

DETERMINANTS OF SELECTING A RESEARCH LABORATORY OF AGRICULTURAL MACHINERY – REQUIREMENT SIGNIFICANCE ASSESSMENT

Summary

The subject of this research – constituting its final study – are the determinants of selecting a research laboratory for the needs of conducting the operational safety tests and compatibility assessment in order to issue an EC conformity declaration, as well as to voluntarily certify for a “B” safety symbol. The studies were run from the point of view of small, medium, and large manufacturing companies of agricultural machinery. The fundamental objective of this research is an attempt to reply to the question: what factors – from the point of view of the manufacturers of agricultural machinery – are relevant when selecting a research entity by them. The main objective achievement required identifying the determinants of selecting a research laboratory by the Polish manufacturer of agricultural machinery (first part of the study – research model construction), which was subject to exploration in this part of the study; theoretical model validation (assessment of the significance of requirements). Such an activity allowed for interference profiled towards the indication of a recommendation related to the way and direction of the research laboratory improvement.

Key words: selection determinants, research laboratory, agricultural machinery, empirical identification

DETERMINANTY WYBORU LABORATORIUM BADAWCZEGO MASZYN ROLNICZYCH – OCENA ISTOTNOŚCI WYMAGAŃ

Streszczenie

Przedmiotem badań niniejszego opracowania – stanowiącego badanie właściwe – są determinanty wyboru laboratorium badawczego dla potrzeb przeprowadzenia badań bezpieczeństwa użytkowania, oceny zgodności w celu wystawienia deklaracji zgodności WE oraz dobrowolnej certyfikacji na znak bezpieczeństwa „B”. Badania prowadzono z perspektywy małych, średnich i dużych przedsiębiorstw produkujących maszyny rolnicze. Fundamentalnym celem badań jest próba odpowiedzi na pytanie: jakie czynniki – z punktu widzenia wytwórców maszyn rolniczych – są istotne przy wyborze przez nich jednostki badawczej. Osiągnięcie celu głównego wymagało zidentyfikowania czynników warunkujących wybór laboratorium badawczego przez polskiego producenta maszyn rolniczych (część pierwsza opracowania – budowa modelu badawczego), który w niniejszej części opracowania poddano eksploracji; walidacja modelu teoretycznego (ocena istotności wymagań). Takie działania pozwoliło na wnioskowanie sprofilowane na wskazanie rekomendacji dotyczącej sposobu i kierunku doskonalenia laboratorium badawczego.

Słowa kluczowe: determinanty wyboru, laboratorium badawcze, maszyny rolnicze, weryfikacja empiryczna

1. Introduction

The deliberations in this paper refer to the criteria for choosing a research laboratory from the point of view of a manufacturer of agricultural machinery. The determinant term – the key one for this paper – is defined as a requirement, condition, factor, or a set of standards that should be met, so that the relation between the achieved results and the used resources would be as favourable as possible.

The agricultural machinery manufacturers operating on the Polish market feel an increasingly stronger need to verify their machines' conformity in the designing, manufacturing, and operation phases. Testing the machines for their conformity in order to issue an EC conformity declaration and a "B" symbol certificate are becoming a good practice. The organisation that runs such tests can be a research institute, the aim of which is to independently conduct basic tests, industrial tests, or experimental development work, and to distribute the results of such activities on a large scale through teaching, publishing or knowledge transfer.

Research institutes are state organisational units having their legal personality and appointed in order to carry out research studies aimed at economic use. The legal status of the research institutes as state legal entities is a sign of membership of the sphere of science and conducting the research studies for the state tasks. An institute can be created by the Council of Ministers in the form of a regulation at the request of the competent minister due to the planned activity of the institute, in consultation with the competent minister responsible for science. The institute establishment can take place, if there is a need for conducting a research activity within a given field, when the necessary personnel with relevant qualifications, test and laboratory apparatus, IT potential and other necessary material-technical conditions are provided [1].

An institute is a legal entity responsible for its own obligations, occurring in trading on its own behalf and its own account. It covers the costs of the current activities of the obtained revenues. The revenues may be achieved in relation to conducting the core business and other, including, among others, the sale of the research study and develop-

ment work results, patents, protection rights and licences, implementation works, manufacture of devices and apparatus and other manufacture or services.

The activity of research institutes is of special nature. It is situated at the point of scientific and economic activities [2]. Therefore, a question arises, whether research institutes conduct a business activity, or whether they are regular entrepreneurs?

The commercial nature of the activity of research institutes may be supported by the fact that its objective is not only to conduct research, but also to sell their results [3]. These institutes do not conduct the scientific activity only for the science development, but also for the economic application of the research results. Therefore, they occur in the form of a business entity providing specific services that find their buyers – entities (also entrepreneurs), who report demand for them. The implementation degree of the research results is one of the indicators of the institutes' operation efficiency.

A research laboratory organised within the institute structure participates in the works implemented within the framework of statutory tests and research-development projects carried out by the unit to expand the knowledge resources, to better understand and distribute their results. Apart from them, the research is carried out at the request of individual manufacturers who by becoming the owners of the research results developed in the project do not always agree to their distribution.

Therefore, it is necessary to take action creating the image of a laboratory in the consumers' minds. The starting point to position a research laboratory is a product in the form of services offered. Their scope should be adapted to the requirements and expectations of the current clients and flexible enough to be capable of acquiring new contractors. In order to offer the widest range of services to the manufacturers, the laboratory performs operation safety tests for an extensive catalogue of machines and devices, develops the conformity assessment documentation with a risk analysis, which can be the basis for marking the machine with CE and implements the machine safety modelling at the stage of industrial research [4].

The institute must carry out the research activity, and it is not possible to freely change the subject matter of this activity to non-research one, but to the most cost effective one. The institute conducts the activity focused on self-financing, hence, the activity carried out by the research laboratory requires funding and maintenance of the test apparatus. The risk of the conducted research failure is included in it.

Due to the costs and risk of the activity of the research institutes, it is therefore necessary to recognise the factors, which – from the point of view of the agricultural machinery manufacturers – are key when selecting the research laboratory services. The main objective achievement required identifying the determinants of selecting the research laboratory by the Polish manufacturer of agricultural machinery (first part of the study – research model construction), which was subject to exploration in the presented part of the study; theoretical model validation (assessment of the significance of requirements). Such an activity allowed for interference profiled on the indication of a recommendation on the way and direction of the research laboratory improvement. The undertaken research has a methodical and practical dimension, on the one hand, in the construction of

a set of factors shaping the research laboratory competitiveness, and on the other hand, they can be used in order to formulate an answer to the question what research laboratory model is desired from the point of view of the agricultural machinery manufacturers.

2. Research subject, body, range and method

At the first stage of the research which is a preliminary study, with the use of a method of reconstruction and interpretation of the Polish and foreign subject matter literature and a discussion among deliberately selected experts, a number of determinants of the research laboratory selection was chosen. Such action – at the project level – made it possible to compile a research tool in the form of an assessment sheet consisting of 74 desiderata [5]. Since the introduction of such a large number of variables complicates and prevents the formulation of relevant conclusions, an originally prepared research model was verified among 30 deliberately selected experts, among whom there are:

- 12 owners and co-owners – 42.11% of all the surveyed - companies operating in the agricultural machinery sector;
- 7 managers – 31.58% of all the surveyed - employed on an employment contract;
- 3 representatives of the Industrial Institute of Agricultural Engineering employed in the research laboratory within the range from 9 to 23 years (15.79%);
- 2 representatives of the technical university specialising in the design and testing of agricultural machinery and equipment (5.26%);
- 2 representatives of the Polish Chamber of Commerce of Agricultural Machines and Facilities;
- 3 representatives of the university specialising in industrial marketing and client relationship management;
- 1 expert associated with the manufacturing companies operating in the agricultural machinery sector, who has the 16- year experience (5.26%); specialised in: machinery ergonomics and safety.

The objective of this study was to verify the accuracy of the selection of determinants and to reduce their number. The experts were asked to identify fifteen – in their opinion – most important determinants for the research laboratory selection. The significance was marked by their sorting (in the specially prepared table) in the order from the most to the least important ones. 30 correctly completed questionnaires were returned, which means that all the invited experts took part in the study. Among the surveyed, a group of people with higher education was the biggest (78.95%); 15.78% of experts had high school education, and 5.26% had vocational education. The age of those surveyed was between 33-71 years (including 21.05% of the surveyed from 31 to 40 years, 36.84% between 41-50 years, 31.58% between 51-60 years, and 10.53% of experts were older than 60 years).

By taking the decision on selecting the experts, a significant criterion was their direct acquaintance with the researchers. This made it possible to determine whether a respondent was independent in the presented views, and whether it had a sufficient knowledge and experience in the field concerned. In addition, taking into account communication barriers, the persons invited to participate in the survey had direct relations with the authors.

Based on the experts' suggestions, a list consisting of 18 determinants for the research laboratory selection by the

agricultural machinery manufacturers (Table 1) was prepared. It was assumed that the key selection determinants would be formulated by a subset constituting 20% of the entire set of the outlined – in the research model – selection determinants. (On account of the similar number of indications, 18 determinants (more than 24% of all the surveyed) were qualified for the research).

Table 1. Key determinants of the research laboratory selection

Tab. 1. Kluczowe determinanty wyboru laboratorium badawczego

Item	Selection determinant
Dw_[1]	Previous cooperation/relations
Dw_[2]	Trust towards the entity/the laboratory
Dw_[3]	The laboratory personnel's competences
Dw_[4]	Performed service price
Dw_[5]	Payment terms and conditions
Dw_[6]	Order lead time
Dw_[7]	The commitment to Client's needs
Dw_[8]	Consulting on product introduction to the market
Dw_[9]	Test Impartiality
Dw_[10]	Test Independence
Dw_[11]	The compliance of activities with standards/procedures
Dw_[12]	Test complexity
Dw_[13]	Flexibility allowing to modify an order or change the subject of the tests (attachments)
Dw_[14]	Caring for the subject of the test during storage
Dw_[15]	Experience in running tests
Dw_[16]	The level of the tests' compliance with the contract
Dw_[17]	The laboratory's technical facilities
Dw_[18]	Ability to run tests at the client's

Source: own study based on research / Źródło: opracowanie własne na podstawie badań

In this way, a tool oriented on conducting the final research, within the framework of which the interviews were carried out among 49 deliberately selected companies, was defined.

The primary stage of the research was implemented in the period from 3 September to 1 November 2018. Originally, the research was planned to be carried out at two stages, using the direct meetings for this purpose. However,

in order to achieve greater representativeness of the surveyed target group and to obtain quick responses, a survey was carried out among the deliberately selected companies cooperating with THE Production Plant of Agricultural Spare Parts and Machines "Fortschritt" and the Industrial Institute of Agricultural Engineering as the research partners. The manufacturers of manure spreaders, straw crushers, rotary and disc mowers, tipping trailers, cultivators, seeders, silos and any devices used in the livestock breeding and husbandry, such as feed carts and feeding systems.

The respondents were owners and managers representing: micro – 1 person (2.04%), small – 12 people (24.49%), medium – 30 people (61.22%) and large – 6 people (12.24%) manufacturing companies operating in the agricultural machinery sector. Small and medium companies occupy a key place in the agricultural machinery sector, hence such entities constituted more than 60% of all the surveyed. In case of large companies, 50% declared a foreign capital share.

The study involved the participation of 23 owners (46.94% of all the surveyed) and 26 managers (53.06% of all the surveyed). The age of those surveyed was between 26 and 73 years (including 22.45% of the surveyed between 31 and 40 years, 40.82% between 41 and 50 years, 18.37% between 51 and 60 years). The youngest participant was 26 years old, and the oldest one was 73 years old. In a group of owners, 39.13% was more than 50 years, the age of 34.87% of owners was in the range of 40-50 years, however, 26.09% of owners was under 40 years.

Taking into account the group of managers, the distribution was as follows: 23.08% were more than 50 years old, the age of 46.15% was within the range of 40-50 years, 23.08% of managers were between 30 and 40 years, however, 7.69% were under 30 years. The detailed characteristics were shown in Table 2.

Among the surveyed, a group of people with high school and higher education was the biggest (90%); in which 52.17% of owners had higher education, 30.44% had high school education, and 17.39% had vocational education. In case of managers, 69.23% had higher education, 26.92% had high school education, and 3.85% had vocational education. The detailed characteristics were shown in Table 3.

Table 2. Characteristics of the population being tested in terms of age (N=49)

Tab. 2. Charakterystyka badanej zbiorowości ze względu na wiek (N=49)

	Age					
	Owners		Managers		In total	
	46.94%		53.06%		100%	
	Number of participants	%	Number of participants	%	Number of participants	%
to 30 years	N=1	4.35	N=2	7.69	N=3	6.12
from 31 to 40 years	N=5	21.74	N=6	23.08	N=11	22.45
from 41 to 50 years	N=8	34.78	N=12	46.15	N=20	40.82
from 51 to 60 years	N=4	17.39	N=5	19.23	N=9	18.37
over 60	N=5	21.74	N=1	3.85	N=6	12.24
In total:	N=23	100.00	N=26	100.00	N=49	100.00

Source: own study based on research / Źródło: opracowanie własne na podstawie badań

Table 3. Characteristics of the population being tested in terms of age (N=49)

Tab. 3. Charakterystyka badanej zbiorowości ze względu na wykształcenie (N=49)

	Education					
	Owners		Managers		In total	
	46.94%		53.06%		100%	
	Number of participants	%	Number of participants	%	Number of participant s	%
Primary	N=0	0	N=0	0	0	0
Vocational	N=4	17.39	N=1	3.85	N=5	10.21
High school	N=7	30.44	N=7	26.92	N=14	28.57
Higher	N=12	52.17	N=18	69.23	N=30	61.22
In total:	N=23	100.00	N=26	100.00	N=49	100.00

Source: own study based on research / Źródło: opracowanie własne na podstawie badań

The analysis and interpretation of the research results are one of the most important stages of the research process. The paper makes an attempt to interpret the results and a thorough analysis based on the respondents' declarations. The necessary action included a description of the obtained data and their interpretation as shown in the further part of the paper.

3. Assessment of the significance of requirements

The main objective of the study presented was to identify a catalogue of determinants for choosing the research laboratory by the Polish manufacturer of agricultural machinery – Table 4.

Table 4. Determinants of the research laboratory selection – requirement significance assessment

Tab. 4. Determinanty wyboru laboratorium badawczego – ocena istotności wymagań

Item	Selection determinant	Criterion significance			%		Point
		1	2	3	Indications:		
					4	5	
1.	Previous cooperation/relations	-	-	-	14.3%	85.7%	4.86
		-	-	-	7	42	
2.	The laboratory personnel's competences	-	-	2.0%	14.3%	83.7%	4.82
		-	-	1.0	7.0	41.0	
3.	The commitment to Client's needs	-	-	4.1%	16.3%	79.6%	4.76
		-	-	2.0	8.0	39.0	
4.	Test impartiality	-	-	2.0%	20.4%	77.6%	4.76
		-	-	1.0	10.0	38.0	
5.	Order lead time	-	-	4.1%	18.4%	77.6%	4.73
		-	-	2.0	9.0	38.0	
6.	Flexibility allowing to modify an order or change the subject of the tests (attachments)	-	-	4.1%	18.4%	77.6%	4.73
		-	-	2.0	9.0	38.0	
7.	Test Independence	-	-	2.0%	24.5%	73.5%	4.71
		-	-	1.0	12.0	36.0	
8.	Test complexity	-	2.0%	6.1%	20.4%	73.5%	4.71
		-	1.0	3.0	10.0	36.0	
9.	Consulting on product introduction to the market	2.0%	-	4.1%	14.3%	79.6%	4.69
		1.0	-	2.0	7.0	39.0	
10.	Experience in running the tests	-	2.0%	4.1%	18.4%	75.5%	4.67
		-	1.0	2.0	9.0	37.0	
11.	The level of the tests' compliance with the contract	-	2.0%	4.1%	20.4%	73.5%	4.65
		-	1.0	2.0	10.0	36.0	
12.	Trust towards the entity/the laboratory	-	-	6.1%	22.4%	71.4%	4.65
		-	-	3.0	11.0	35.0	
13.	The laboratory's technical facilities	-	2.0%	6.1%	18.4%	73.5%	4.63
		-	1.0	3.0	9.0	36.0	
14.	Performed service price	-	2.0%	4.1%	22.4%	71.4%	4.63
		-	1.0	2.0	11.0	35.0	
15.	The compliance of activities with standards/procedures	-	2.0%	4.1%	30.6%	63.3%	4.55
		-	1.0	2.0	15.0	31.0	
16.	Caring for the subject of the test during storage	2.0%	2.0%	4.1%	32.7%	59.2%	4.45
		1.0	1.0	2.0	16.0	29.0	
17.	Ability to run tests at the client's	2.0%	6.1%	10.2%	22.4%	59.2%	4.31
		1.0	3.0	5.0	11.0	29.0	
18.	Payment terms and conditions	2.0%	6.1%	10.2%	32.7%	49.0%	4.20
		1.0	3.0	5.0	16.0	24.0	

Source: own study based on research / Źródło: opracowanie własne na podstawie badań

The market effectiveness of the research entity depends on establishing partnerships with the manufacturing companies operating on the market (average rating of 4.86%; 85.7% of indications for the assessment of 5 points). The high importance of this factor allows to conclude that the managers of research entities in their everyday activities should practically implement the assumptions of the management strategy of the relations with clients. It seems that in the marketing activities, the direct contacts (meetings, discussions, joint integration trips) are an essential condition for the market success and should be considered as a long-term process of building the continuous relationships with manufacturers. The building of a network of relationships is a permanent feature of the laboratory resulting from its properties as an open system which must perform constant exchanges with the environment, because it only allows it to survive and develop. The more conscious and methodical action of management boards and officers will be the formation of relationships and care for basing them on the unit employees' competences, the more likely is to obtain approval for business activities, to strengthen a positive image of the laboratory on the market and to form solid bases to create cooperation (average rating of 4.82; 83.7% of indications for the assessment of 5 points).

The key to the market success of the research laboratory, in terms of the marketing concept, is to identify and meet the needs and preferences of the functioning companies (average rating of 4.76; 79.6% of indications for the assessment of 5 points). In the fierce competitive battle conditions, it is not enough only to declare orientation on the client, but it is necessary to properly understand the essence of this orientation and its actual use in the laboratory activity, the sign of which should involve taking into account special requirements and solutions exceeding the standards by the entity, including the willingness to introduce changes (average rating of 4.73; 77.6% of indications for the assessment of 5 points).

In relation to the verification of requirements in terms of directives and standards as well as the conformity assessment, having regard to social trust to the carried out tests of products, and conformity assessment, the laboratory should make all possible efforts in order to maintain impartiality during the performance of the mentioned activities and to be perceived as an independent entity (the decision-making on conducting the research and conformity assessment on the basis of the obtained objective evidence of compliance (or noncompliance), including the lack of the impact of any interest groups or other parties on the decisions – in the opinion of the surveyed companies – makes the research entity selection (average rating of 4.71; 73.5% of indications for the assessment of 5 points)) and thus, to contribute to the popularisation and further development of the implemented management system (average rating of 4.76; 77.6% of indications for the assessment of 5 points).

The order lead time is a very important issue from the point of view of the agricultural machinery manufacturers (average rating of 4.73; 77.6% of indications for the assessment of 5 points). Often – in the context of the research laboratory selection – the order lead time is more important than the price of the performed service (average rating of 4.63; 71.4% of indications for the assessment of 5 points), which is confirmed by the results of the carried-out analyses. Professionalism, individual approach and transaction safety may be also pushed into the background, if the con-

tractor cannot meet the deadlines or he offers an overlong period of the order execution. Hence, the order lead time should constitute a priority in the research laboratory development strategy. Of course, it cannot have an impact on the quality; it must interact and complement.

The factor that differentiates the research entities is the complexity of customer service, and this one depends on employees who can have an impact on customer satisfaction through the proper way of service, and consequently, on the laboratory image, its development and financial result. The task of those responsible for contact of the laboratory with companies is their comprehensive service, including a series of activities performed in the direct contact with the client, which makes – in the opinion of the companies – the research entity selection (average rating of 4.71; 73.5% of indications for the assessment of 5 points).

The placing of a new machine on the market is an essential form of development of the Polish manufacturers. However, it is not an easy task. How to professionally prepare yourself for the introduction of a new product in order to achieve the objective? What mistakes should be avoided? Most manufacturers expect the answers to these and other questions – in accordance with the survey results – from the research laboratory (average rating of 4.69; 79.6% of indications for the assessment of 5 points). Within the framework of the research service, the interest of companies in acquiring new knowledge is indicated, including support at every stage of preparing the innovation and implementation of tasks occurring at different stages of placing the product on the market.

One of the most important aspects that often determines the choice of a research laboratory is the experience of its hired employees (average rating of 4.67; 75.5% of indications for the assessment of 5 points). Extensive knowledge of consultants in combination with the experience at work is the basis of a strong team with unique abilities. It is also a guarantee that the scope of the carried-out research will be compliant with the previous arrangements between the contracting parties, which is the condition of starting the cooperation with the research entity by the companies (average rating of 4.65; 73.5% of indications for the assessment of 5 points). Each time, the manufacturer should have the opportunity to familiarise himself not only with references that the research laboratory obtained from other partners, but also with consultants, who will be involved in the research. It allows to build trust – which is an important criterion of the research laboratory selection – (average rating of 4.65; 71.4% of indications for the assessment of 5 points); however, building of an entity based on mutual trust requires high awareness and involvement of employees of the laboratory.

A decisive factor in the choice of a research entity includes harmonious development of the related technical facilities (average rating of 4.63; 73.5% of indications for the assessment of 5 points). Having the right kind of technical facilities depends on the size and nature of the research performed by the laboratory and on the market and economic conditions.

The carried-out research shows that the determinant of the research laboratory selection by the machinery manufacturer is the relation of a quality level to a level of prices of the offered services (average rating of 4.63; 71.4% of indications for the assessment of 5 points). The price importance decreases when the quality diversity of the re-

search increases. At a high level of the research diversity, the purchasers are more inclined to treat the price as an indicator of the offered service quality. A range of prices has a similar influence. At a large price difference of the research, the manufacturers are more willing to treat the price as a signal of their scope and quality. By selecting the research laboratory – to a slightly lesser extent - the manufacturers take into account the compliance of activities with the procedures, concern about the object during its storage, the possibility of conducting the research at the client's or payment terms.

4. Summary and recommendations

In order to meet the current cognitive trends, the research subject of this study included the research laboratory selection determinants assessed from the perspective of the agricultural machinery manufacturer. As a result of the conducted evaluation, the authors of this paper confirmed that what most strongly affects the possibility of cooperation in the scope of the research services is long-lasting relationships, sometimes far beyond business activities.

The development of a proper method for assessing the research laboratory, and its selection based on it, is a crucial task that the current agricultural machinery manufacturers must face. The research presented in the study may provide

the companies with the direction of conducting such activities, with particular emphasis on the selection of appropriate assessment criteria. It will allow the manufacturers to choose the research entity, which will provide the maximum high research quality adequate to its price, what is not irrelevant in the final settlement.

The issues addressed above require further, more detailed studies. The study should be treated as a foundation for further research works, whose results will be successively presented in this publishing.

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