4P. Most of them have functional or divisional organization but matrix organization also appears. The owner and manager roles are separated, due to their growth stage and foreign owner. Formalized planning is at high level, logistics organization is developed and separated into an independent unit. Logistics investments are remarkable.

Cluster 3: Large, developed companies
The majority of the companies in this cluster is manufacturer, they produce mainly finished goods. Big retail chains also belong to this cluster. Their age is between 5 and 10 years but as they are affiliates of large multinationals, their age in Hungarian market has a distorting effect on age statistics. They are clearly large companies based on both their revenue and number of employees. They are also developed according to their lifecycle: most of them belong to phases 5P-5C. The most typical is the functional organization but divisional and matrix structures are also present. These companies are lead by a professional manager. Formalized planning is at high level in all companies. Logistics organization is present in all cases, most of them are integrated.

4. NEW SCIENTIFIC RESULTS AND VERIFICATION OF HYPOTHESES

4.1 Model for solving the classification problem of company growth models

During my research I faced with the problem of the lack of classification method for the most widely used company growth models. As a solution for this problem I created a method that is based on fuzzy logic, that makes possible to assign companies to the phases of a growth

model. The method handles or eliminates the following problems defined in the literature review:

- classification by a standard questionnaire
- classification based on mathematical methodology
- overlapping, unclear borderlines between phases and gradual transition between the phases.

The analysis of the questions relevant for the growth model but not used for classification shows that **sample companies classified to the separate phases have the characteristics described in the original model**. This indicates that the classification was successful, the fuzzy classification method is applicable for the Greiner model. Therefore **hypothesis H1 is verified**.

Since the classification method is not bound to a specific model (e.g. the Greiner model), it is applicable to other growth models by changing the attributes representing the phases of the model. **Application of my method makes possible the examination of conjectures and hypotheses on other growth models**.

By analysing the sample classified with my method we can have a clearer picture of the Hungarian manufacturing and commercial companies. The size of the sample does not make possible to draw statistically significant conclusions but it can give a starting point for further researches.

4.2. Demographics of Hungarian manufacturing and commercial companies based on the Greiner model

After the classification of companies I had the opportunity to specify the characteristics of the phases defined by Greiner. My scope included revenue, number of employees, age, organizational structure, the manager-owner relationship, strategy-making, ERP systems and logistics.

Although these characteristics show similarity with the attributes defined by Greiner, there are also differences. The most remarkable difference is the low correspondence between age and growth stage. I defined a regression function on number of employees, revenue and growth stage, that determines their correspondence more exactly than a description. In summary, I managed to give more specific descriptions of the phases regarding to the Hungarian market, and expand the dimensions of characteristics on logistics organization (existence, size, type), and ERP systems (use, logistics module). Therefore **hypothesis H2 is verified**.

4.3. Relationship between logistics organization and company lifecycle

One of the most important results of my dissertation is that I determined the stage of development and the typical organizational structure of company logistics along the Greiner model. As a basis for possible structures of logistics organization I took the configurations given by Bowersox et al. (2002). In the course of the survey I found a parallelism between the growth phases of the Greiner model and the stages of development of logistics organization defined by Bowersox. The survey data validated the correspondence between the two models. This parallelism can be used in further scientific or practical analysis of company logistics: if

a company is classified in the Greiner model, a typical structure of logistics organization can be defined for it. Therefore **hypothesis H3 is verified**.

4.4. Cluster analysis

I used cluster analysis for finding other aspects for grouping the sample companies besides classification into growth phases. The characteristics of the clusters help in drawing conclusions on the way of evolution of similar Hungarian companies, and they also contribute to the better understanding of the demographics of Hungarian enterprises.

The analysis resulted in five clusters:

Cluster 1: Underdeveloped small companies
Cluster 5: Stagnating finished goods manufacturers
Cluster 4: Moderately developed commercial companies
Cluster 2: Large suppliers
Cluster 3: Large, developed companies

In case of four out of the five clusters a parallelism can be found between the characteristics of the clusters and the growth phases the cluster members belong to. This confirmed the correctness of the classification. The only exception was the cluster of "Stagnating finished goods manufacturers".

The cluster analysis also confirmed the correspondence between growth dimensions (age, number of employees, revenue) and the actual stage of growth I revealed in the regression analysis. According to this, the correspondence between age and growth phase is insignificant in the Hungarian market. **Based on the results of the cluster analysis hypothesis H3 is verified**.

4.5. Limitations of the research and further research opportunities

I consider the creation of the fuzzy classification method the most important result of this research. In my dissertation I not only present the method but also the way the calculations are built up on Greiner's model. Based on the same logic a classification method can be built for any similar growth or lifecycle model, supposing that the description of the model provides enough information for the composition of a questionnaire and testing the results. The models I have processed in the literature review fulfill this criterion. This makes the application of growth models possible is researches of similar scope by providing statistically processable data on each growth phase. Numerical data makes the comparison of different samples or data of the same sample in different time periods.

The method above gives the opportunity to get an overview on the position of a company in its lifecycle. This option can be used in researches focusing on one company. If more questionnaires, based on different growth models are applied on the same company, the models themselves can be statistically compared. This can be a basis for a new, synthetized model or can help to reveal the defects of the existing models and the barriers of their applicability.

The sample used for my survey shows distortion compared to the population in its parameters (age and size) in favour of larger companies. Although these companies were overrepresented

in the sample, the members of the late growth phases did not reach the number that would have made statistical results significant. The regression function I have defined can be used in further researches for determining the number of elements necessary to valid statistical results.

Researches made in other countries can provide answers for further questions and opportunity to compare results in countries that had accessed the EU earlier, later or at the same time as Hungary.

Cluster 5 (Stagnating finished goods manufacturers) identified in the cluster analysis as a deviant group gives further research opportunities (reason of stagnation, their role in the economy). Other question is whether further groups of companies can be identified using a larger sample of Hungarian companies.

Fitting affiliates of multinational companies into a growth or lifecycle model designed for organic growth was a problem I faced during my research. Further research on these large, important but young companies can be a basis for the renewal or expansion of the original models.

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