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Management and quality sciences as a discussion implicator on the maturity of Polish manufacturers of the agricultural machinery sector

"Be a yardstick of quality"
Steve Jobs

1. Introduction

In the management and quality sciences, the issue on maturity in relation to industrial companies both constitutes a source of satisfaction and poses many problems. This area of operation thus becomes an interesting field for development in research and economic practice. This article meets these expectations.

The maturity determination is not easy because this concept refers to almost any type of human activity, and besides, it is considered in many aspects of various areas. While discussing this term, many aspects were emphasised. It was determined, among others, as a state of readiness of specific activities, the ability of the organisation and processes that it implements to systematically provide increasingly better business results (Kalinowski, 2011, p. 173) or a state of being complete, perfect or ready (Lahrmann et al., 2010). Such definitions get to the point of the issue on the management and quality sciences.

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Taking into account their characteristics, for the purposes of this paper, the authors propose to determine maturity as a reached level of the implementation of tasks, methods and tools that can be considered mature from the qualitative perspective[1].

The maturity measurement is not easy. The primary cause of difficulties is the fact that several sciences deal with the maturity study, which results in the situation that there are various definitions and different test methods of these processes. The points of view of individual researchers may thus be different, which may lead to the situation that the identification, analysis, measurement or design are carried out according to various approaches. Thus, companies face many difficulties here. How to design the maturity management system? How to construct assessment indicators? In what way and how often the measurements should be carried out? How to analyse the obtained results? These are the most common questions, to which they look for replies.

In the context of the above, the studies, the primary purpose of which was the attempt to answer the following question, were started: *what is the maturity level of the Polish companies operating in the agricultural machinery sector within the area of the implementation of quality management principles, methods and tools?* In connection with the so outlined aim, the following have been recommended as necessary activities:

- at the theoretical level – using the reconstruction and interpretation method of the subject literature – to nominate the questions giving opinions on the maturity level in the sphere of the effective implementation of quality management principles, methods and tools,
- at the design level – to compile a research tool in the form of an assessment sheet that constitutes a result of the literature exploration and discussion among deliberately chosen experts[2],
- at the empirical level – questioning among manufacturers of parts, components and finished agricultural machinery.

The recommendations resulting from the theoretical considerations conducted by the authors and the implemented research proceedings constitute an important knowledge base that empowers the authors to conclude that the surveyed manufacturing companies operating in the agricultural machinery

1 Especially that the maturity concept originates from both the quality management fields and the subject of good business practices (Auksztol, Chomuszko, 2012, p. 42).

2 It is reasonable to ask the question: *what quality management principles, methods and tools can determine the maturity level of companies?*

sector show a relatively low level in the scope of the implementation of quality management principles, methods and tools.

The assessed desiderata do not exhaust the discussed issue; however, they are key quality management areas, and as such, they can constitute a basis for the maturity evaluation. The authors draw attention to emerging hybrids in the management and quality sciences, which cause "mixing" of different management principles, methods and tools. As a result, the integrated solutions, which allow for combination of solutions making it possible to achieve a variety of objectives, under one management system, began to be created (Starzyńska, 2013, p. 12). Not all the emerging management concepts are reflected in the formalised frameworks of requirements of the specific standard, hence their overall classification was deliberately abandoned.

2. Starting point

The companies searching for a key to the further development and maintenance of a permanent competitive advantage put emphasis on various factors. Some of them invest in technical innovations, other ones in the optimisation of processes and organisational structure, while others – in building of pro-quality culture. The object of interest in this publication includes these companies, which see the sources of building their position in the high-quality management processes. They assume that there is a relationship between the quality of these processes and the probability of opportunities for good prospering of the company in a longer term.

In the recent decades, the orientation towards quality, involving the implementation of quality management systems and application of a method for management by quality – TQM (Mantura, 2000, pp. 13-17), occurred. Only the totally understood quality is the most effective instrument for achieving the competitive advantages over market rivals (Haffer, 2003, p. 7). However, it is important to remember that in order to meet the qualitative objectives of the company and their resulting tasks, it is necessary to have adequate knowledge on the possibilities of using and assessing the suitability of the quality management principles, methods and tools.

In the paper, it was assumed that the quality management methods are a set of systematic and repetitive activities that lead to the achievement of specific objectives; they are used in the selected process stages. The methods are often associated with quality tools which are the source of data and information processed further within the framework of the method. The tools are characterised

by simplicity and they are used in order to collect and process quantitative and qualitative data into information used for quality control, or consequently, in the quality management methods. The principles are characterised by a long-term impact and affect the company development strategy, and they exceed the company frameworks, and the application results are difficult to the current assessment. Depending on the complexity of the problem, the applied method is defined as a tool. It results from the degree of generalisation, in which the method is applied (Mazur, Gołaś, 2010, p. 26). The introduction of principles, methods, techniques and tools to practice of the process of improving the quality often faces resistance and the lack of understanding. Therefore, a prerequisite for effective use of these instruments is to understand the needs of their application and full commitment and support from the top management board, planning and organisation of activities related to the implementation of these techniques, as well as the involvement and participation of employees based on teamwork, and also the properly conducted training programme (Jazdon, 2002).

Maturity is a dimension codified in the field of management and quality sciences directly oriented towards an increase in efficiency and effectiveness of the taken activities. It is implied by the ability of companies to meet the requirements related to the quality. The proper quality management improves competitiveness, efficiency and flexibility of the entire organisation (Oakland, 2004, p. 42). The elements supporting the "mature organisation" operation include the quality management principles, methods and tools that should be commonly used. Accordingly, it is not surprising that the quality management principles, methods and techniques are, according to many authorities, the management and quality sciences, that is the foundation of the company.

The management and quality sciences describe many quantitative and qualitative methods, tools and techniques for the improvement of key elements, which relate to quality, such as uniformity of characteristics of the product or service and the compliance with standards or customers' satisfaction (Vernon, 2002; Ishikawa, 1976; Juran, 1988; Barker, 1989; Dale, McQuater, 1998). Among these principles, methods and tools, traditional tools, the so-called "big seven" quality management methods and techniques, are mentioned; flow diagram, Ishikawa cause and effect diagram, Pareto-Lorenz diagram, histogram, reference sheet, correlation diagram and Shewart control charts. The tools called "new quality management tools" are also singled out. They include: relationship diagram, affinity diagram, systematics diagram, matrix diagram, matrix data analysis, programme diagram of the decision process and arrow diagram (Starzyńska, 2013; Mazur, Gołaś, 2010; Hamrol, Mantura, 2004).

All these quality management principles, methods and tools play a key role in the companies focused on continuous improvement. Their effective application allows to: assess and monitor the processes, recognise each process or problem in the improvement process, the pursuit of continuous improvement, transfer of experience from the activity of the quality improvement to everyday operational activities in business, strengthening of teamwork through methodical problem solving (McQuater et al., 1995, p. 38).

Although none of the principles, methods or tools is not more important than others (Bamford, Greatbanks, 2005, pp. 378-379)[3], the essence of the presented publication is to present and assess the situation related to the degree of their implementation by the manufacturing companies operating in the agricultural machinery sector. The reason for choosing this research problem is the fact that among many requirements for the suppliers of parts, components and finished agricultural machinery, the applied principles, methods and tools constitute one of the most important requirements of the quality management system.

By taking the research work, the authors put the conceptual model of the thesis: *The authors' practical experience allows to presume that the quality management principles, methods and tools are not used by the surveyed companies in an effective manner.* However, it should be empirically verified. It will allow to propose possible directions of operation in the scope of using several most effective principles, methods and tools, which will allow the companies to obtain the status of "mature". Especially that it seems that there is a lack of discussion related to the low level of their application, in particular, in the sector of manufacturers of the agricultural machinery.

In the context of the above, it seems accurate to plan research based on the methodology of literature studies, expertise, creative discussion, participating observation and interviews with selected representatives for the studied sector. The studies having theoretical grounds, for management practitioners, can become the basis for evaluation and inspiration to build own strategies in the scope of the implementation of selected principles, methods and tools.

The presented studies do not exhaust the discussed issue. Despite the unquestionable popularity of the quality management concept in the business environment and continuously increasing research interest in this issue, it occurs that there are still many areas requiring the solution in the nearest future.

3 They are all different and used in various situations, and each of them has unique quality and puts emphasis on the same data in different ways.

However, it is important that the presented studies even minimally became a guideline for those who want to introduce changes in their company.

3. Material and method

3.1. Research tool development

The objective of the research was to identify the quality management principles, methods and tools reflecting the maturity of manufacturing companies operating in the agricultural machinery sector. By using the method of reconstruction and interpretation of the Polish (Starzyńska, 2013; Hamrol, Mantura, 2002; Hamrol, 2005; Kolman, 2009; Łuczak, Matuszak-Flejszman, 2007; Mazur, Gołaś, 2010; Sęp, Pacyna, 2001; Sęp, Perłowski, Pacyna, 2006; Żuchowski, Łagowski, 2004; Wolniak, Skotnicka, 2007; Karaszewski, 2006; Łuczak, Maćkiewicz, 2006; Łunarski, 2008; Mazur, Gołaś, Łężak, 2008; Mazur, Szalbierz, 2003) and foreign (Moreira, Pais, 2011; Shingo, 1985; Starzyńska, Hamrol, 2013; Bamford Greatbanks, 2005) subject literature, a range of the quality management principles, methods and tools giving opinions on the level of the maturity of companies (figure 1) was selected.

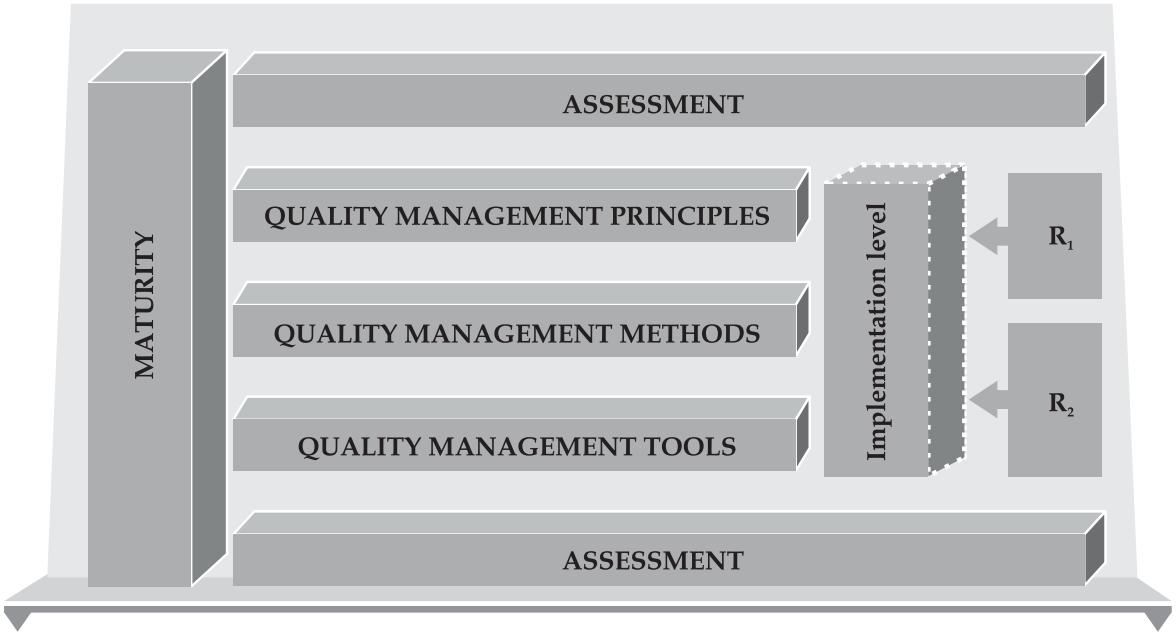

Figure 1. Assessment subject

Source: own study

Such an activity – at the design level – allowed to compile a research tool in the form of an assessment sheet that constitutes a result of the literature exploration and discussion among deliberately chosen experts. In the first phase, the research was targeted to the intellectual abilities of the entity without taking into account the entire group. Therefore, the research participant did not present his/her observation within the group, only individually pointed to these quality management principles, techniques and tools, which in his/her opinion can be used by the Polish manufacturers of the agricultural machinery sector (individual brainstorming). The discussion was attended by 12 experts associated with the agricultural machinery sector (table 1).

Table 1. List of experts

Group/Institution/Position	Number	Specialisation/Qualifications	Share [%]
Owners and co-owners of manufacturing companies in the agricultural machinery sector	6	Organisation and Management, owner's supervision	33.33
Managers of manufacturing companies in the agricultural machinery sector	2	Management of product, technological and organisational innovations	11.11
Expert associated with manufacturing companies operating in the automotive sector for over 12 years	1	Certified Risk Manager ISO 31000; representative for the Integrated Management System (ISO 9001, ISO 14001, PN-EN 18001) in one of the companies of the machinery sector (manufacturing of trailers)	5.56
Instructor	1	Quality management methods and techniques, quality planning, ISO 14001, ISO/TS 16949, Management of projects (prince2), Advanced product quality planning and production parts approval process (APQP/ PPAP)	5.56
Quality Management System Representative	1	Quality Management System (ISO 9001:2015) Environmental Management System (ISO 14001:2015) Quality requirements for fusion welding of metallic materials (EN ISO 3834-2) Adhesive bonding of railway vehicles and parts (DIN 6701-2)	5.56

Manager of the Testing Laboratory of Industrial Institute of Agricultural Engineering	1	Modelling of the machinery safety and the assessment of conformity with requirements of the EU directives and standards harmonised at the concept and product designing stage	5.56

Source: own study

In the second stage of the study, a group of 18 managers[4] assessed, and then, selected the previously reported ideas. The discussion took place in teams of six, in which the participants were intensively writing down the quality management principles, techniques and tools that they selected on a piece of paper for six minutes. After this time, each group presented its types. The expert studies (method 66) – of phenomenological nature (based on experience) – allowed to identify the opinions, feelings and associations, which in the analysed case resulted from a number of factors related to the quality management problem. Based on the experts' interviews, the guidelines for quantitative studies were determined[5]. The experts provided interesting information on the language that "industry experts" use to describe the phenomena constituting the subject matter of interest. The authors believe this allowed avoiding mistakes at the level of constructing questions and to adapt the language to the potential respondents. These studies significantly made it easier for the researchers to approach the natural world of respondents, and to understand their attitudes, language, which greatly helped to properly carry out the quantitative studies while ensuring full understanding of the studied phenomena among the potential respondents.

4 The experts represented: micro – 1 person (5.56%), small – 6 persons (33.33%), medium – 9 persons (50%) and large – 2 persons (11.11%) companies. The answers were provided by: owners of companies – 8 persons (44.44%), managers directly supervising the work on the implementation, maintenance and improvement of the quality management systems – 7 persons (38.89%), production manager (5.56%), the main technologist/constructor (5.56%) and representative for quality (5.56%); where: 61.11% of experts had higher education, 27.78% – secondary education, and 11.11% had vocational education; 4 persons (22.22%) were more than 50 years, the age of 7 persons (38.89%) was within the range of 41-50 years, 6 persons (33.33%) were 30-40 years, 1 person (5.56%) was under 30 years.

5 The carried-out studies helped to generate the areas for the further study, formulate problems and specific issues.

3.1. Model verification

The fundamental studies (self-assessment) were conducted on a test of 56 companies representing the agricultural machinery sector, deliberately selected on the basis of a criterion of pro-quality maturity perceived through the prism of 10 desiderata referred to the human resources (Table 2). The studies involved the companies, in which the hired employees:

D_1) are engaged in the implementation of pro-quality objectives of the company;
D_2) can be the initiator of changes;
D_3) constantly improve their knowledge searching for opportunities for the organisation improvement;
D_4) have a positive approach to new experience and changes, treating them as an opportunity for improvement;
D_5) are willing to communicate and share knowledge with other employees;
D_6) are willing to take innovative activities;
D_7) implement their own ideas to improve work, not fearing the risk of failure;
D_8) openly share their ideas, thoughts and knowledge;
D_9) actively seek the internal and external sources of improvement;
D_10) understand the impact of own work on the organisation quality and result[6].

The respondents included owners (55.36%) and managers (44.64%) representing: micro – 4 persons (7.14%), small – 19 persons (33.93%), medium – 27 persons (48,21%) and large – 6 persons (10.71%) manufacturing companies operating in the agricultural machinery sector[7], where 33.93% constituted the respondents in the age group of 31-40 years, 35.71% in the age group of 41-50 years and 19.64% in the age group of 51-60 years). Taking into account the group of owners, 35.48% was more than 50 years old, 35.48% was in the age group of 41-50 years, while 29.03% was younger than 40 years. In case of managers, 26.79% of respondents was more than 50 years, 36% was in the 41-50 age group, 44% of managers was 31-40 years old, while 4% was under 30 years old. The detailed characteristics are shown in table 2.

6 The respondents were asked to assess the maturity of their company in the scale of 1-5, where 1 meant very low maturity within the specified desideratum, however 5 – very high. None of the surveyed companies assessed its maturity as satisfactory, poor or very poor, which affected their qualification for the studies.

7 The study was participated by manufacturers of tractors, combine harvesters, trailers, combined cultivators, seeders, silos, forklifts and any equipment used in livestock rearing and breading, such as feeder wagons and feeder conveyors.

Table 2. Characteristics of the surveyed population by age (N=56)

	Age					
	Owners		Managers		In total	
	55.36%		44.64%		100%	
	Number of participants	%	Number of participants	%	Number of participants	%
up to 30 years	N=1	3.23	N=1	4.00	N=2	3.57
from 31 to 40 years	N=8	25.81	N=11	44.00	N=19	33.93
from 41 to 50 years	N=11	35.48	N=9	36.00	N=20	35.71
from 51 to 60 years	N=7	22.58	N=4	16.00	N=11	19.64
more than 60	N=4	12.90	N=0	0	N=4	7.14
In total:	N=31	100.00	N=25	100.00	N=56	100.00

Source: own study

Among the surveyed, a group of persons with high school and higher education was the biggest, where 61.29% of owners had higher education, 25.81% – secondary education, and 12.90% – vocational education. In case of managers, 72% had higher education, 24% had secondary education and 4% graduated from vocational schools. Detailed characteristics are shown in table 3.

Table 3. Characteristics of the surveyed population by education (N=56)

	Education					
	Owners		Managers		In total	
	55.36%		44.64%		100%	
	Number of participants	%	Number of participants	%	Number of participants	%
Primary	N=0	0	N=0	0	0	0
Vocational	N=4	12.90	N=1	4.00	N=6	9.52
Secondary	N=8	25.81	N=6	24.00	N=20	31.75

Higher	N=19	61.29	N=18	72.00	N=37	58.73
In total:	N=31	100.00	N=25	100.00	N=56	100.00

Source: own study

The further part of the paper attempts to interpret the results and conduct a more thorough analysis based on the respondents' declarations. The analysis proceeded according to pre-established stages. The first of them included the appropriate preparation of the obtained primary data and its proper arrangement. Such a method for data processing allowed for the material segregation, listing of the quality management principles, methods and tools in the respective groups. The next stage was a description of the obtained data and its interpretation. In order to carry out the assessment, a five-point scale that describes the maturity level of the implementation of the individual quality management principles, methods and tools (table 4).

Table 4. The level of implementation of the selected quality management rule, method or tool – assessment scale

Level	Description
5	Quality management rule, method or tool operates as a model; a high level of knowledge and use.
4	Quality management rule, method or tool is rather used; however, there are significant opportunities in the scope of improving its systematic implementation.
3	Quality management rule, method or tool – although known and consciously used – it is very occasional.
2	Quality management rule, method or tool – although known – it is used very rarely, rather intuitively.
1	Quality management rule, method or tool is not consciously applied; if it is, accidentally.

Source: own study

As a rule, the average value of a given feature should not be calculated in the ordinal scale. However, in the research methodology, it is used in the survey questionnaires, and owing to it, it is possible to obtain a response concerning the acceptance level of a phenomenon or a view. Therefore, it is reasonable and appropriate to use it in these studies.

4. Study results

4.1. Quality management principles –R_1

Knowledge and effective application of the quality management principles are a sign of high technological culture. Their implementation should be associated with a specified maturity level of the quality management system, on the grounds of which there is the management staff's awareness of the legitimacy of their use and the necessity to blend corrective activities and continuous improvement into practice. Here it is necessary to draw attention to the fact that the companies deliberately subjected to the study, to a large extent, comply with these principles as a permanent management practice element (table 5).

Table 5. Quality management principles in the opinion of the surveyed companies

Item	QUALITY MANAGEMENT PRINCIPLES	Implementation level (% of indications)					AVG.
		1	2	3	4	5	
ZZ_[1]	System approach to management	1.0	2.0	5.0	26.0	22.0	4.18
		1.8	3.6	8.9	46.4	39.3	
ZZ_[2]	Decision making based on facts	-	1.0	6.0	26.0	23.0	4.27
		-	1.8	10.7	46.4	41.1	
ZZ_[3]	Mutual use of associations (relationships) with suppliers	-	2.0	7.0	22.0	25.0	4.25
		-	3.6	12.5	39.3	44.6	
ZZ_[4]	Stability (constancy) of the objective	-	2.0	7.0	28.0	19.0	4.14
		-	3.6	12.5	50.0	33.9	
ZZ_[5]	Teamwork principle	-	4.0	6.0	26.0	20.0	4.11
		-	7.1	10.7	46.4	35.7	
ZZ_[6]	Kaizen	-	1.0	7.0	27.0	21.0	4.21
		-	1.8	12.5	48.2	37.5	
ZZ_[7]	Poka-Yoke	1.0	3.0	10.0	27.0	15.0	3.93
		1.8	5.4	17.9	48.2	26.8	

ZZ_[8]	Zero defects	-	2.0	9.0	26.0	19.0	4.11
		-	3.6	16.1	46.4	33.9	
ZZ_[9]	Customer-oriented approach	-	-	-	15.0	41.0	4.73
		-	-	-	26.8	73.2	
ZZ_[10]	Leadership	-	1.0	3.0	23.0	29.0	4.43
		-	1.8	5.4	41.1	51.8	
ZZ_[11]	Involvement of people	1.0	3.0	3.0	21.0	28.0	4.29
		1.8	5.4	5.4	37.5	50.0	
ZZ_[12]	Process approach	1.0	2.0	4.0	31.0	18.0	4.13
		1.8	3.6	7.1	55.4	32.1	
ZZ_[13]	Teaching everyone a new philosophy	2.0	3.0	11.0	23.0	17.0	3.89
		3.6	5.4	19.6	41.1	30.4	
ZZ_[14]	Elimination of the mass inspection need	2.0	4.0	11.0	23.0	16.0	3.84
		3.6	7.1	19.6	41.1	28.6	
ZZ_[15]	Basing business on quality and not on price	-	1.0	9.0	19.0	27.0	4.29
		-	1.8	16.1	33.9	48.2	
ZZ_[16]	Elimination of waste	-	-	3.0	15.0	38.0	4.63
		-	-	5.4	26.8	67.9	
ZZ_[17]	Practice (training)	2.0	2.0	11.0	18.0	23.0	4.04
		3.6	3.6	19.6	32.1	41.1	
ZZ_[18]	Modern supervision methods	2.0	2.0	11.0	23.0	18.0	3.95
		3.6	3.6	19.6	41.1	32.1	
ZZ_[19]	Getting rid of fear	-	2.0	7.0	25.0	22.0	4.20
		-	3.6	12.5	44.6	39.3	
ZZ_[20]	Elimination of slogans and reminders	1.0	2.0	8.0	25.0	20.0	4.09
		1.8	3.6	14.3	44.6	35.7	

ZZ_[21]	Elimination of limits at work	-	-	8.0	25.0	23.0	4.27
		-	-	14.3	44.6	41.1	
ZZ_[22]	Creation of conditions to be proud of the performed work	-	-	4.0	27.0	25.0	4.38
		-	-	7.1	48.2	44.6	
ZZ_[23]	Action plan - PDPC	1.0	3.0	5.0	25.0	22.0	4.14
		1.8	5.4	8.9	44.6	39.3	

Source: own study

The organisation is a system that behaves deliberately and consists of at least two deliberately behaving components with common intention, due to which there is a functional division of work in the system (Koźmiński, 1976; Ackoff, 1973). Therefore, the manager, who follows the system approach principles, can easier and better maintain a balance between the needs of individual subsystems and the needs and objectives of the entire company. The surveyed managers think systemically (average rating of 4.18; 39.3% of indications for the assessment of 5 points). They are aware of the need for interaction with other people, units and organisational entities. The key is to understand the interdependence of processes in the system and their continuous improvement through measurements and assessment. The data analysis of processes, products and results of qualitative objectives, inspections carried out by the management, and also the results and conclusions of the audits may become a source of enhancement, improvements and innovations, especially, the organisational ones. Hence, the decision making in the surveyed companies is based on an analytical, logical or intuitive analysis of all available data and information (average rating of 4.27; 41.1% of indications for the assessment of 5 points).

The supply chain integration has become the essence of modern management (Ciesielski, 2011). The study results confirm the authors in their belief that cooperation in the supply chain is not only related to logistics, but also to marketing, production, quality management, research and development, etc. The surveyed companies are oriented towards thinking about the suppliers' capabilities; they do not only focus on goods (products), which results in the situation that the supply becomes proactive, determines networking and the management direction of networks and processes taking place in them. The

mutual use of links with suppliers is indicated (average rating of 4.25; 44.6% of indications for the assessment of 5 points). The managers are aware of the fact that the cooperation with the suppliers participating in the development of goods and services can be a source of innovative ideas, new technologies or unique solutions for the companies.

One of the main attributes of a modern manager is the ability to decompose the objectives into specific activities and tasks. The defined and accepted main objective is a starting point to determine the so-called partial objectives, which should be characterised by great details. It is important to notice the relationships and implications that this is the implementation of all the assumed partial objectives that becomes an element determining the main objective achievement, which in its essence, should be relatively fixed (constant). The surveyed companies are presented as relatively fixed (constant) within the range of the defined strategic objectives (average rating of 4.14; 33.9% of indications for the assessment of 5 points). However, it does not mean the lack of flexibility in the implementation of partial objectives constituting a response to emerging changes. They are aware of the fact that the lack of the objective redefinition may dangerously extend the implementation of the main objective. By taking into account the number of changes, which take place in the world, the advice to quickly carry out the planning process, immediately moving to implementation, monitoring and correction during implementation, seems to be valuable. It is important that the objective is consistent with the mission, vision and other objectives, properly formulated and understandable for all.

In order to achieve the set objectives – the organisation functioning in the conditions of knowledge-based economy appoints the appropriate teams. The creation of space and conditions for effective and efficient teamwork is a major challenge for modern companies. The surveyed companies declare interdependence, a sense of joint responsibility for the implemented tasks and objectives, but first and foremost, the capability of effective and efficient communication between participants of the action and mutual trust (average rating of 4.11; 35.7% of indications for the assessment of 5 points). Honesty and trust are the foundation of good teamwork.

The development of each company is based on strengthening and improvement of the currently existing standards by formulation of new and higher goals. Such development can be based on the kaizen philosophy, which directs the management activities to continuous improvement with the use of small, effective steps, based on the knowledge and experience of all employees of the company. By involving employees within the implementation of the kaizen

philosophy – the surveyed companies – give them the opportunities to create new or better standards, at the same time, developing a certain way of behaviour and thinking as well as discipline necessary to adapt to it (average rating of 4.21; 37.5% of indications for the assessment of 5 points).

In the course of the performed studies, attention was drawn to the analysis of error causes. The respondents declared such organisation of work in the companies, which significantly reduces the probability of the error occurrence, and if this error occurs, it does not cause a failure and it is immediately visible and detected (average rating of 3.93; 26.8% of indications for the assessment of 5 points). The "zero error" principle is closely associated with continuous improvement and teamwork principles. The application of this principle – by creating a suitable system in the company that allows for easy communication of employees with superiors, as well as between each other, which enables the proper identification of non-compliances and causes for their occurrence, and formulation of principles of the improvement of processes and goods – is declared by the surveyed companies (average rating of 4.11; 33.9% of indications for the assessment of 5 points).

The core competence that requires constant improvement is the ability to properly analyse the customers' needs. The ability of their proper reading is the basis for functioning of every company and the condition of its financial success. The best offer proposed by the company is the one that most accurately and most fully corresponds to the customer's needs, which the surveyed companies realise (average rating of 4.73; 73.2% of indications for the assessment of 5 points). The maintenance of a dialogue with a customer, mutual trust and willingness to achieve mutual benefits in a long time period allow them to have a new look on the marketing concept emphasising the share of information in order to increase the level of knowledge of the customer with new possibilities of the company, technological solutions, new products, and also development directions in the sector and on the market.

When owing to leaders, employees strive for objectives that represent the values and motivations common for both parties – as in case of the surveyed companies – it is possible to speak about leadership (average rating of 4.43; 51.8% of indications for the assessment of 5 points). The entire art of leadership is based on the ability to perceive and implement these common objectives, and to implement the potential of other people and to direct talents, knowledge and abilities of the group to the predetermined results. A leader inspires, motivates, encourages and engages (average rating of 4.29; 50.0% of indications for the assessment of 5 points). Therefore, people that are led by him/her have much

greater knowledge, they are specialist, experts, and they have the potential to be able to change the reality.

Attention is drawn to the identification of processes needed to achieve the intended purposes, implementation of measurements of input and output elements, identification of relationships between the processes, determination of a range of responsibility and improvements in the area of managing the processes, as well as the analysis of methods, training and resources needed to achieve the intended result. The surveyed companies can identify and monitor all relevant processes implemented in the organisation, determine their sequences and interactions, methods supporting their proper course and criteria for their effective monitoring and control (average rating of 4.13; 32.1% of indications for the assessment of 5 points).

The appropriate work culture, specifying the proper relationships between the management and contractors of manufacturing tasks, determines the effectiveness of functioning of work teams, and they set the pace and type of activities intended to obtain the appropriate quality state. When the management actively involves itself in determination and implementation of tasks, the conditions to change the current attitude towards quality will be created. According to the surveyed companies, the employees hired in the organisation treat their tasks seriously. Being aware of the full responsibility for the correctness of the quality creation process course, the managers affect the shaping of their cultural values determining the course of this process and take non-technical steps in order to create quality (average rating of 3.89; 30.4% of indications for the assessment of 5 points). It required the development of new cultural values based on knowledge, reliability, qualifications and ethics of the employees hired in companies.

The constant striving for the quality improvement, in the opinion of the surveyed companies, means shaping the awareness of employees in its scope. An important aspect involves making the employees aware of their impact on the quality of manufactured products. In addition, attention is paid to the necessity of promoting and using traditional and modern quality tools which will allow constructing and secure the process in such a way, as to avoid unnecessary errors (average rating of 3.95; 32.1% of indications for the assessment of 5 points). Even quickly noticed and immediately removed defects generate unnecessary costs for their removal or other indirect costs for the company. Therefore, it is crucial to determine and remove the most significant defects in every manufacturing area, starting from the smallest technological operations. The entrepreneurs are aware of the fact that it is not

possible to rely on mass control as a way of the quality assurance; gradual elimination of mass inspection (average rating of 3.84; 16.0% of indications for the assessment of 5 points). Attention is drawn to striving for the situation that the statistical quality confirmation becomes part of the manufacturing process and sales.

The need to abandon the transaction, the condition of which is only the purchase price; the key and only selection criterion, is postulated. It is important to strive for reduction of the total cost, and not just the initial cost. Of course, the primary selection criterion should be to minimise the total costs, and first and foremost, to create the foundation for the smooth manufacturing course while ensuring the appropriate quality level[8]. The surveyed companies declare to base business on the quality, and not the price (average rating of 4.29; 48.2% of indications for the assessment of 5 points). The manifestation of it involves even striving for establishing long-term cooperation based on trust and loyalty.

The production management processes in their current shape will be significantly changed. The concept which permanently changes the model of functioning of industrial companies is lean management. The lean management implementation is the expression of a widely held belief that counteracting the waste is one of the possibilities of increasing the effectiveness and quality of the company operation. The elimination of losses, although important and desired (average rating of 4.63; 67.9% of indications for the assessment of 5 points?), cannot be treated as the sole direction of the pro-quality strategy implementation in any situation and at any time. The successful transformation towards the lean company should, at the same time, focus on technical changes aimed at building the technical stability of processes, the implementation of a rapid course of values and technical enhancement and improvement of processes, including procurement processes. It requires the employees to acquire new knowledge and new practical skills, which the surveyed companies seem to remember (average rating of 4.04; 41.1% of indications for the assessment of 5 points). One of the Lean pillars is work with people based on respect for every person who is part of the company. In order to build the Lean company, the surveyed

8 Despite the increasingly rich subject literature on the relationship of the price and perceived offer quality, there is no clear position of researchers in this scope (Völckner, Hofmann, 2007). The postulate that the phenomenon on the inference related to the quality on the basis of the price is less common than it may seem, is more frequently formulated (Boyle, Lathrop, 2009).

companies create the environment, in which all people work hard, but they do not live in fear of losing their job, in which the leaders, through the challenges, create the leaders around them (average rating of 4.20; 39.3% of indications for the assessment of 5 points). The lack of fear contributes to the greater involvement of employees, better information exchange, reduction of errors and the company's economic losses. With the leaders' support, the employees know how to take full responsibility for their lives and how to rely on themselves, and they are focused on the implementation of valuable objectives.

Attention is paid to the elimination of empty phrases, slogans and reminders (average rating of 4.09; 35.7% of indications for the assessment of 5 points). In order to increase the productivity and quality, the managers postulate the implementation of methods for improving the work system.

The role of managers evolves towards helping people in performing the best work, as well as anticipation and elimination of limitations that prevent the constant quality provision (average rating of 4.27; 41.1% of indications for the assessment of 5 points)[9]. Wherever the limitations, competition and lack of trust can be seen, the companies currently introduce teamwork and cooperation between individual departments. It indicated the elimination of barriers, which deprive the employees of their right to be proud of their professionalism (average rating of 4.38; 44.6% of indications for the assessment of 5 points). In practice, it means the abolition of the annual assessment and the assessment of merits. In the surveyed companies, the conditions in which the employees see the need to involve themselves in action for the realisation of changes taking place in their companies are provided (average rating of 4.14; 22.0% of indications for the assessment of 5 points).

4.2. Quality management methods and tools – R_2

An important aim of the implemented studies was also the determination which of the selected quality management methods and tools are most commonly used by the surveyed companies (table 6).

9 Attention is drawn to the quantitative standard abolition, leaving of management by objectives or management by numbers and numerical objectives.

Table 6. Quality management methods and tools in the opinion of the surveyed companies

Item	QUALITY MANAGEMENT METHODS AND TOOLS	(% of indications)					AVG.
		1	2	3	4	5	
MiNZJ_[1]	FMEA – Failure Mode and Effect Analysis	-	3.6	8.9	39.3	48.2	4.32
MiNZJ_[2]	Control plan	1.8	5.4	16.1	37.5	39.3	4.07
MiNZJ_[3]	PPAP - Production Part Approval Process	-	1.8	12.5	46.4	39.3	4.23
MiNZJ_[4]	SPC - Control charts	3.6	7.1	21.4	41.1	26.8	3.80
MiNZJ_[5]	8D - Global 8 Disciplines	1.8	3.6	23.2	42.9	28.6	3.93
MiNZJ_[6]	MSA - Measurement System Analysis	3.6	7.1	35.7	33.9	19.6	3.59
MiNZJ_[7]	APQP - Advanced product quality planning	-	1.8	12.5	48.2	37.5	4.21
MiNZJ_[8]	Diagram Pareto	3.6	12.5	37.5	30.4	16.1	3.43
MiNZJ_[9]	Flow diagram (block diagram, algorithm)	3.6	14.3	35.7	32.1	14.3	3.39
MiNZJ_[10]	Reference sheet of data collection	3.6	17.9	37.5	26.8	14.3	3.30
MiNZJ_[11]	Brainstorming	1.8	3.6	14.3	42.9	37.5	4.11
MiNZJ_[12]	Histogram	1.8	10.7	39.3	32.1	16.1	3.50
MiNZJ_[13]	AQL - Acceptance Quality Level	3.6	14.3	37.5	28.6	16.1	3.39
MiNZJ_[14]	Cause and effect diagram	1.8	8.9	33.9	33.9	21.4	3.64
MiNZJ_[15]	DOE - Design of Experiments	3.6	19.6	33.9	28.6	14.3	3.30
MiNZJ_[16]	Arrow diagram	3.6	17.9	39.3	25.0	14.3	3.29
MiNZJ_[17]	Matrix data analysis	3.6	19.6	32.1	28.6	16.1	3.34
MiNZJ_[18]	PDPC - Process decision programme chart	3.6	16.1	33.9	28.6	17.9	3.41
MiNZJ_[19]	QFD - Quality Function Deployment	-	1.8	12.5	46.4	39.3	4.23

MiNZJ_[20]	Matrix diagram	3.6	17.9	37.5	30.4	10.7	3.27
MiNZJ_[21]	Stratified analysis	3.6	23.2	37.5	25.0	10.7	3.16
MiNZJ_[22]	Tree diagram (decision tree)	7.1	23.2	33.9	25.0	10.7	3.09
MiNZJ_[23]	Relationship diagram (relation)	7.1	25.0	32.1	25.0	10.7	3.07
MiNZJ_[24]	Affinity diagram (KJ method)	7.1	26.8	33.9	21.4	10.7	3.02
MiNZJ_[25]	ABCD method (Suzuki)	7.1	23.2	35.7	25.0	8.9	3.05

Source: own study

The quality management method widely recognised and used by the surveyed companies – allowing for identification of errors and help in their elimination – FMEA method (average rating of 4.32; 48.2% of indications for the assessment of 5 points). The FMEA method allows to subject the product or process to analyses, on the basis of which the corrections and new solutions effectively eliminating the sources of the occurrence of defects are introduced.

An important stage of the product quality planning process – applied by the surveyed companies – is the control plan (average rating of 4.07; 39.3% of indications for the assessment of 5 points). During the course of regular production, the control plan indicates the control methods, which should be used in order to control the specific characteristics of the process or product. It is important from the perspective of the surveyed companies to determine whether all records of the customer on engineering design and requirements included in the specifications have been properly understood and if the manufacturing process has the potential to manufacture in a certain amount of the production batch (average rating of 4.23; 39.3% of indications for the assessment of 5 points).

Within the framework of the volatility control, as well as in order to identify and control the reasons that cause an increase in volatility [Dahlgard, Kristesen, Gopal, 2000, p. 92], the surveyed companies – to a limited extent – use the control charts (average rating of 3.80; 26.8% of indications for the assessment of 5 points). The data observation on the control charts makes it possible to determine whether the process is stable. Therefore, they are a tool for statistical control of the process used for indication whether the monitored process functions as intended, and when the corrective actions are necessary.

The determination of the cause of the occurred non-compliance and indication of the way to solve the problem, as well as the opportunity to verify the carried-out activities allow the companies to use a tool in the form of Global 8 Disciplines (average rating of 3.93; 28.6% indications for the assessment of 5 points)[10].
The tests and instruments for measuring the quality characteristics should be calibrated – ensure relevant information that is provided by measurement traceability. Therefore, the measurement system analysis – however, poorly recognised and applied – which is focused on understanding the measurement process by showing the number of errors in the process and assessing the measurement system accuracy, is key (average rating of 3.59; 19.6% of indications for the assessment of 5 points)[11].

A method commonly used by the surveyed companies, defining and determining the steps needed to ensure that the product satisfies the customer includes advanced planning of the quality of products (average rating of 4.21; 37.5% of indications for the assessment of 5 points). This is one of the most important processes, which often constitutes a requirement within the framework of customer specific requirement (CSR).

In order to analyse the data collected in the control chart – to a limited extent – it is declared to use the Pareto Diagram (average rating of 3.43; 16.1% of indications for the assessment of 5 points). The Pareto chart is also very often used as a tool for determining the quality improvement plan. It allows prioritising the factors, which have the most significant impact on the studied phenomenon. It shows both relative and absolute distributions of the error types, problems and their causes (Evans, Lindsay, 1999, pp. 440-441; Wolniak, Skotnicka, 2007, p. 22; Łańcucki, 2001, p. 195).

In order to graphically present the process course in order to indicate the points needed to be improved or to eliminate the process stages, which provide no added value – the surveyed companies – to a limited extent, use the process flow diagram (average rating of 3.39; 14.3 % of indications for the assessment of 5 points). Its application gives them the opportunity to learn about the proper course or sequence of events of individual stages of the process course of the steps presented in a logical sequence (Łuczak, Matuszak – Flejszman, 2007; Evans, Lindsay, 1999).

10 Despite the fact that 8D constitutes multi-stage and team-based activities, which refer to other methods and tools in the quality management area at each stage, in this paper, they were treated as an autonomous tool.

11 There are many studies on assessing the measurement system capabilities, including: (Tsai, 1989; Montgomery, Runger, 1993; Levinson, 1996; Jheng, 2001; Pan, Jiang, 2002; Bird, Dale, 1994).

In the initial stage of determining the problems in the scope of statistical control of the process and quality of the company, they declare relatively poor recognition and application of the form allowing for collection and compilation of data or observations in order to detect and visualise the dominant trends (average rating of 3.30; 14.3% of indications for the assessment of 5 points). The control chart constitutes the simplest form of quantitative assessment of the process course.

Within the framework of searching for new ideas on solving the problems and identification of possible solutions of problems, as well as on potential possibilities of the quality improvement, the surveyed companies declare the systematic use of brainstorming (average rating of 4.11; 37.5% of indications for the assessment of 5 points). During the brainstorming session, a list of ideas, problems or issues to solve is created. Mostly, the brainstorming adopts the form of a discussion.

In order to visualise the volatility of, e.g. results of the process course or specific characteristics of the product, and assist in making decisions on the quality improvement activities (Jazdon, 2002, p. 188), a histogram is sometimes used (average rating of 3.50; 16.1% indications for the assessment of 5 points).

To a limited extent, the acceptable quality level which in case of considering the course of successively supplied batches is a limit value of the satisfactory mean quality of the process, is indicated (average rating of 3.39; 16.1% of indications for the assessment of 5 points).

In order to make hypotheses as to the causes of defects and problems, a cause and effect chart is sporadically used (average rating of 3.64; 21.4% of indications for the assessment of 5 points). It allows to prioritise the causes of a given problem and correlation of these causes while using the chart (Smith, 1998). The cause and effect diagram, also called Ishikawa diagram and a fish bone diagram, constitutes one of the most widely used quality tools (Costin, 1999).

A set of preventive tools, which is comprised of a DOE method, is extremely important and useful – although rarely used by the surveyed companies (average rating of 3.30; 14.3% of indications for the assessment of 5 points). It is based on planning experiments and it is helpful in identifying the factors that may have a significant or slender impact on the product in various phases of the life cycle.

From the perspective of the surveyed companies, a tool for planning and communication used in order to provide the most appropriate planning time for a particular task, thus facilitating the controls in the work course, is of less importance (average rating of 3.29; 14.3% of indications for the assessment of 5 points). The arrow diagram is most often applied to develop the most effective

daily plan of the project implementation, and also to monitor its effectiveness (Łuczak, Matuszak – Flejszman, 2007).

In order to quantify a degree of the relationship between various factors – the surveyed companies – to a slight extent – use the matrix data analysis (average rating of 3.34, 16.1% of indications for the assessment of 5 points).

From the perspective of the surveyed companies, it is relatively important to determine which processes should be used in order to achieve the expected results. Therefore, it is important to assess the progress of events and a variety of possible results. Therefore, it is surprising that, in order to present a sequence of activities and decisions needed to achieve the expected result or prevention of an undesirable event, a diagram of decision-making is poorly used (average rating of 3.41, 17.9% of indications for the assessment of 5 points).

A maturely managed company should take into account all factors that affect the quality of the designed products or processes, from the beginning of their creation, that is from the design stage through production (Cohen, 1995). Therefore, it is key to take into account the customers' expectations, referred to as "voice of customer"and to transfer them to the product features expressed as "counterpart characteristics". In the context of meeting the customer's requirements, by designing the process and manufacturing processes, attention is paid to the development of a quality function (average rating of 4.23; 39.3% of indications for the assessment of 5 points); the company takes into account the "voice of customer" and it is sure that it was transformed into the correct strategy, rpoduct and process requirements.

A tool insufficiently used in order to collect a large amount of data (ideas, opinions, issues, facts), related to a broad issue or subject of the study, applied by the surveyed companies, is the affinity diagram (average rating of 3.02; 10.7% of indications for the assessment of 5 points); it constitutes a graphical complement of brainstorming, applied in order to group facts, opinions, ideas and desires of the customer, according to a specific form of natural affinity. Another rarely used graphical tool of the cause and effect analysis intended for problem identification and description of a strategic quality planning phase, when explanation and understanding of complex relationships are necessary, is a relationship diagram (average rating of 3.07; 10.7% of indications for the assessment of 5 points).

The studies, presented in the paper, carried out among the selected companies operating in the agricultural machinery sector, however, indicates the low frequency of using the tree diagram (3.09), matrix diagram (3.27) and ABCD method (3.05). The reason that these tools are not used may be the fact that several other tools are more popular and used for the same purpose. Among the

often-used tools and techniques, there are: Failure Mode and Effect Analysis, Production Part Approval Process, Quality Function Deployment, Advanced product quality planning, Brainstorming and Control plan (average above 4.0).

5. Conclusion

The studies described in this publication were aimed at recognising the actual level of knowledge and using the quality management principles, methods and tools. The studies were carried out among the selected companies operating in the agricultural machinery sector. The material collected during the research procedure allowed to draw conclusions of a general and cognitive nature. The analysis of the results was based on the arithmetic average of ratings on a scale from 1 to 5. In the opinion of the surveyed companies, all the quality management principles specific to the studied sector obtained a very high rating. However, the performed verification of knowledge of methods and tools, by defining the frequency of their application or non-use among the manufacturing companies of the agricultural machinery sector, allows to conclude that among many available methods and tools in the quality management system improvement process, only a few of them are used. According to the authors, it results from the difficulty of determining the positive impact of individual methods and tools on the achievement of economic and financial benefits by the organisation.

The paper emphasised the relationship between the company maturity and the application of the quality management principles, methods and tools. It was noted that the component that determines their effective use includes people. The achievement of increasingly greater maturity through improving the quality management processes should be treated as a cyclic activity, which is aimed at constant search for more and more effective and efficient solutions, adequate for the issues arising in given conditions.

The need for further, even more in-depth research work, is recognised. The problems solved in subsequent parts of the paper may be the subject of separate studies. There is a need for further research work on identifying the causes of the implementation and application of methods and benefits resulting from their use. It is also legitimate to identify difficulties related to the implementation of the discussed principles, methods and tools and to assess their suitability in the processes of logistics, supply and production. The research on the technical culture of companies and the demand for knowledge, related to this area, on the conditions of shaping the pro-quality policy in the companies will be also important.

Summary

Management and quality sciences as a discussion implicator on the maturity of Polish manufacturers of the agricultural machinery sector

In the paper, an attempt was made to answer the following question: what is the maturity level of the Polish companies operating in the agricultural machinery sector within the area of the implementation of quality management principles, methods and tools? In reference to such an outlined purpose, as necessary activities, it was recommended: at the theoretical level – using the reconstruction and interpretation method of the subject literature – to nominate the questions giving opinions on the maturity level in the sphere of the effective implementation of quality management principles, methods and tools; at the design level – to compile a research tool in the form of an assessment sheet that constitutes a result of the literature exploration and discussion among deliberately chosen experts; and at the empirical level – questioning among manufacturers of parts, components and finished agricultural machinery.

Keywords: *quality management, company maturity, principles, methods and tools of quality management.*

Streszczenie

Nauki o zarządzaniu i jakości jako implikator dyskusji o dojrzałości polskich wytwórców sektora maszyn rolniczych

W pracy podjęto próbę odpowiedzi na pytanie: jaki jest poziom dojrzałości polskich przedsiębiorstw działających w sektorze maszyn rolniczych w obszarze implementacji zasad, metod i narzędzi zarządzania jakością? W nawiązaniu do tak nakreślonego celu jako działania niezbędne zarekomendowano: na płaszczyźnie teoretycznej – wykorzystując metodę rekonstrukcji i interpretacji literatury przedmiotu – wytypowanie pytań opiniujących poziom dojrzałości w sferze skutecznej implementacji zasad, metod i narzędzi zarządzania jakością; na płaszczyźnie projektowej – skompilowanie narzędzia badawczego w postaci arkusza oceny będącego wypadkową eksploracji piśmiennictwa oraz dyskusji wśród celowo dobranych ekspertów; na płaszczyźnie empirycznej – indagacja wśród producentów części, podzespołów i gotowych maszyn rolniczych.

Słowa kluczowe: *zarządzanie jakością, dojrzałość przedsiębiorstwa, zasady, metody, narzędzia zarządzania jakością*.

JEL Classification: E20, I12, E24

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