



**SZENT ISTVÁN
UNIVERSITY**

**ANALYSIS OF THE QUALITY ASPECTS
SYSTEM OF THE CAR INDUSTRY SUPPLIER
ASSESSMENT AND SELECTION CRITERIA**

THESES OF DOCTORAL (PhD) DISSERTATION

By

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1. INTRODUCTION

*„I was taught that the way to progress
neither fast nor easy. “
Marie Curie*

1. 1. Actuality of the topic

In the middle of the 20th century, the perception of quality was to make the product suitable for use, to meet the technical parameters. Later, the need for quality enhancement appeared, that is, they expected the customer's expectations to be over the lifetime of the product. Recently, the concept of quality has come to the forefront to satisfy customer needs first (BUSICS, 2005).

The question often arises as to why the car industry is chosen as a supplier rather than another industry. The answer is very simple. This is the only industry where there are spectacular developments, improvements, and failures. Because it is highly developed and is constantly evolving - thanks to stable large companies - there are still unexplored areas. It is so diverse that it can show something new at any moment. Car manufacturing is one of the most innovative industries in the world. The relatively young industry has carried out a number of revolutions, which also had a significant impact on other industries, meaning that the changes in the automotive industry were a kind of forecast for the development of other industries (HUDSON, 1994).

From a number of research areas, I highlighted supplier management, the process of supplier selection and evaluation through the perspective of automotive companies.

The timeliness of my chosen research topic is also represented by the fact that during my research I did not find any Hungarian literature that would take into account the advantages and disadvantages of the selection and evaluation methods of the automotive supply, comparing it with other methods, procedures known in the international literature and putting it in order. factors, criteria.

1. 2. Goals of the dissertation and hypotheses

Since the beginning of my studies, I have been dealing with a number of questions about quality management, but my choice has been in the field of automotive supplier selection and evaluation. There are many national and international studies in the literature, but based on my preliminary research I have found that there are no answers for my questions, or only a small number of Hungarian literature are published. My knowledge and experience in this subject - after my university studies - was based on the jobs I selected and the job I occupied there

as a quality assurance engineer. As an engineer, I got an insight into the supplier evaluation system used by the company, where I got information about their strong and weak points, and what is needed to be developed. In the light of these facts, the primary goal of my research work was to investigate the situation of companies operating in the automotive industry in Hungary, with particular regard to supplier selection and evaluation. The main purpose of the empirical research is as follows: **Establishing a process model of becoming a supplier in the automotive industry.** Referring to the complexity of the model, I divided it into the following four topics.

1. Goal (G₁): Examining the criteria and factors involved in the automotive supplier selection and evaluation process.

1. Question (Q₁): What customer requirements can be set for suppliers in the automotive industry?

2. Goal (G₂): Investigating the potential of automotive suppliers for development.

2. Question (Q₂): What supplier negatives are exposed, which may influence the development of customer-supplier relationships?

3. Goal (G₃): Examination of selection and evaluation methods known in the literature.

3. Question (Q₃): What methods and procedures are known for selecting and valuing automotive suppliers?

4. Goal (G₄): Examining the current process of supplier selection and evaluation.

4. Question (Q₄): Which participant play an important role in selecting and evaluating suppliers?

6 hypotheses were set up to answer the questions and achieve the goals:

1. Hypothesis (H₁): The ranking of the three most important selection and evaluation criteria (quality, delivery time, and price) varies by company size.

2. Hypothesis (H₂): Considering the importance of the criteria and requirements, there is no difference between the supplier in the existing supplier base and the new potential supplier company.

3. Hypothesis (H₃): Potentials that need to be repaired show differences in company size.

4. Hypothesis (H_4): Among the potential for improvement, time delivery (JIT) as a theoretical approach to basic automotive requirements is reflected in practice, ie the majority of companies follow the JIT strategy.

5. Hypothesis (H_5): In Hungary, automotive companies are applying in practice the selection and evaluation methods that are easy to apply, interpret, and not the other professional benefits.

6. Hypothesis (H_6): The literature classifies supplier selection as a process of procurement tasks, but in reality this task is carried out jointly by the purchasing department together with supplier quality assurance.

2. Material and method

*“For the person who worked out and created the goal
And to the way, the road is the point.
Everything you reach on the way will be his.”
(Sándor Lengyel)*

2. 1. Research methodology

Before starting my research, I have already studied several national and international literature on the sources of information gathering, and which ones should be used to draw appropriate conclusions from the results. During the examination of the chosen topic **secondary** (overview and summary of the results of Hungarian and international publications and studies, studies of research institutes, information obtained from theses, collection, systematization and processing of statistical data) and **primary** (background materials of participation in international and domestic conferences, in-depth interviews, questionnaire survey) resources were used. During the evaluation criteria, systems and the process of supplier selection, a number of tools were also provided that helped me gather information (question list, interview, customer portals, domestic and international literature backgrounds, etc.).

According to LEHOTA (2001), however, the most important point of research is secondary research, in which valuable information can be obtained after systematizing the data. As a **secondary source**, I worked on past evaluations, studies, and the results of these documents, where I had to take into account the dates of the various national and international studies, as I wanted to rely on the most recent data when processing the background literature. Nonetheless, there were some older basic information that I couldn't ignore. Thus, it was also important to check these data.

Qualitative research

Based on BABBIE's (2003) suggestion, it is advisable to conduct qualitative deep interview research, the main purpose of which is to easily identify difficulties and problems, and to explain possible questions and answers that are difficult to understand. That is why I have also tried with deep interviews to map out the cornerstones of my topic, ie to examine the selection and evaluation criteria, methods through selection and evaluation process.

During the selection of the discussion partners, **I decided on the basis of company size which companies should be included in the qualitative research.** So I interviewed five small and large companies accordingly. The conversations took about 1-1.5 hours, and since I visited the interviewees, the

place was given and known to the respondents, so they weren't frustrated in their honest response. The interviews started with an informal conversation, but I determined the chord of the conversation and sometimes left it to my interviewees to unfold. During the interviews I always tried to avoid personal areas, because this was not the purpose of the interview. Based on the summary of the results of the in-depth interviews, the corner points on the basis of which I compiled the questionnaire of my quantitative research, ie the material of the questionnaire survey, were determined.

Quantitative research

At the beginning of the research, I determined a sample of **150 to 250 elements**. The publication of the questionnaire I edited was done on a web interface, on a portal. The link to this portal was sent to the e-mail address of that company along with a cover letter. The portal provides the opportunity to automatically arrange answers in an Excel table after completing the questionnaire. Since I conducted the query through my own website, I have exclusive access to the data, thus guaranteeing the requested anonymity from the respondents.

Regarding the list of questions, we have to distinguish between existing and new suppliers, as the databases of the existing companies are provided with information about the existing suppliers. When compiling the questions I took into account that the question list should be clear and direct. The questionnaire is partially closed; it includes multiple choice questions and Likert - scale statements¹, as well as individual opinion creation. The **29 questions of the compiled questionnaire cover the topic**, which is to answer the research questions I have set up (Table 1).

1. Table The structure of the questionnaire

<i>Issues</i>	<i>Questionnaire's chapters</i>	<i>Questions</i>	<i>Hypotheses</i>
General data of companies	A	8	-
Supplier selection and evaluation criteria	B	9	H₁-H₅
Supplier selection and evaluation process	C	9	H₇
Supplier selection and evaluation method	D	3	H₆

Source: Own research (2018)

¹ **Likert Scale** - An evaluation scale where one must express an opinion on a given subject 1 (totally disagree with it) and 6 (fully agree). If the respondent is not able to take a clear position, the Likert scale gives the opportunity to specify the mean value.

2. 2. The characteristics of the sample, the theoretical population

In my doctoral dissertation, the size of the company to be examined is set out in the 2004. year XXXIV. law². Accordingly, large companies operating in Hungary (more than 250 employees), medium-sized companies (between 50 and 250 people) and small enterprises (under 50 with micro-enterprises) participated in my research. My goal was to play the "all levels" of the supplier pyramid.

I did not consider the classification of companies according to the size of their turnover as a relevant issue, because in my opinion and on the basis of my experience, the criteria and methods chosen in the selection process are not related to sales revenue. The following table summarizes the number of companies involved in the study (Table 2).

2. Table Distribution of sample by number

Size categories	Companies in the sample	
	Companies number	%
Unemployed and micro company 0-9 people	0	0
Small Business (10-49 people)	98	49
Medium Business (50-249)	69	35
Large Companies (250-)	32	16
In all	199	100

Source: Own research (2018)(N=199)

During the research, between **June and December 2017**, a total of **226 completed questionnaires were returned**, 23 of which were invalid (non-automotive supplier, incomplete questionnaire, etc.), and four questionnaires were not taken into account because of the test period I specified they arrived late. By specifying the time interval, I tried to ensure that there were no big differences between the responses of the suppliers involved in the study. I think the six months I specified were optimal. My thesis was based on the answers to these questionnaires, ie, taking into account the above corrections, **I processed a sample of 199 elements**, thus fulfilling my goal defined at the beginning of the research (sample number 150-250). There are about 720 companies in the domestic road vehicle industry: the majority of automotive suppliers are mainly engaged in the production of plastic and machined metal parts. However, in the

² Small and Medium-Sized Enterprises, Supporting Their Development in Hungary, **2004. year XXXIV. law** (hereinafter referred to as the "SME Act"), which has transposed the provisions of EU Recommendation 2003/361 / EC1 into the Hungarian legal system. The recommendation is about the definition of micro, small and medium-sized enterprises.

information gathering phase, I did not find any data on the proportion of these companies, which means the size of the company.

2. 3. Statistical Methods for Data Analysis

Data collected from primary and secondary sources were analyzed using statistical analysis. In evaluating the quantitative data, I used the SPSS suite, where I had different methods to help me:

- descriptive statistical methods (frequency distributions)
- Pearson-correlation
- Khi-square test
- Cross-table analysis
- Multiple Variable Statistical Methods (Factor and Principal Component Analysis)
- Fuzzy Logic

3. Examination of research hypotheses

The results of my hypotheses are summarized in this chapter, where two of the six hypotheses of statistical instruments were rejected, one partially accepted and three accepted.

H₁: The ranking of the three most important selection and evaluation criteria (quality, delivery time, and price) varies by company size.

The beginning of the analysis of the criteria dates back to the 60s. In 1966, the first publication on this issue appeared, where DICKSON set up a list of 23 criteria. During my research, I also used this list as a basis and examined whether there was any significant difference since the publication of the study, since more than 50 years have passed since then. During the examination of the criteria I approached my hypothesis from different directions. On the one hand, I examined the company-size ranking, or whether we are talking about a new potential supplier or an existing supplier that is already part of the supply chain.

During the study I found that the ranking I set up is partly in line with the DICKON list, as quality and delivery are in the top two. The research carried out almost 35 years later confirms that quality and delivery are the criteria in the first two places. Accordingly, it can be stated that, in line with domestic and international research, these two criteria may be the basis for remaining in the supplier base. Based on the results, my first hypothesis is as follows:

As there are differences between the objectives of the companies, there may be differences between the importance of the selection and evaluation criteria. However, based on the above studies, I found that the three most important criteria for existing suppliers are *quality, process safety and delivery time*. The criteria for new supplier companies are ranked as *quality, process safety and price*.

The analysis of the criteria was carried out at company size level, as a result of which we can say that the importance of the criteria is not directly proportional to the size of the company. Examining quality as a criterion, I found that for small businesses this is more important than for the other two corporate groups. Looking at the price, I got a similar result, where big companies were followed by medium and small companies. Based on the results of small businesses, price is more important for them than for large or medium-sized companies. Based on the overall results of the research, I found that the ranking of the criteria varies with the size of the company.

My H₁ hypothesis was partly accepted in terms of the above results.

H₂: Considering the importance of the criteria and requirements, there is no difference between the supplier in the existing supplier base and the new potential supplier company.

If a company decides to make a supplier selection, the process is carried out according to a specific set of criteria, according to which companies project their own needs to the supplier partner. In the course of the research, I examined the requirements and criteria for existing and new supplier companies separately. I examined the frequency by criteria and analyzed the ranking criteria set for the supplier groups. Based on the results, the rankings of the examined criteria were clearly outlined.

Based on the results of the surveyed companies, I found that domestic automotive companies distinguish between the two supplier groups, eg. For existing suppliers, delivery time is more important than professional competence. However, we find the opposite for new suppliers.

Based on the above results I *rejected* the **H₂** hypothesis.

Selection of suppliers, as I mentioned earlier, is a complex process where not all supplier companies can fully meet the selection criteria. During my research, I found it important to summarize the difficulties that future partners face, which may need improvement. So my hypothesis is:

H₃: Potentials that need to be repaired show differences in company size.

I divided the test into two parts within the enterprise size to distinguish between existing and new suppliers. As for the two supplier groups, I deliberately did not examine the same points and potentials as we will see, as there are different problems in the two supplier groups. In Table 3, I summarized my results for my hypothesis (H₃), **ie there is a difference between the company size and the supplier groups (existing and new suppliers).**

3. Table Summarizing potentials for improvement for new and existing supplier companies

Existing supplier	Rank	Large companies (N=32)	Medium-sized companies (N=69)	Small companies (N=108)	Full pattern (N=199)
	1.	<i>Quality</i>	<i>Quality</i>	<i>Capacity</i>	<i>Capacity</i>
2.	<i>Does not meet quality requirements</i>	<i>Does not meet quality requirements</i>	<i>Technical and technological deficiencies</i>	<i>Quality</i>	
3.	<i>Logistical problems</i>	<i>Technical and technological deficiencies</i>	<i>Lack of Know- How</i>	<i>Technical and technological deficiencies</i>	

	Rank	Large companies (N=32)	Medium-sized companies (N=69)	Small companies (N=108)	Full pattern (N=199)
New supplier	1.	<i>Inappropriate communication tools</i>	<i>Quality</i>	<i>Capacity</i>	<i>Capacity</i>
	2.	<i>Logistical problems</i>	<i>Capacity</i>	<i>Inappropriate communication tools</i>	<i>Inappropriate communication tools</i>
	3.	<i>Capacity</i>	<i>Logistical problems</i>	<i>Technical and technological deficiencies</i>	<i>Quality</i>

Sources: Own research (2018)

Based on my results summarized in Table 3, **I accepted** the H_3 hypothesis.

H₄: Among the potential for improvement, time-based transportation (JIT), as a theoretical approach to basic automotive requirements, is reflected in practice, ie the majority of companies follow the JIT strategy.

The purpose of the JIT system is to create an efficient flow of material and information. With the introduction of the system, lead times are reduced, costs are lower, and space requirements are lower for storage. One of the peculiarities of the JIT approach is the little supplier application. Because shipments are frequent, it is important that suppliers should be geographically relatively close. Communication is also an important factor, so that it does not break between the two sides and thus build a long-term business relationship with each other.

As a further condition, we can mention the high quality of the products as there is no quality control after the commodity arrival, as this would be a loss. Since there is no warehouse, the supplier produces directly to the customer production line, so it is important that the ordered goods arrive on time, not sooner or later.

The consequence of using the JIT system is to encourage suppliers to continually solve problems, as they have to adapt to the demanding (or drastically) fluctuating needs and orders of the buyer companies. About **two-thirds of the surveyed companies (71.4%) said that the supplier partners did not ship in the JIT system**, although this is already a basic requirement in today's world (2018). In the evaluation of the results, only a small number of companies (12% of the total sample) - mainly in small enterprises - indicated that the practicality and operation of the system is very difficult in practice.

As a result of the above results, *I rejected the H_4 hypothesis.*

One of the most interesting topics of my research is the background literature of selection and evaluation methods. As I explained earlier in the literature review, many decision-making methods are used in practice and in the literature, which have been developed to help the process of supplier selection. Some procedures have been known for decades, while some have only been introduced a few years ago. In my dissertation, one of my goals was to summarize and systematize all the selection methods available in the literature. My hypothesis is:

H₅: In Hungary, the automotive companies apply the selection and evaluation methods in practice, which are easy to apply, interpret (eg fill out a form), and not the other professional benefits.

The methods and procedures listed in the questionnaire were analyzed during the full sample examinations, where I also examined the reasons leading to the selection of the given procedures. Based on the results, I set up a ranking, which I found that companies mostly decide on a method, procedure, how easy it is to interpret and apply. Based on ranking, respondents ranked first for ease of use (eg filling out a form), ranked second for ease of interpretation, and ranked in detail for the third stage of the podium.

In the ranking, *I accepted my H₅ hypothesis.*

In the selection of suppliers, the sole purpose of companies is to find the most suitable supplier partner(s) with whom they will be able to establish long-term business partnerships to achieve common goals. There are many different approaches in the literature, depending on how the researchers define the selection as a process. It is difficult to present two completely identical approaches, but there are points of agreement. The question of who is behind them is also divided in different publications.

Based on preliminary research, I formulated my hypothesis as follows:

H₆: The literature classifies supplier selection as a process for procurement tasks, but in reality this task is performed jointly by the purchasing department together with supplier quality assurance.

One of the most interesting questions in my research was engagement, who is behind the above-mentioned processes. In completing the questionnaire, I gave the respondents a free hand because I did not sort out the answers. I was curious about the person or department in the company who (s) evaluate and select suppliers. I got different results as a corporate size. In the case of small businesses, the executive (45.9%) makes the final decision on selecting a supplier partner, while the quality assurance engineer (SQ) is responsible for these

processes in medium-sized companies (46.4%). In the same corporate group, 20.3% indicated that procurement, 10.1% of procurement, combined with quality assurance, selected suppliers, which, if combined, would result in a purchase (+ SQ) of about 30.4%. decide the fate of the supplier partner. In the case of large companies, 42.9% of the respondents are in the hands of purchasing, and 18.8% of strategic purchases are combined with supplier development (SQD) to select the best supplier for the company.

Combining the above results, *I accepted the H₆ hypothesis.*

The summary results of my hypotheses presented in this chapter are in Table 4.

4. Table Summary results of hypotheses

GOALS	HYPOTHESES	EVALUATION OF HYPOTHESES
G₁ : Examining the criteria and factors involved in the automotive supplier selection and evaluation process.	H₁ : The ranking of the three most important selection and evaluation criteria (quality, delivery time, and price) varies by company size.	H₁ : <i>Partly accepted</i>
	H₂ : Considering the importance of the criteria and requirements, there is no difference between the supplier in the existing supplier base and the new potential supplier company.	H₂ : <i>Rejected</i>
G₂ : Investigating the potential of automotive suppliers for development.	H₃ : Potentials that need to be developed show differences in company size.	H₃ : <i>Accepted</i>
	H₄ : Among the potential for improvement, time-based transportation (JIT), as a theoretical approach to basic automotive requirements, is reflected in practice, ie the majority of companies follow the JIT strategy.	H₄ : <i>Rejected</i>
G₃ : Examination of selection and evaluation methods known in the literature.	H₅ : In Hungary, automotive companies apply the selection and evaluation methods in practice, which are easy to apply, interpret, and not the other professional advantages behind the decision.	H₅ : <i>Accepted</i>
G₄ : Examine the current process of selection and evaluation.	H₆ : The literature classifies supplier selection as a process for procurement tasks, but in reality this task is performed jointly by the purchasing department together with supplier quality assurance.	H₆ : <i>Accepted</i>

Sources: Own research (2018)

4. New and novel scientific results

My hypotheses at the beginning of the research were analyzed using quantitative and qualitative methods, which resulted in new and novel scientific results.

Re1: Establishment of a set of criteria (criteria ranking) independent of the size of the company for modern automotive companies in Hungary.

Based on the results of the in-depth interviews, I formulated 13 criteria in my dissertation, where I carried out various statistical tests. In my opinion, the criteria are the cornerstones of the supplier selection and evaluation process, which is why, as I have mentioned in my objective, a comprehensive examination of the topic of the criteria is the primary goal (*G₁: Examination of the criteria and factors involved in the automotive supplier selection and evaluation process*).

The tests were carried out along two ways, i.e. distinguishing between the suppliers in the supplier base and the new potential supplier partners. Based on statistical surveys, I have set the *basic criteria* for the criteria on the basis of which a clear order of priority was created (Table 5), thus defining the *three most important criteria* requirements for each supplier group and company size.

5. Table Importance of requirements set by companies

	<i>Requirements for existing suppliers</i>	<i>Requirements for new suppliers</i>
Corporations	Quality Process safety Reliability	Price Quality Reliability
Medium-sized companies	Price Quality Process safety	Quality Process safety Price
Small companies	Flexibility Quality Professional competence	Flexibility Quality Process safety

Source: Own research (2018) (N=199)

The order of criteria set by DICKSON (1966) is constantly changing according to customer requirements, the results of which are summarized in Table 6, where I came to the conclusion that after the list of criteria published by DICKSON in 1966 we can talk about two permanent decision factors that always occupied a podium during the last 51 years. These two criteria are quality and delivery performance, which includes both delivery time and delivery loyalty.

6. Table Summary of criteria ranking (1966 – 2017)

<i>Criteria ranking</i>	<i>DICKSON (1966)</i>	<i>WEBER and his partners (1991)</i>	<i>CHERAGHI and his partners (2004)</i>	<i>Own research (2017)</i>
1.	Quality	Price	Quality	Quality
2.	Delivery performance	Delivery performance	Delivery performance	Price
3.	Performance story	Quality	Price	Delivery time

Source: Own research (2018) (N=199)

In the course of examining this topic, I did not find any domestic study summarizing the criteria for the Hungarian automotive supplier companies in order of importance. Table 7 summarizes the changes over the past 51 years.

Re2: On the basis of mathematical - statistical calculations, there is a verifiable difference in the requirements of the two supplier groups (companies that already occupy a supplier base and new potential companies).

With cross-tabulation studies, I concluded that the companies involved in the study differentiate the importance of the criteria according to the choice of supplier groups (Table 7).

7. Table Ranking the most important criteria for existing and new suppliers

<i>New suppliers</i>			<i>Existing suppliers</i>		
<i>Criteria</i>	<i>Ranking</i>	<i>Mean</i>	<i>Criteria</i>	<i>Ranking</i>	<i>Mean</i>
Quality	9,85	5,598	Quality	9,53	5,352
Process safety	9,33	5,447	Price	8,74	5,030
Price	9,04	5,302	Delivery time	8,67	5,101

Source : Own research: (2018) (N=199)

New supplier (W=0,392; df=12; p<0,01), existing supplier (W=0,374; df=12; p<0,01)

The set of requirements set by the company size also presents the differences that can be justified by mathematical-statistical calculations. Comparing the two benchmarks, we can say that companies are unanimous about quality as the most important criteria to be met when selecting a supplier, either as a supplier to a supplier base or as a new potential entrant to the base.

Re3: The need for synthesized development potentials at supplier companies shows a difference in company size.

The automotive industry requires a number of requirements to be met by new and existing companies wishing to enter the supply chain. Of course, meeting some of these requirements is a major concern for some companies, and some are easy to overcome.

In my dissertation, using descriptive statistical methods and correlation analysis, I investigated the factors that need to be developed on the supplier side based on company size and supplier group. What are the factors based on the opinions and information of the buyer companies that the supplier partners are struggling to become members of the supplier base. As a result of my research, I have found that differences in company size can be synthesized just as well as customer requirements for supplier companies.

Re4: In the domestic automotive industry, only one-quarter of the companies deliver the standard *Just In Time* system.

By analyzing descriptive statistical methods, I concluded that in the Hungarian automotive companies only a small number (a quarter of the total sample) is delivered by the supplier companies in accordance with the JIT approach. There are a number of conditions that need to be met in order for the system to work, which is not fully or partially implemented by companies, thus generating a risk that a given supplier is unable to meet these conditions, ie delivery in the JIT approach is unworkable. The reasons behind this - based on the companies' responses - are the difficult feasibility of the system, and there is no trend in the size of the company regarding the usability of the system.

According to Lean's theory, high inventory levels, stored quantities indicate lack of information, and that system performance is ineffective. However, if we approach the problem from the production point of view, the kit provides a kind of security in case of a crisis (eg sudden increase in customer demand, complaint, etc.).

Res: The Fuzzy rule-based process can be an effective tool for all companies in the assessment and selection of suppliers.

The period between the development and production of a new product is getting shorter, making participants in the process increasingly meeting the requirements they need. To be successful, constant monitoring and development is required. That is why the choice of a potential supplier is a key issue that requires thought-out, simple, easy-to-understand criteria. This allows us to more accurately define the parameters to be measured, thus providing a more accurate picture of the

suppliers involved. It is difficult to tighten the boundary, which is why Fuzzy Logic can be used to eliminate this limit, which allows us to give an accurate picture of a potential supplier by examining several factors simultaneously. When using fuzzy set theory and logic, we can make decisions on a given supplier or against it, taking into account several criteria at the same time.

Supplier evaluation and selection is not about giving up on inadequate suppliers, but about making every effort, if necessary, to support that supplier to meet his customer requirements. In my dissertation I proved that it is possible to select the most suitable suppliers with the help of a Fuzzy rule-based procedure, thus making the decision-making process easier, since this method is able to distinguish between two suppliers even if the difference is very small. It makes it easy to decide which potential supplier partners to release, meet customer requirements, and which ones are worth developing and, in the last case, those that can't meet their requirements, for supplier status They were undercut in the "fought" battle, so they could not be part of the supply chain.

Re6: The sub-processes of the present-day domestic automotive industry, such as supplier selection and evaluation, focus on the procurement department.

Crosstab studies have confirmed that different departments play an important role in managing the selection and evaluation process. Accordingly, in the case of large companies, procurement (*Procurement + Supplier Quality Development - 61.7%*), in mid-company processes, SQ, or SQE (*Quality Assurance Engineer*) (46.4%) and Commercial Manager (11.6%), while the final decision on the suppliers of small companies is made by the management (37.8%; *Chief Executive Officer 45.9*) (Table 8).

8. Table Distribution of role based on company size

<i>Company size</i>	<i>Name of position</i>	<i>Percentage distribution</i>
Corporation	Procurement	42,9%
	Strategic Procurement + SQD	18,8%
Medium-sized company	SQ, SQE	46,4%
	Acquisition	20,3%
	Sales Manager	11,6%
Small company	Executive Director	45,9%
	Sales Manager	37,8%

Source:: Own edition (2018), N=199

I was looking for relationships between engagement and ownership in cross-tabulation analyzes. In the course of the analysis, I found that the importance of

the purchasing position indicated by the large companies at 20.2% is attributable to German ownership. In the case of medium-sized companies, they have a very different view of the task. In the case of the commercial management position, 71.4% of the French influence is felt, while the quality of the engineering position lies behind the Japanese culture (54.5%).

Re7: List of Hungarian automotive companies, based on the results of the research (*International Owners, Mixed Medium Enterprises, Loyal Partners, Companies with German and French influence*).

Using the information gathered during my research, I created well-separable groups using multivariate analyzes (factor and cluster analysis), into which Hungarian automotive companies can be classified. In the course of the study, 4 methodologically separated factors were created: *QSC (Quality - Supply Chain) factor; Total impression factor; Geographic location factor; Guarantee factor*. The factors were used in the last step of my research to classify the current Hungarian automotive companies into a cluster. During the analysis of the data, I performed a hierarchical cluster analysis, in which 4 clusters were defined. On the basis of these cluster groups, it can be stated, on the one hand, what kind of companies belong to a cluster and how they think about the topic of supplier evaluation and selection.

The "*International Owners*" group has been given this name because it is a group of companies with a significant foreign (German, American and French) ownership.

I have named the cluster "*Mixed medium-sized companies*" where medium-sized companies are typically located.

The name "*loyal partners*" reflects the characteristics of the companies, according to which the enterprises that have a business relationship with domestic suppliers like Hungary have fallen into this cluster, although the number of suppliers is small. Most of the businesses are majority owned by Hungarians.

In the "*German and French-influenced companies*" group, small businesses have been in business relations with few suppliers, but always aiming to work together with the "best" in terms of competitiveness.

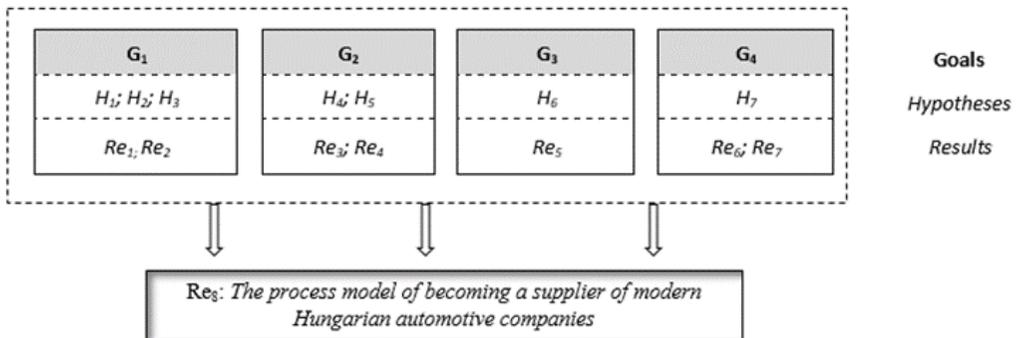
Based on the above four clusters I made the following statements:

- 1) In Hungary, the process of selecting and evaluating suppliers for automotive companies **needs to be revised and improved**. There are some who know the right way and there are some businesses that are very far from it.
- 2) 1-3. clusters typically consist of interested companies, as if a new product is to be manufactured, they will be selected, but first they will not look at the partners of the existing supplier base in order to get a "own" supplier

to produce a new product. Thus, every supplier company (existing - new) starts with equal chances, no competitive advantage.

- 3) **The process of selection and evaluation is not concentrated in the hands of procurement, but is divided.** Quality assurance is the background to the selection and evaluation process for clusters 1 and 2. In the case of the other two clusters the management performs this task (managing director, commercial manager). Some purchasing effect can be observed in part 4.
- 4) **The application of the JIT approach to the four clusters examined is not relevant.** Only a few percent of companies can apply the approach.
- 5) If we look at the distribution of ownership, we can see that the clusters have a **strong international impact**, behind which there are countless investments. In the case of three clusters we can talk about mixed corporate groups (1; 2; 4). Only in the third cluster can loyalty be discovered, where 73.3% of domestic businesses are concentrated.

In the course of the hypothesis examination, I formulated 7 scientific results covering my 7 years of full research (2011-2018). However, as a summary of my research findings, I have created the eighth result of my doctoral dissertation (E8), which is illustrated in the following figure (Figure 1).



1. Figure Relationships between objectives, hypotheses, results

Source: Own edition (2018)

Re8: The process model of becoming a supplier of modern-day automotive companies in Hungary, including the definition of criteria until decision making. The process model reflects the characteristics of the automotive supplier companies involved.

The results outlined above have been contributed to the above results. The process model reveals all the attitudes of the Hungarian automotive companies involved in the study, which illustrates the attitude of modern-day Hungarian automotive companies by defining selection, evaluation criteria, reviewing the repair

potentials, methods, and procedures. I divided the model into 6 separate parts according to the selection and evaluation process.

Phase 1: Determining customer needs

It means market research, ie the company's purchasing department summarizes customer needs, ie what product range is needed. First, they examine whether there is a supplier available in the supplier base and whether it is suitable for the task, the production and assembly of the products. If yes, it is and is suitable for one, so Phase 3 comes into effect. Otherwise, you need to find the right supplier.

Phase 2: Pre-selection

Step 2: Take stock of potential vendors who request a first-round vendor form ³. In addition to the evaluation sheets, it is important for the company to have certificates and whether it meets the K.O. criteria ⁴. Acquisition of information can be complemented by company auditing in conjunction with a visit. If the purchasing department has gathered all the important information, then the suppliers are selected.

Phase 3: Select Suppliers

Negotiations are already underway at this stage, logistical and quality agreements will be concluded, and last but not least, potential suppliers will be selected (supplier audits with visit). These steps are focused on the purchasing department. However, it should be taken into account that the selection decision is made jointly by the purchasing department with the quality policy, since quality professionals are required to assess compliance with the quality requirements. That is why it is worth setting up a multidisciplinary unit to select supplier partners.

Phase 4: First Samples

The first sample orders are received, which are checked together with the documentation of the samples. Once accepted, the supplier has been approved and can enter the next phase. Otherwise, you need to fill the gaps. Here, we can talk about document-related errors or, if necessary, missing records, audit plans, after which the first samples submitted by the supplier are accepted.

³ First round vendor form contain the following information: general data on the supplier company, revenue, headcount, insurance, product range, quality assurance system, process descriptions, change management, commodity collection, delivery, measuring instrument monitoring, complaint process.

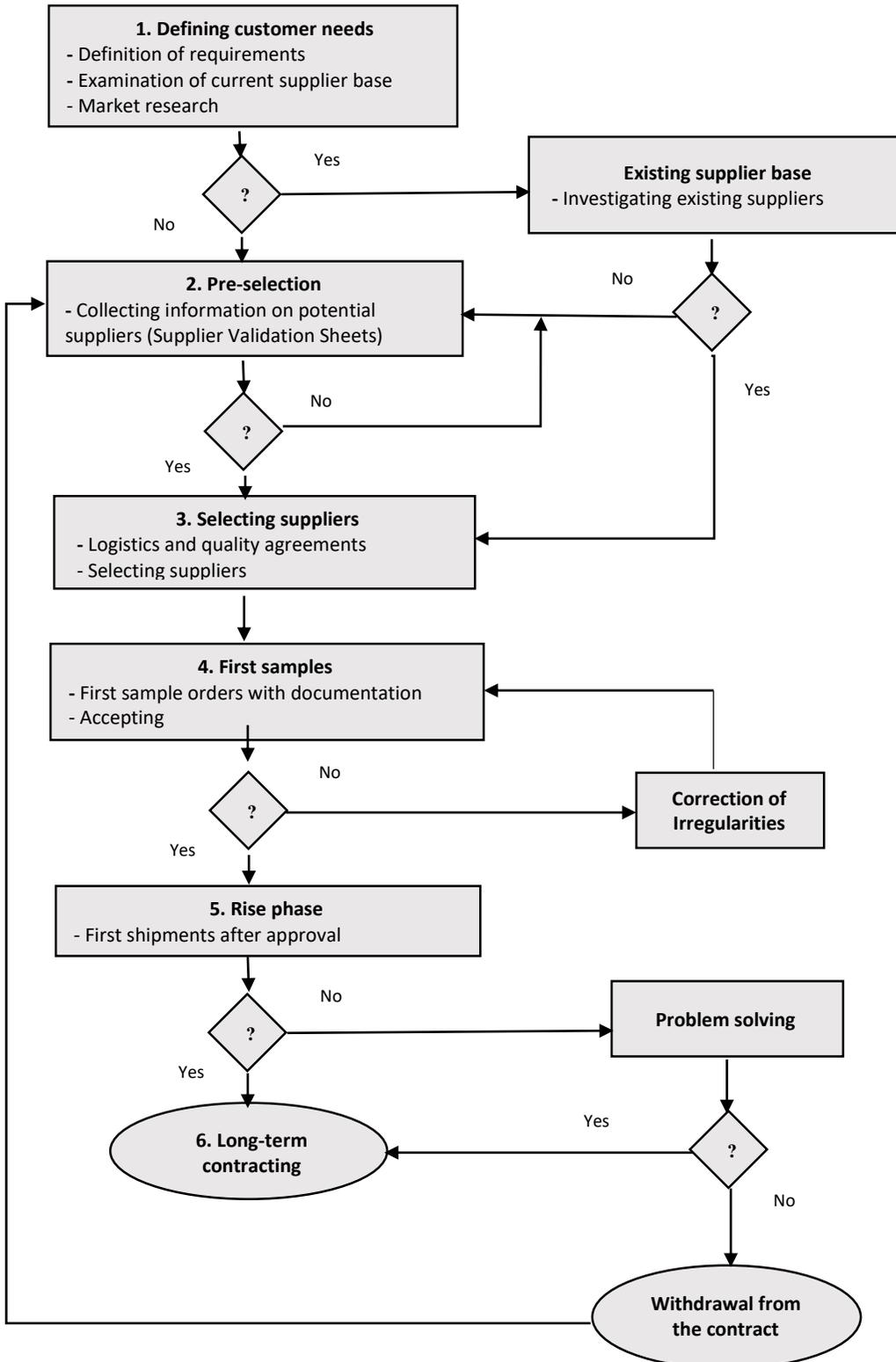
⁴ **K.O. - Criteria:** Criteria for non-compliance, ie serious failure if the potential supplier is unable to do so. Such criteria include e.g. supplier's solvency, lack of certificates. This means that not all criteria are of the same severity int the supplier assessment.

Phase 5: Rise phase

After the supplier's approval, the first shipments arrive, which are also under control. This phase can take up to several months - depending on shipping frequency. Based on their performance, they decide on the selected supplier partner. Based on my research results, Fuzzy Logic can serve as an effective evaluation method for all companies, as it is possible to make a decision with or against a particular supplier, taking into account several criteria at the same time. If the selected supplier complies with the required requirements, they can complete the long term contract in phase 6. Otherwise, they will try to solve the problems that have occurred together. In this way, supplier relationships need to be nurtured, managed and developed, as this is an indispensable condition for a well-functioning business relationship. If the supplier's situation does not change despite the attempts, the company will withdraw from the contracting.

Phase 6: Long-term contracting

The final passage of a long process of becoming a supplier, when the supplier company becomes a member of the supply chain (Figure 2).



2. Figure The process of becoming a supplier in the automotive industry

Source: Own edition (2018)

5. Conclusions and recommendation

The domestic automotive industry (2018) is characterized by continuous innovation and the use of the most advanced technologies, and companies are continuing to invest in order to remain competitive in the supply chain. As the industry evolves, customer expectations and demands evolve with the satisfaction of companies. The purpose of the enterprises is thus to build and operate a supplier network that called for the achievement and maintenance of the aforementioned competitiveness. The emergence of international companies has prompted Hungarian companies to develop quality assurance and continuous monitoring. As a result, the domestic supply chain started to expand. There is a spectacular development in the domestic automotive supplier system. This is partly due to the arrival of Western large companies coming into the country, which indirectly, but the outsourcing of partial activities has become more and more prominent. However, the level of development is still below the level of Western states. The struggle for the supplier base is increasing, it is difficult to get into the supplier system, because the requirements are set by the companies relatively high, which cannot be fulfilled by all supplier partners. This is not just about quality requirements, because the picture is more complex. Equally important are the financial factors in selecting a supplier, such as professional qualifications or technological readiness.

After formulating my research results, I formulated conclusions and suggestions, which are summarized below:

***R₁**: Based on the rankings set up, a standardized set of requirements can be created to assist in the selection and assessment of automotive suppliers.*

***R₂**: Creating a unified evaluation system that allows you to filter out the use of routine sources of procurement.*

***R₃**: During the selection of a particular supplier, it is advisable to take into account the differences as a result of the research.*

***R₄**: Further investigation of the JIT system's operational difficulties and underlying obstacles is required. After evaluating the results, suggestion to eliminate the problem. More possibly research area.*

***R₅**: Propose the applicability of the Fuzzy rule-based procedure in other industry sectors to select the appropriate supplier partner.*

***R₆**: Collaboration of company areas (procurement, quality) that are involved in the process of supplier evaluation and selection, with the aim of getting the most suitable supplier partner to the supplier base.*

***R₇**: When compiling different strategic plans, it is advisable to take into account the cluster characteristics established during the research.*

With the 6 hypotheses I set up, I tried to cover my research topic, but there are still unexplored areas that I could not sum up by referring to volume constraints. I plan to do this in the future. I believe that the results of my research can be used in both theoretical and practical contexts, as I formulated the requirements set for suppliers in the course of the research, I pointed to problems that can be used as a basic idea of later researches, and the process model of becoming a supplier created by me can be applied in the long term for research.

Since the model has not been tested, ie the process steps have not been implemented for the responding companies, the model needs further development. In the model, we can only get information from one side, which can be supplemented with additional moments in the future. Such as background work, ie, examining what happens in the background when competent professionals make a decision on a supplier partner.

During my research, I began to outline that becoming a supplier is actually a long, systematic process that involves many steps. Often the road to the multinational corporation in Hungary is driven only through the international purchasing center of the parent company of the buyer. New, potential suppliers should be aware that a multinational company is looking for and competing with each other for the best suppliers around the world.

I believe that the enterprise groups that form the basis of the process model can form the basis for further research, which would provide an opportunity for a better understanding of corporate thinking. The complete research of my chosen topic cannot be ruled out, as my further plans include testing the Hungarian process model and comparing it with the process model of foreign (eg German, French, Italian) companies, thus synthesizing the European image of the automotive supplier companies.

The full story of my research - from hypotheses to results and conclusions - is summarized in Table 9.

9. Table Relationship between research objectives and results (1)

<i>Goals</i>	<i>Hypotheses</i>	<i>New and novel results</i>	<i>Conclusions and recommendations</i>
<p>G₁: Examining the criteria and factors involved in the automotive supplier selection and evaluation process.</p>	<p>H₁: The ranking of the three most important selection and evaluation criteria (quality, delivery time, and price) varies by company size.</p>	<p>Re₁: Establishing a set of criteria (criteria ranking) independent of the size of the company for modern automotive companies.</p>	<p>R₁: Based on the rankings set up, a standardized set of requirements can be created to assist in the selection and assessment of automotive suppliers.</p>
	<p>H₂: Considering the importance of the criteria and requirements, there is no difference between the supplier in the existing supplier base and the new potential supplier company.</p>	<p>Re₂: On the basis of mathematical-statistical calculations, there is a verifiable difference in the requirements of the two supplier groups (companies that are already in the supplier base and new potential companies).</p>	<p>R₂: Creating a unified evaluation system that allows you to filter out the use of routine sources of procurement.</p>
<p>G₂: Investigating the potential of automotive suppliers for development.</p>	<p>H₃: Potentials that need to be developed show differences in company size.</p>	<p>Re₃: Potentially synthesized potentials at supplier companies show a difference in company size.</p>	<p>R₃: During the selection of a particular supplier, it is advisable to take into account the differences as a result of the research.</p>
	<p>H₄: Among the potential for improvement, time-based transportation (JIT), as a theoretical approach to basic automotive requirements, is reflected in practice, ie the majority of companies follow the JIT strategy.</p>	<p>Re₄: In the domestic automotive industry, only one-quarter of the companies deliver the standard Just In Time system.</p>	<p>R₄: It is necessary to further investigate the operational difficulties and obstacles of the Just In Time system. After evaluating the results, suggestion to eliminate the problem. More research area.</p>

9. Table Relationship between research objectives and results (2)

<i>Goals</i>	<i>Hypotheses</i>	<i>New and novel results</i>	<i>Conclusions and recommendations</i>
G₃: Examination of selection and evaluation methods known in the literature.	H₅: In Hungary, automotive companies apply the selection and evaluation methods in practice, which are easy to apply, interpret, and not the other professional advantages behind the decision.	Re₅: The Fuzzy rule-based process can be an effective tool for all companies in the assessment and selection of suppliers.	R₅: Propose the applicability of the Fuzzy rule-based procedure in other industry sectors to select the appropriate supplier partner.
G₄: Examine the current process of selection and evaluation.	H₆: The literature classifies supplier selection as a process for procurement tasks, but in reality this task is performed jointly by the purchasing department together with supplier quality assurance.	Re₆: The sub-processes of the present-day domestic automotive industry, such as supplier selection and evaluation, focus on the procurement department.	R₆: Collaboration of company areas (procurement, quality) that are involved in the process of supplier evaluation and selection, with the aim of getting the most suitable supplier partner to the supplier base.
		Re₇: List of Hungarian automotive companies, based on the results of the research (International Owners, Mixed Medium Enterprises, Loyal Partners, Companies with German and French influence).	R₇: When compiling different strategic plans, it is advisable to take into account the cluster characteristics established during the research.

Source: Own edition (2018)

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