

## MEASUREMENT SYSTEM ANALYSIS IN POLISH PRODUCTION ENTERPRISES

**Magdalena Diering**  
Poznan University of Technology  
Poznan  
Poland

**Edward Pająk**  
Poznan University of Technology  
Poznan  
Poland

### SUMMARY

*A measurement system analysis (MSA) is a vital component for many quality improvement initiatives in production enterprises. Premises which persuaded authors to research on MSA mainly are existing conditions in measurements quality control field. Recently there had been prepared an special inquiry and had carried out the sample survey in few dozen production enterprises which run their business in Wielkopolska Province in Poland. The aim of this paper is to describe research methodology, respondents profile, results and conclusions from the surveys and to justify that taken research is right and needed. There is also an intention to subject the poll research results to the readers consideration. After many conversations with experts and authorities from quality management field and after questionnaire ad hoc research there has drawn up an online idea for MSA. Online MSA is characterized by taking the measurements directly from the work position and during the production process. The another purpose of this paper is to define this new conception.*

**Keywords:** measurement system analysis, online MSA, sample survey

### 1. STATISTICAL PROCESS CONTROL AND MEASUREMENT SYSTEM ANALYSIS

Statistical Process Control (SPC) is the analysis of the manufacturing process carried out in the real time of the process with the use of statistical tools, both analytical and visual [1]. Information in the process control is collected straightforward from a particular workplace in the course of the process. The information from the coupling allows the preventive and not corrective impact on the process, which is quicker and cheaper [3]. Providing current information about the process is the essence of SPC – the idea of SPC assumes the connection between the manufacturing process and the statistical analysis in the form of feedback. The running analysis of the manufacturing process serves therefore for the detection of potential adjustment problems and, as a consequence, it is a tool of constant improvement, i.e. the perfection of the manufacturing process.

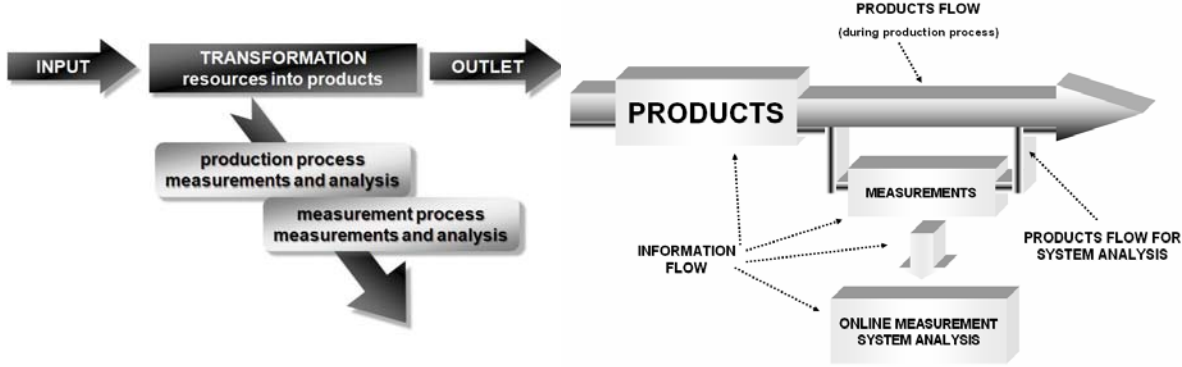
The measuring system is a set of procedures, tasks, assumptions tools (measurement equipment) software and staff which is necessary for determining numerical values for the characteristics which are to be measured [5,7]. The purpose of the assessment of Measurement System Analysis (MSA) is to obtain information about the extent and types of measurement variation caused by the measurement system [8]. Motor industry enterprises assess their measurement systems obligatorily – world motor corporations strictly require that MSA is applied by cars and

parts producers. In other trades it has not been a common practice yet – organizations which optimize their activity, have quality management system certificates and control their processes statistically still introduce MSA procedures quite rarely [2].

**2. THE PURPOSE OF THE SURVEY STUDY AND THE ONLINE CONCEPTION**

The essence of the survey study conducted was to obtain information about the usage and usefulness of methods and tools of the measurement system analysis in industry enterprises which conduct their basic activity in the area of Great Poland (but not only in this area). The questions in a questionnaire were formulated in a way which would allow the description of the existing state of the respondents' companies as far as measurement quality control is concerned and which would make possible the indication of favourable conditions as well as obstacles in the usage of these instruments. What was also crucial was surveying the attitudes of the employees of these enterprises as far as the idea of the measurement system usefulness in the manufacturing process is concerned (this method is called further the online method; it is the method on whose development the authors of this article are working [2,3]). The purpose of the study was therefore to obtain the answer whether, according to practitioners, there is demand for the development of measurement system analysis methods and whether the introduced idea of the online method will win support or criticism. The study took therefore the verificational approach.

The research underway is heading towards an attempt of devising the online method, i.e. the assessment of the usefulness of measurement system working on a current basis. The idea of the online method has its source in the "traditional" approach to MSA and the inspiration for its devising is the character of the statistical process control (measurement conducted in the course of the manufacturing process), as well as Deming's principle which propagates ideas of constant improvement (Fig.1).



*Figure 1. The online method conception. Source: own study based on [3].*

In the online method production workers, being at the same time operators of the measurement equipment, carry out the measurement of a given feature immediately on their workplaces in the course of daily work; not, as in case of the "traditional" MSA method (authors referred to the R&R–ARM method as the "traditional" method) which was discussed in detail in the guide for motor industry companies issued by Ford Motor Company [7]. This change will help in eliminating a part of the observed changeability characteristic for the analysis in its "traditional" type, which is laden with the impact of changing environmental conditions during the assessment.

### 3. THE SAMPLE SURVEY – A RESEARCH METHODOLOGY

The execution of the study was therefore aimed at obtaining two kinds of data: qualitative and quantitative. Quantitative questions were to collect data on the basis of which devising the image of the population was possible [6]. The purpose of qualitative questions was primarily the understanding of the given phenomenon, i.e. insight into how companies of Great Poland perceive statistical methods in measurement system analysis. The answers obtained from qualitative and quantitative questions were supposed to complement mutually [4]. Concerning aforementioned study aims, the endorsement and usage of at least one of management systems: ISO 9001, QS 9000 or TS 16949 by the surveyed enterprises was a requirement necessary for the participation on the study (Fig.2).

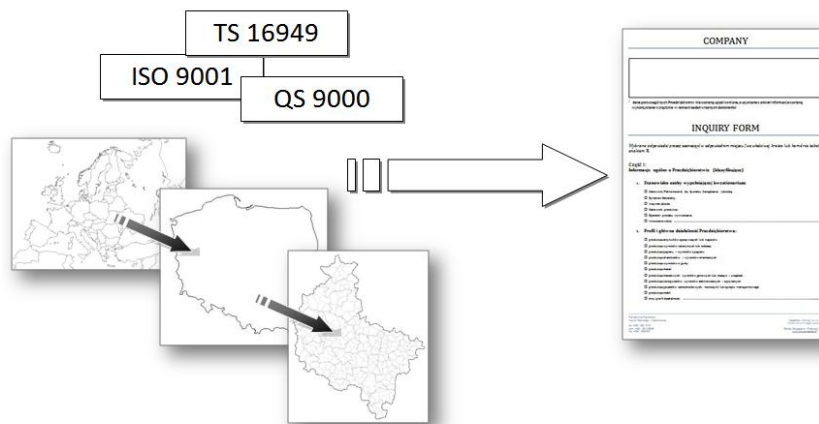


Figure 2. Choice of a random sample for a sample survey. Source: own study.

The research was divided into three stages:

1. Preparation of the survey questionnaire
2. Survey study execution
3. Results analysis and the forming of conclusions

#### 3.1. Preparation of the survey questionnaire

The questionnaire form consisted of 22 questions ordered into three parts. It was a questionnaire of a structured type with multichotomous and fill-in-the-blank questions. Both behaviour questions (How often...?), attitude questions (What do you think about...?) and classifying questions were included in the survey [4].

The first part consisted of 6 classifying questions and general issues allowing the obtainment of basic data about the surveyed enterprises (e.g. "What is the activity profile of the enterprise?"). The second part of the questionnaire consisted of another 12 questions concerning the chosen statistical methods and tools implemented in the production area. The last part of the form was aimed at obtaining information about the perception of the idea of the current assessment of the measurement system usefulness by the entrepreneurs.

#### 3.2. Survey study execution

Results of the return replies shown that enterprises were interested in received questionnaires. Within the confines of the second part of research there was sent a survey form to 70 enterprises which came up to a premises assumed for a participants of the survey study (with a instruction letter as an enclosure), which from 63% of them delivered back filled questionnaire. In was an ad hoc study, that is single.

#### 4. RESULTS AND ANALYSIS

While analyzing the profiles of the surveyed enterprises, one can perceive that the majority (as much as 37%) of the respondents belong to ready-made metal devices industry and engineering industry; however, there were also food processing, electronic and chemical industry enterprises. The questionnaire was most often filled in by managers, management system representatives and quality engineers – 36%, as well as production managers – 25%. Having filled in the general part, the respondents had to cope with questions concerning instruments aiding quality management in the production area.

As regards the whole of the respondents, only 27,3% of them admitted that their company carried out statistical analyses of measurement systems used in the manufacturing process; i.e. endorses MSA. The rest does not use MSA, but, as visible from the analysis of the questionnaires they completed, they show interest concerning this topic.

A vast majority (almost 80% of the respondents) marked a correct answer to the question checking the familiarity with the definition of the concept of the measurement system. A wrong answer can be deemed acceptable in case when a company does not use MSA procedures (as mentioned afore, it is not obligatory for non-motor industry enterprises). However, the fact that some enterprises which use MSA chose the wrong answer may be confusing – 16,7% of these respondents endorse measurement system analysis methods and at the same time do not understand them.

In earlier studies [2,3] authors hinted the negative attitude of engineers towards the execution of MSA and the fact that they often carry out the analysis with the lack of conviction as to its purposefulness. In one of the questions from this area respondents who cope with MSA were asked to indicate problems and obstacles accompanying the procedure. A number of the respondents reported lack of any problems (16,6%). The rest indicated mainly the following obstacles:

- lack of correlation between analysis results and statistical manufacturing process control,
- reluctance and lack of conviction among the employees as to the execution of MSA methods and tools,
- insufficient knowledge among the employees as far as this topic is concerned.

In another entry of the form all respondents were given a set of potential causes of measurement system changeability and asked to pick from among them those which they think are most substantial (i.e. have a greatest impact on the changeability). Causes picked by the respondents most often belonged to the following as it is shown in Table 1.

What was important (from the point of view of the research on statistical instruments aiding measuring management, conducted by the authors of the article) was the result obtained from the following question: "How often and in which situations MSA test/analysis is conducted in your enterprise?" Only 16% of the organizations which conduct MSA chose the answer which is crucial from the point of view of measurement process control: "as often as the situation demands – always when the stability of the measurement system becomes out of adjustment in a visible way (e.g. when successive control chart graphs of the same manufacturing process differ considerably depending on which operator is conducting the measurement or when the discriminating capacity of the measurement system exceeds 1/10 of the value of tolerance or of the changeability in the manufacturing process)". A majority, 66,7%, admitted that their company carries out the analysis once a year, a certain time before the audit, so they do it not with control and improvement of the measurement process in mind, but rather in order not to show incompatibilities during the audit.

Table 1. Respondents opinion about causes of a measurement system variation. Source: own study.

The possible cause of a measurement system variation	% of the respondents who pointed at that the cause is crucial
competence level (experience, skills, understanding) of the operator of the measurement tool (the evaluating person)	25,0%
the choice of measuring points	22,7%
the cleanness of the examined parts (e.g. dirt in measuring points)	20,5%
environmental conditions – the environment of the measurement system (ergonomics, temperature, lighting)	20,5%
the level of the measurement technique (cheap manual measurement devices or expensive coordinate measuring tools)	16,3%
reproducibility of the measurement tool (the changeability of the measurer)	11,4%
repeatability of the measuring tool (the changeability of the equipment)	9,0%
number and numerousness of measuring trials in one study	9,0%
other causes	13,6%

The last part of the form was composed with the bottom line finding out about the opinion on the online method as held by engineers. 77,3% assumed that carrying out such studies is arguable and purposeful (Fig.3).

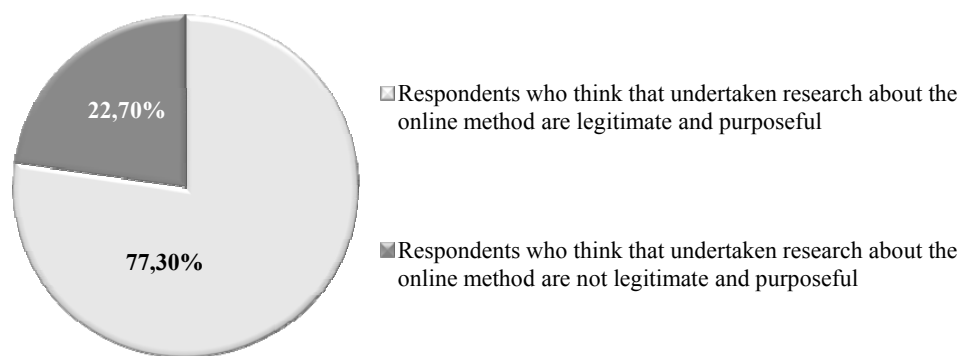


Figure 3. Respondents opinion about the online method undertaken research legitimate and purposeful. Source: own study.

Among the companies which have already conducted MSA 75% hint that there is a demand for such a method (Fig.4).

From among the distinguishing features suggested by the authors of the questionnaire for the online method, the respondents interested in the aforementioned research most frequently chose:

- a possibility of conducting the measurement system assessment during the manufacturing process undergoing (i.e. on a current basis) – 50%,
- a possibility of using the existing measurement data from manufacturing process control procedures for the assessment of the measurement system – 41,2%,
- a possibility of monitoring the state of the measurement system on a current basis – by means of a control chart devised for this purpose – 41,2%.

Features which proved to be less important included: the facility in introducing the method, i.e. quickly and cheaply (31%), the minimalised number of actions conducted in measurement process control (as compared with existing MSA methods) – the facility of usage (32%) and a possibility of the comparison between the results from the running

assessment of the usefulness of manufacturing process measuring system and the results of the assessment of this measuring system done by means of the conventional method (20%).

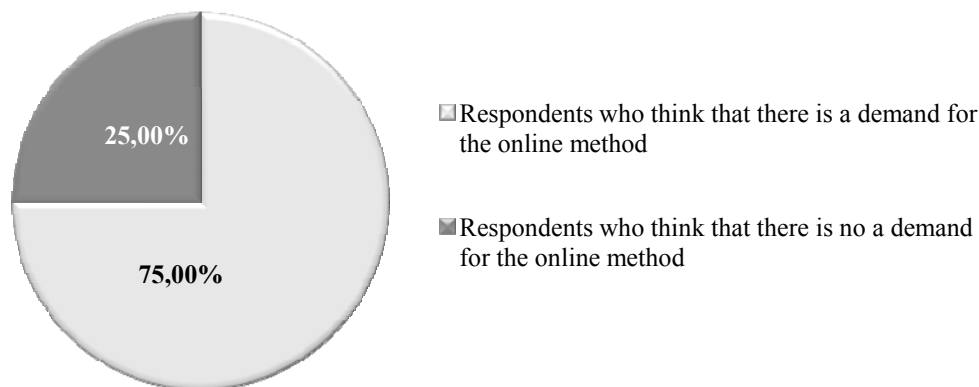


Figure 4. Respondents opinion about demand for the online method in production and measurement processes. Source: own study.

## 5. CONCLUSIONS

To sum up, despite the considerable expansion of the philosophy of Total Quality Management and the growing popularity of quality management instruments among industries, the usage of MSA methods is still unpopular among the enterprises in Great Poland. However, the majority of entrepreneurs understand that the usage of MSA is necessary for the correct course of the manufacturing process and that a company should use analysis procedures and measurement system assessment if they want to develop, improve their processes, meet growing requirements from the part of customers, and if they want to have a good, certified Quality Management System (ISO 9001 [9]). Consequently, engineers will assume the research aimed at devising the online method, i.e. the assessment of the usefulness of the measurement system on the current basis, as arguable, purposeful and useful.

## 6. REFERENCES

- [1] Aczel Amir D.: Statystyka w zarządzaniu. Wyd. PWN, Warszawa, 2005,
- [2] Diering M., Pająk E.: Measurement System Analysis - a computer aided research, in: ENBIS8, Athens, Greece, 2008,
- [3] Diering M., Pająk E.: Sterowanie jakością systemu pomiarowego, in: XI Konferencja Komputerowo Zintegrowane Zarządzanie, Polskie Towarzystwo Zarządzania Produkcją, Opole 2008,
- [4] Hague P.: Badania marketingowe. Planowanie, metodologia i ocena wyników, wyd. HELION, Gliwice, 2006,
- [5] Hamrol A.: Zarządzanie jakością z przykładami. Wyd. PWN, Warszawa, 2005,
- [6] Jednoróg A., Olejnik M., Sierżucha Z., Torczewski K.: Wykorzystanie metod i narzędzi statystycznych w polskich przedsiębiorstwach, Problemy Jakości (Quality Problems) 6/2005, p. 36 – 40,
- [7] Measurement Systems Analysis, MSA-Third Edition. (2002) - Reference manual. AIAG-Work Group, Daimler Chrysler Corporation, Ford Motor Company, General Motors Corporation, 2002,
- [8] Pajzderski P.: Dobór i nadzorowanie wyposażenia do pomiarów i monitorowania w procesach wytwarzania, praca doktorska, Politechnika Poznańska, Poznań, 2001,
- [9] PN-EN ISO 9001:2001, Systemy zarządzania jakością. Wymagania.