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USE OF QUALITY IMPROVEMENT TOOLS IN THE CROATIAN METAL PROCESSING INDUSTRY

KORIŠTENJE ALATA ZA POBOLJŠAVANJE KVALITETE U HRVATSKOJ METALOPRERAĐIVAČKOJ INDUSTRIJI

Dražen Čelar, Živko Kondić, Vinko Višnjić

Izvorni znanstveni članak

Sažetak: *Suvremena proizvodnja iziskuje svakodnevno praćenje procesa te teži njihovom kontinuiranom poboljšavanju kako bi se povećala njihova kvaliteta, a samim time i efektivnost. Alati koji se koriste su raznovrsni i njihovo korištenje trebalo bi postati svakodnevnica kako bi pomogle sudionicima procesa na svim nivoima proizvodnje od uprave do radnika u neposrednoj proizvodnji. U svrhu analize učestalosti korištenja i dokazivanju premalog korištenja alata i metoda poboljšavanja provedeno je istraživanje unutar hrvatskog metaloprerađivačkog sektora. Istraživanjem je dokazana premala učestalost korištenja alata, ali i daje neke smjernice za povećanje korištenja u budućnosti.*

Ključne riječi: *alati i metode kontinuiranog poboljšavanja, kvaliteta, proizvodnja, metaloprerađivački sektor*

Orginal scientific paper

Abstract: *Modern production requires a daily monitoring process and seeks its continuous improvement in order to increase the quality, and therefore effectiveness. There are various tools and their use should become a daily routine to help participants in the process at all levels; from management to production workers. For the purpose of analyzing the frequency of use and confirming the insufficient use of tools and methods of improvement, a research was conducted among Croatian metal processing manufacturers. The research has confirmed a low frequency of tool use, but has also provided some guidelines for increasing their use in the future.*

Key words: *tools and methods of continuous improvements, quality, production, metal processing manufacturer*

1. INTRODUCTON

The notion of continuous improvement is contained in the ISO 9001 norm that stipulates the following under Item 8.5.1: *"Continuous improvement: An organization must continually improve the efficiency of its quality management system by implementing quality policies, quality objectives, results of independent assessment /audit, data analysis, corrective and preventive actions and the management's system assessment."*

There are many improvement tools and methods. Many of them are used, although we actually do not know that they are considered to be improvement tools, but frequently, due to a lack of knowledge regarding these tools, our processes do not experience positive changes. In the previous issue of the Technical Journal we got acquainted with some of the improvement tools and the methods of their practical use. This articles aims at highlighting the fact that such tools are insufficiently used in practice, as well as at connecting their application with competitiveness of a company [1].

2. RESEARCH "USE OF QUALITY IMPROVEMENT TOOLS IN THE CROATIAN METAL PROCESSING INDUSTRY"

In order to directly connect the use of process improvement tools and methods among Croatian metal processing companies, a research was conducted on the use of quality management system, the use of improvement tools and their connection with a company's business results. The following hypotheses were made:

H1: Implementation of improvement management system and methods significantly contributes to the competitiveness of a company.

H2: Croatian metal processing companies do not use improvement management systems and methods to the extent as they should.

This research was conducted by applying the online questionnaire method. The sample included 305 Croatian metal processing companies, which is, according to data of the Croatian Bureau of Statistics, somewhat less than 5 % of the overall number of companies that deal with metal processing in any (N= 7,142 / source: CBS).

The questionnaire was of a closed type with answers already provided, and it contained 15 questions that may be divided into three groups. The first group involves general information about a company:

1. Name of company
2. Selection between a production and supply company
3. County
4. Number of employees

This group of questions aimed at identifying the companies, their territorial characteristics and their size. The second group of questions refers to the application of the ISO 9001 norm:

5. Has your company implemented the quality management system ISO 9001
6. In which year was the system implemented
7. Is there a person at your company who only deals with quality management
8. To which extent have the employees been trained regarding the system
9. Defining the usefulness of system implementation from the aspect of customer relations
10. Defining the usefulness of system implementation from the aspect of product quality

The third group of questions is about other management systems and improvement tools and methods:

11. Has your company implemented any of the management systems (norms)
12. Has your company used any of the quality control and improvement tools
13. Does your company apply any of the quality management methods (philosophies)
14. If the state / ministries / agencies decided to fund the implementation of a system or trainings in the area of management, would you take the offer
15. Evaluation of the importance of the management system implementation

According to the structural-business indicators of companies in the Republic of Croatia for 2012, 84 % of companies are qualified as micro-companies (1-10 employees), 12.2 % as small companies (10-49 employees), 3.1 % as middle-sized companies (50-249 employees) and only 0.7 % as large companies (more than 250 employees). According to the number of employees, micro-companies employ only 16.6 %, small companies 19.8 %, middle-sized companies 27.1 %, and the large ones as much as 36.5 %. According to the added value, data are almost completely opposite to the number of companies and very similar to the percentage of employees, but with a bit more influence exerted by large companies. The relations regarding the added value are as follows: 7.6 % micro, 16.6 % small, 26.4 % middle-sized and 49.3 % large companies. Relative to these data, the sample was selected among the collected questionnaires. From micro- and small companies 5 questionnaires were selected per group, while 10 questionnaires per group were selected from middle-sized and large companies, which gives a total of 30 companies.

The percentage of certified companies according to ISO 9001 in the overall number of the selected sample is shown in Figure 1. The graphical representation may indicate a very high percentage of certified companies; however, this percentage is more of an indicator of the percentage of certified companies in the overall value of the added value. When the data are divided according to the size of the economic subjects, different data are obtained.

As many as 80 % of micro-companies are not certified. Bearing in mind that they account for 84 % of the overall number of subjects, it turns out that more than two thirds of business subjects from the metal processing branch do not have the certificate for the ISO 9001 quality management system. The companies included in the sample received their certificates within a very wide time span.

Figure 1 Percentage of ISO 9001 certificates in companies involved in the research

There are even "veterans", as two companies involved in the research possess their certificates from the far 1995, while the last certificate (among the companies included in the sample) was obtained in 2012. The average length of owning the ISO 9001 certificate is shown in Figure 2.

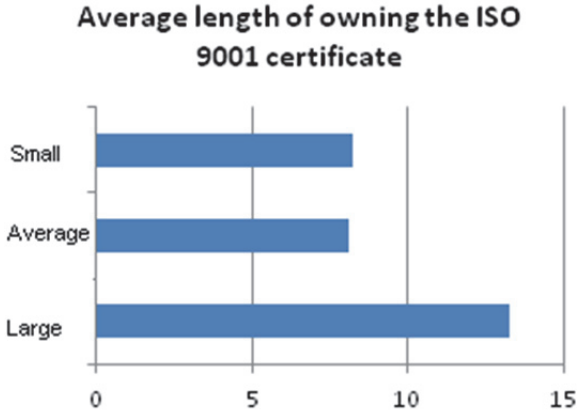

Figure 2 Average lenght of owning the ISO 9001 certificate

The following question was aimed at finding out how many companies have an employed person dealing only with quality. Among the companies included in the research 52 % have such an employee (expert); however, this information does not reflect the actual situation, as it depends on the selected sample (Figure 3).

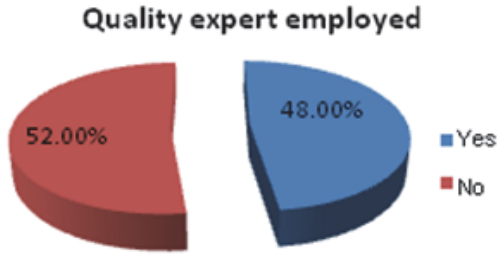

Figure 3 Quality expert employed

The actual situation is reflected by the division according to the size of companies. As 96.2 % of companies belong to the group of micro- and small companies, and 3.1 % in the group of the middle-sized companies, it turns out that 97.75 % of companies in the metal processing branch do not have an employee dealing with the quality management system. Figure 4 shows the structure of quality experts in Croatian companies.

Figure 4 Quality expert employed

The next question directly connects the employed expert and the knowledge on the ISO 9001 norm among the employees. Figure 5 shows the level of knowledge among the employees in companies certified with the ISO 9001 norm.

Figure 5 Level of knowledge / ISO 9001

Direct connection between the quality expert and the level of knowledge of other employees may be seen in Figure 6. The following question tested the correlation between the implementation of the ISO 9001 norm and the relations with business partners (customers / suppliers). Subjects were asked to use the scale from -5 to 5 in order to express their opinion on the relevance of the norm implementation for customer relations and product quality. Figure 7 shows that the companies involved in the research consider that there was a correlation between the norm implementation and improving relations with partners, but also with product quality.

Figure 6 Connection between the quality expert and the level of knowledge on the ISO

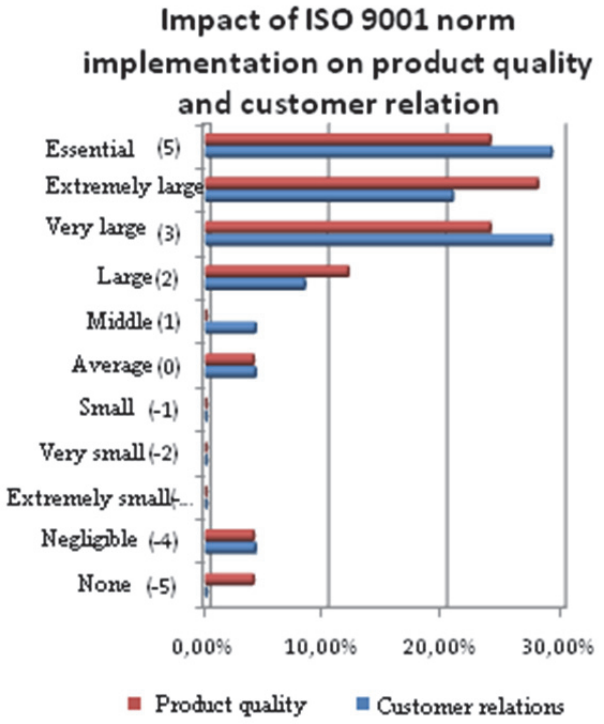

Figure 7 Impact of ISO 9001 norm implementation

The following sequence of questions referred to the implementation of other management norms. Although the question contained a large number of norms, the results showed that among many applicable norms only two more are used by the metal processing industry. Among other norms some internal ones were mentioned, as well as a few belonging to the area of welding. Figure 8 shows certificate coverage of the metal processing industry by the ISO 14001 and OHSAS 18001 norms.

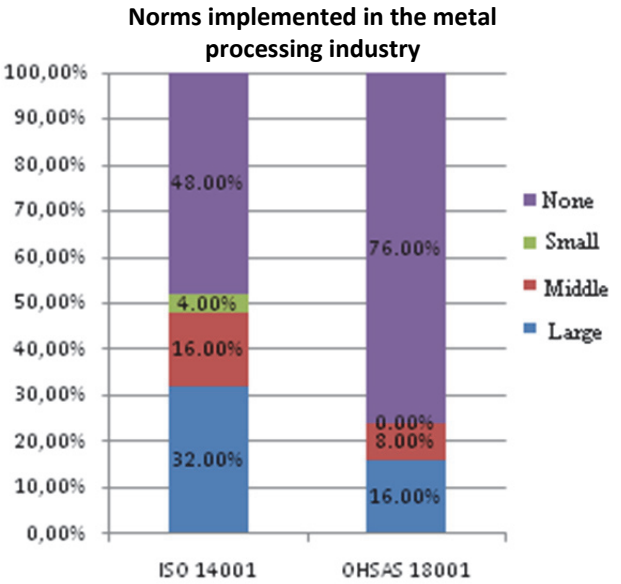

Figure 8 Norms implemented in the metal processing industry

Question 12 referred to the application of improvement tools. As shown in the graph, improvement tools are very rarely used in micro-companies. Their application refers to statistical methods of production control. New, so called management tools are not used in companies with less than 10 employees. Small subjects use the tools to a somewhat larger extent, but their application again comes down to the use of statistical tools, whereat the use of a management tool (brainstorming) was noticed. The first larger step forward in the application of improvement tools was noticed in middle-sized subjects. In middle-sized companies this mostly refers to the use statistical methods, but the application of management tools has been more frequently noticed as well. Control and test cards and flowchart are the most frequently used tools. They are used by almost 60 % of middle-sized business subjects. However, the concerning fact remains that 20 % of them use no tools.

The information that large companies use improvement tools is definitely to be praised. Tools are used more often, but the conservative use of newer tools such as the affinity diagram or matrix diagram is concerning. The frequency of improvement tools use is directly connected with the employee in charge of the quality management system.

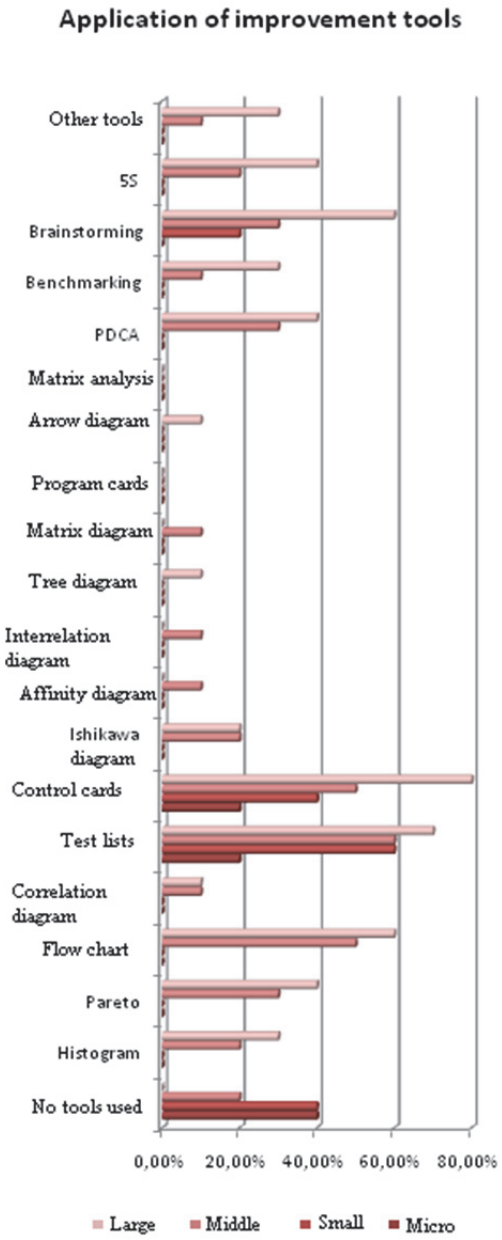

Figure 9 Application o improvement tools

Question 13 referred to the use of quality management methods. Subjects were offered the four most frequently used methods, as well as the option to add another one. In micro- and small companies there was no record of using quality management and improvement methods, while in the middle-sized companies their use remained at the low 50 %. Even 30 % of large companies use no management and improvement methods. As in the case of improvement tools, the use of these methods is also directly connected with the employee in charge of monitoring quality management. The companies that use improvement methods most commonly use Total Quality Management and Lean Production, while Six Sigma and Lean Six Sigma are less frequently used.

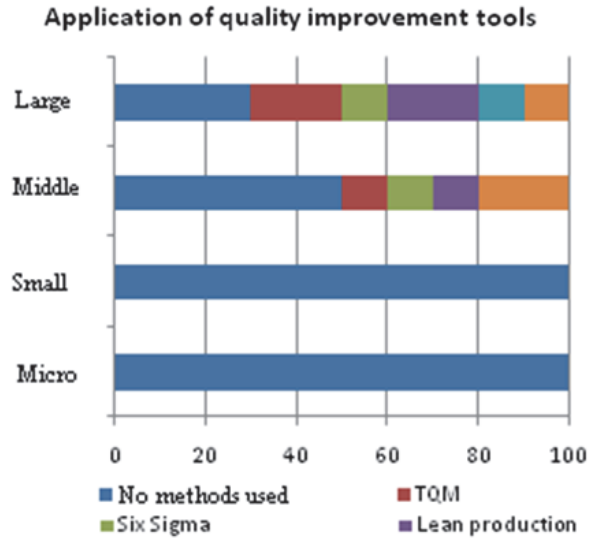

Figure 10 Application of quality improvement tools

The penultimate question referred to accepting encouragement by the state or professional associations during the implementation of a management system and improvement tools. As shown in Figure 11, the majority of companies would accept such help.

Figure 11 Would you accept help in implementing tools and a management system?

The last question referred to the perception of the importance of implementing a management system into business activities. This question was answered by all subjects, even if they have not implemented a system yet. Again it is visible that most of subjects have a positive attitude towards quality systems. The results of question 15 may be found in Figure 12.

The idea for the research was to carry out an analysis of business results. However, such results may not be obtained within the system without burdening the questionnaire with questions, which would surely lead to a very low response. Business results are available over the FINA infoBIZ system, but these data refer only to the last five years of conducting business activities. These data cannot prove a direct influence of system implementation if it did not occur within these five years, or more precisely in the middle of this five-year period. The application of these data would only be possible in companies that had implemented the system in 2011 or 2012. The questionnaire was able to show that companies that had implemented management systems managed to achieve business growth, increase in staff number, while companies that had not done this has grown much more slowly.

It was, however, possible to compare economies according to data available from the international research conducted each year by the International Standardization Organization, and data on the trends of economic indicators of each member.

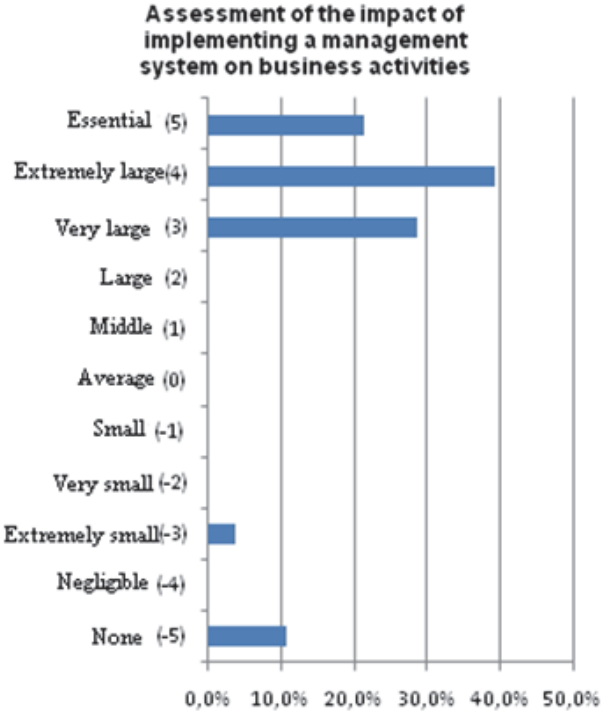

Figure 12 Assessment of the impact of implementing a management system on business activities

3. ISO 9001 SURVEY 2012 DATA ANALYSIS

As data in the ISO 9001 research for 2012 contain information for more than 180 countries, for the purpose of analyzing them more easily, eight European countries were chosen, whose economies have some features similar to the Croatian one or which the Croatian economy should tend to. From the old EU members this refers to Austria, Denmark, Finland and Portugal, and from the new members to Slovenia, Slovakia, Estonia and Romania. These economies were chosen based on the similarity in the level of development (Romania, Slovakia, Estonia), economy size (Slovenia, Slovakia, Estonia), number of inhabitants (Denmark, Slovenia, Slovakia), similarities in economy (Portugal), and Austria as an example of a relatively small European country (8 million inhabitants) with excellently developed industrial sector, especially in the area of metal processing, whose experience, due to vicinity and cultural similarities, may easily be implemented in our economy. For the purpose of comparison, data for three fast-growing global economies were taken into consideration too: Chinese, South-Korean and Brazilian.

The overall number of certified subjects increased from a bit over 46,000 in 1993 to over one 1,100,000 by the end of 2012. The development of the number of certificates is shown in Figure 13.

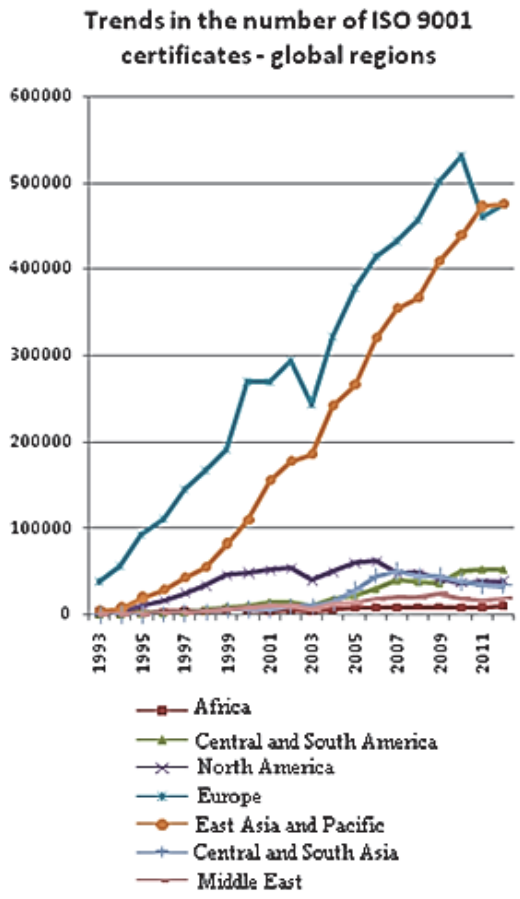

Figure 13 Trends in the number of ISO 9001 certificates – global regions

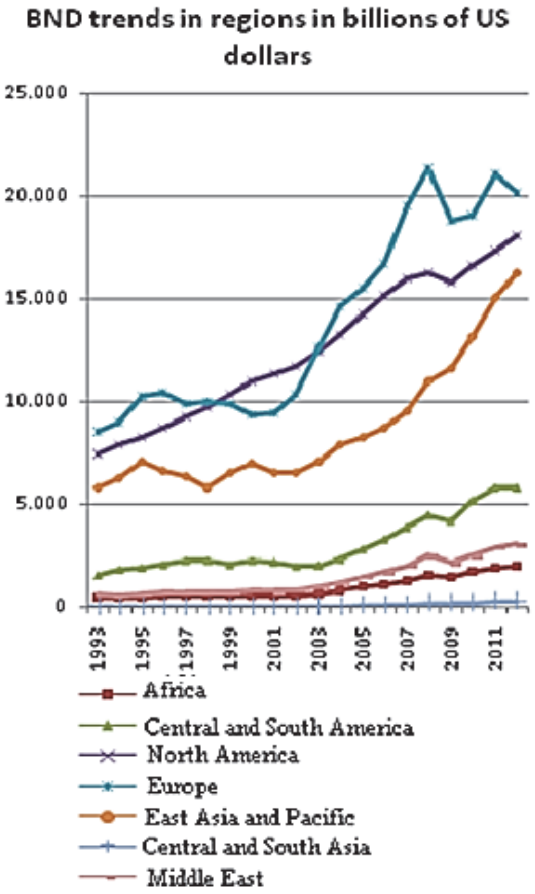

Figure 14 BND trends in regions

However, the increase in the number of certificates with respect to regions is not proportional, but it is almost identical to data on the percentage of GDI, which shows that it has been increasing for Asian countries, while it has been decreasing for European economies.

Figure 14 shows GDI per regions in billions of US dollars. It is visible that in the last 8 years Europe's GDI has remained at the same level, while Asian countries have experienced a constant growth of GDI. Therefore, the percentage of GDP in Asian countries is currently almost equal to the one in Europe, the same as the number of ISO 9001 certificates, which directly connects economy growth and the implementation of a quality management system.

Figure 15 shows the overall number of certificates and the number of certificates in the metal processing industry, while Figure 16 shows the relation of the number of metal processing companies and the relation of the number of ISO 9001 certificates of the metal processing industry against the overall number of certificates within the analyzed economy.

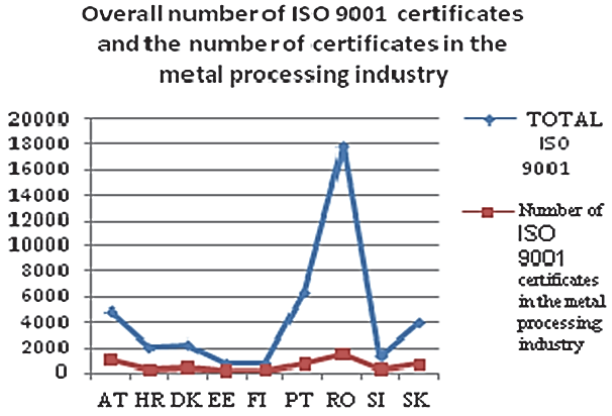

Figure 15. Overall number of ISO 9001 certificates

Figure 16 shows the defeating fact that, among the selected economies, the Croatian one has the worst relation of the number of certificates in the metal processing industry. The percentage of the number of metal processing companies in the overall number of business subjects in Austria amounts to only 2.37 %, but the percentage of the number of certificates of metal processing companies in the overall number of certified business subjects amounts to 20.35 %.

This shows that the implementation of a quality management system in the Republic of Austria is almost 10 times more frequent in this economy branch than in others. Unfortunately, data for Croatia show that the percentage of certificates in the metal processing industry amounts to 11.82 %, while the percentage of metal processing companies in the Republic of Croatia amounts to 10.33 %, i.e. the certificate implementation equals the percentage of business subjects in this economy branch and it is as much as 10 times lower than in Austria. The result is relatively worse only in Romania, which has a lower percentage of certified business subjects; however, at the same time, it is listed as one of the 10 fastest growing economies according to the number of newly certified companies.

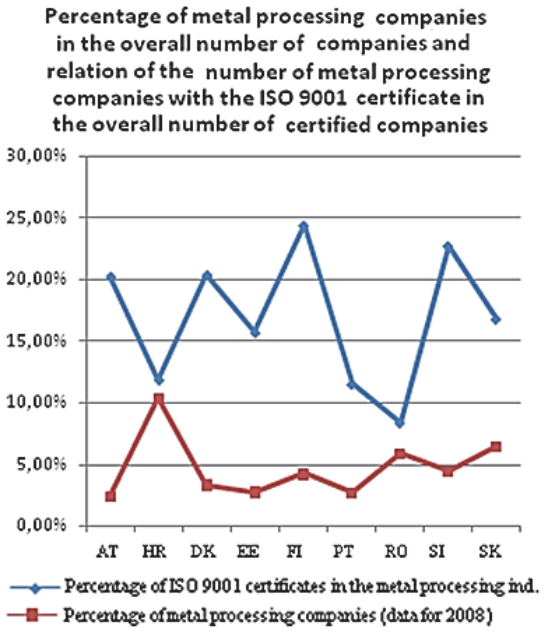

Figure 16 Percentage of metal processing companies with the ISO 9001 certificate

For the purpose of proving the research hypotheses, the $\chi 2$ test shall be used. If the first hypothesis was correct, the imbalance of empirical data with the normal distribution would be proved. Therefore, the zero hypothesis and the alternative hypothesis are made:

H0: Quality of products and services does not depend on the implementation of a quality management system

Ha: Quality of products and services depends on the implementation of a quality management system.

The significance amounts to α=0.05.

	fo	ft	fo - ft	$(fo - ft)^2$	$(fo - ft)^2 / ft$
ISO 9001 certificate HAS NOT helped in raising quality of our products or services and customer relations	5	30	-25	625	20,833333
ISO 9001 certificate HAS helped in raising quality of our products or services and customer services	55	30	25	625	20,833333
$\chi^2 = \sum \frac{(fo-ft)^2}{ft} =$	41,66666667				

Figure 17 Usefulness of ISO 9001 in raising quality

It is possible to obtain the limit value from the table:

$$\chi_0^2 = 3{,}841 < \chi^2$$

Therefore, H_0 is rejected and H_1 is proved, regarding the correlation between the quality management system and the increase in competitiveness.

For proving the second hypothesis, the graphical representation of tools usage shall be compared with the normal distribution, i.e. it shall be assumed that in the case of sufficient tools usage there is normal distribution. The questionnaire provides the option of selecting among 18 tools, and some subjects added their tools, so the number increased to 20, which will be the upper limit of possible number of used tools. Use distribution is shown in Figure 17.

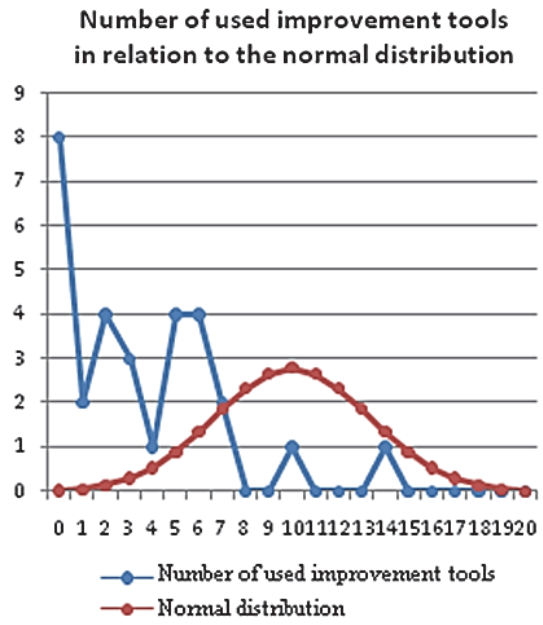

Figure 18 Number of used improvement tools

As it is visible from graphs, the second hypothesis is proved as well. In metal processing companies the number of used tools significantly differs from the expected number of improvement tools.

4. CONCLUSION

Changes that have caused dramatic quality improvement and also an increase in competitiveness of Japanese companies in the middle of the last century have changed the attitude towards quality in the rest of the world as well. Countries that used to be industrially undeveloped are production leaders at the moment, and low labor costs in these countries results in overtaking business activities from former industrial leaders. The World Bank estimations state that the GDP percentage of European countries should drop from the current 17 % to mere 9 % by the middle of this century (Figure 18), which will cause a drastic drop in industrial production and allow only the best ones to take part in it.

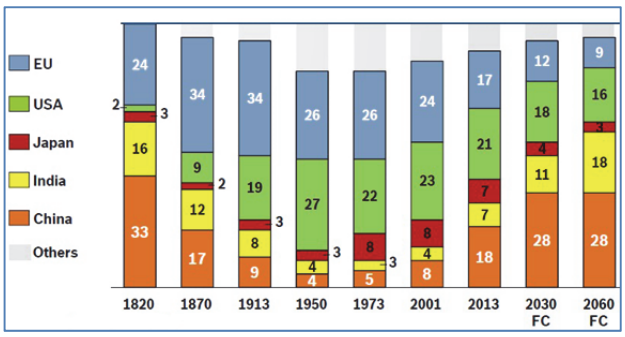

Figure 19. BND share

A reasonable step would be complete quality upgrading of Croatian companies. Unfortunately, our economy system does not involve gurus like Deming, Juran or Crosby, so perhaps it is possible to find

solutions through some of the suggested solutions or assigned roles.

Role of public institutions. On October 25, 2013 the Croatian Parliament passed "The Strategy of Entrepreneurship Development of the Republic of Croatia 2013 – 2020". In the introductory part the fundamental development guidelines are mentioned: "*Achieving the Strategy objectives shall contribute to the realization of the small economy vision that is to be achieved in the future and may be described as: competitive and equally developed small economy in Croatia based on a growing number of successful business subjects, continual export growth, high level of innovations, high level of quality regarding the educated, flexible management, innovative production process, convenient business environment and easy access to financial and other instruments for the purpose of sustaining convenient growth rates and achieving the highest EU standards."* In the text itself the word quality is used 25 times, but in our humble opinion each time it is mentioned in a mostly declarative form. In item 5.3 Access to realization of strategic objectives, among strategic objectives of the 1. type the following is stated: "Providing support to companies in the application of technical norms and quality systems". However, the project of co-funding the development of Croatian entrepreneurs "Entrepreneurship Impulse 2014" supports the co-funding of the implementation of a quality management system only as additional project activities. The state should allow for 100 % funding of the implementation of the quality management system via the Ministry of Entrepreneurship and in this way allow for faster development of quality. As the implementation should not serve as its own purpose, a quality monitoring of the implementation should be set up as well.

Role of the Croatian Chamber of Economy. Croatian Chamber of Economy should via its Quality Department become a training center for quality management and help micro-, small and smaller middle-sized companies that cannot employ a quality manager by constantly training them on quality procedures. This would simplify the implementation of norms, methods and tools in the Croatian industrial sector. Constant publication of educative brochures with examples of improvements and a seminar program aimed at raising consciousness among employees of industrial companies on the importance of quality control and its improvements, would increase the competitiveness of the Croatian economy. Of course, these activities should be free of charge and in acceptable periods, so that regular daily activities of companies are not obstructed in any way. As a good example the training program "Corporate social responsibility" may be mentioned, which was carried out by the Central European Initiative (Central European Initiative-CEI) via online programs, presentations and video materials.

The second important role of the Croatian Chamber of Economy should be setting up the Croatian prize for quality. The Chamber has set up a prize for business results, which are indicators of quality, but it does not encourage the implementation of quality methods, tools and norms as one of the essential elements on the way towards achieving business results. Such national prize is present in most of European industrially developed countries, while awarding the American prize Malcolm Baldrige National Quality Award (MBNQA) is considered as a first-class social event in the USA.

Role of the education process. The last and one of the most important elements is the Croatian education system. One of the authors has for years participated in the work of a company that has adopted the Austrian model of training future employees. Children, future employees, regularly enter production with no knowledge on quality, systems, tools, methods… Implementation of a training program on quality into one of the professional subjects in the high school education (production organization, work studies, measurements, economy…) would significantly increase the consciousness of workers regarding its importance in production processes.

The implementation of these three frameworks would significantly raise consciousness on quality as a vital factor in company competitiveness. Regardless of the level of technological processes, ranging from common welding processes or highly sophisticated processes, quality processes will gain a significant advantage in closing deals.

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Authors contact:

Dražen Čelar
Kostwein proizvodnja strojeva d.o.o.
Pavleka Miškine 65, Varaždin
095 902 3224

Izv. prof. dr. sc. Vinko Višnjić.
Sveučilište Sjever
Sveučilišni centar Varaždin
104. brigade 3
42000 Varaždin
e-mail: vinko.visnjic@unin.hr

dr.sc. Živko Kondić, izv.profesor
Sveučilište Sjever
Sveučilišni centar Varaždin